

Monique Frize



Laura Bassi and Science in 18th Century Europe

The Extraordinary Life and Role of
Italy's Pioneering Female Professor

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In memory of Gabriella Berti Logan

Preface

I met Gabriella Logan for the first time in the late 1980s, when she took my undergraduate women's history class. As an older student with steel grey hair and a habit of peppering the instructor with questions, she did not go unnoticed. She approached me shortly afterwards with her plans for a master's research paper: a study of a woman who became a professor of experimental physics at the University of Bologna in the late eighteenth century. Laura Bassi was first given an honorary lecturer position in 1732, but she was appointed to the Chair in Experimental Physics in 1776, over her husband who was a physician with some interest in experimental physics; he became her assistant until her death in 1778. This was certainly an attention grabber—I knew about eighteenth century high-level female scientists (mostly French ones like the marquise du Châtelet), but those were elite women who preferred spending their spare time stargazing or conducting experiments in their own laboratories than to pursue intrigues at Court—and their activities were not very different from the ones of men of their rank who also engaged in science: they were not professionals.

Gabriella still had family in Bologna and this allowed her to use the Bassi Veratti family papers at the city's library (Biblioteca Comunale de'II Archiginnasio), the first researcher to do so as evidenced by the list of patrons who took out the material, as well as in other local archives. She was also unusually well-equipped to handle such a project as she was fluent in Italian, had a Bachelor of Science, and could read Latin with ease. She was thus able to read the eighteenth century scientific literature (normally written in Latin) and understand the content and the way it fitted into contemporary scientific development. Scientists who know Latin and Latinists who understand sciences are a rarity nowadays. Gabriella was this rarity and a good historian who knew how to ferret information in obscure archives or hidden corners of better known ones.

This allowed her to produce a first rate master's research paper which was published in the prestigious *American Historical Review*. She then segued into a Ph.D. thesis on Italian women in science from the Renaissance to the nineteenth century. Unfortunately, Gabriella was stricken by cancer and lost that battle before she could disseminate her findings through scholarly articles and possibly a book which would have been accessible to a larger public. (One can however access the

dissertation through the Canadian National Library at http://www.nlc-bnc.ca/obj/s4/f2/dsk1/tape9/PQDD_0018/NQ46531.pdf). Italian women of science stood a great risk of relapsing into obscurity.

I was therefore quite excited when Monique Frize contacted me to explain that she wanted to make the results of Gabriella's work accessible to a wider audience. Monique began with Laura Bassi, a woman who fascinated her, perhaps because they shared at least one thing in common: both had been pioneers. Coming out of Convent school in 1959, 17-year-old Monique enrolled at the University of Ottawa to study general science, alongside 7 other young women in a class of 150 students. By Christmas, she was one of two females left in the programme. She did not intend to become a school science teacher, as many probably assumed. By the end of her second year, she had discovered engineering through a student in the field. As far as the university administration was concerned, however, engineering was not a woman's place. Why did she not want to study chemistry, for instance? Wasn't chemistry akin to cooking, something girls are naturally good at? Despite official scepticism, Monique received her BASc in Electrical Engineering in 1966, the first woman in that field to graduate from the University of Ottawa.

After an extensive career in biomedical engineering and several advanced degrees, including a Ph.D. from Erasmus Universiteit in Rotterdam, Monique was appointed Professor in the Electrical Engineering Department and first holder of the Northern Telecom/NSERC (Natural Science and Engineering Research Council) Chair for women in engineering at University of New Brunswick in 1989. This was followed with an appointment as holder of the NSERC/Nortel Chair for women in Science and Engineering for Ontario (1997–2002). In both positions, her mandate was to encourage young women to study science and engineering. The writing and publication of *The Bold and the Brave: A History of Women in Science and Engineering* (University of Ottawa Press, 2009) was the last step she took to share what she had learned with everyone. Monique's first encounter with Bassi was during the research for her book: she came across Londa Schiebinger's book *The Mind has no Sex?* where Bassi is mentioned, and this in turn led her to Gabriella's thesis, done at no other place than one of the institutions where she finished her career.

Bassi deserves a prominent place in the history of female scientists. First, of course, is for her professorship in experimental physics. A few other women had been given a lectureship at northern Italian universities, but the positions were purely honorific: they were not expected to teach or even to do research. Bassi had been given a similar appointment in 1732, immediately after being awarded a Doctor's degree by the University of Bologna. In return for her title and honorarium, she was only expected to deliver public lectures when asked, and not to teach students on a regular basis. Nonetheless, she did, mostly in a private capacity in her home. Bassi thus had been an active lecturer before her appointment, and continued teaching afterwards. Secondly, her contributions to science, especially the science of electricity then in its infancy, were significant. In her day, Bassi achieved the same level of notoriety as Volta or Galvani, but while historians still remember these two men today, Bassi fell into obscurity shortly after her death,

even though she had presented original papers at the Academy every year and made some significant discoveries.

Finally, Bassi was also an independent minded woman, who seized opportunities offered to her, and bent them to her own goals. As a bright adolescent whose talents were recognized early by her tutor, she was only expected to bring prestige to her city through the public display of her talents. The city's elite reasoning was straightforward: they believed, like their contemporaries, that women are by nature less intelligent than men; the presence of exceptionally bright women in a community was therefore proof that the men of the said community had to be superlatively gifted. Like all "exceptional" women who had preceded her, Bassi was displayed through elaborately choreographed ceremonies, including her public lectures, and expected to produce on command pieces of literature to commemorate or celebrate civic events for important city denizens and families. She was expected to remain celibate, thus be available to perform this role, or return to obscurity should she choose to marry. But Bassi wanted to be an active scientist, not some civic decoration, and to do so, she came to the conclusion that she had to marry to escape the restrictions placed on single women's association with men. This also meant finding a husband who shared her interests, who did not expect her to abandon science for housekeeping, and who would not take umbrage of her celebrity status. She found him in Giuseppe Veratti. The couple set up a laboratory in their home and tutored students for 30 years, building a reputation that justified her eventual appointment to a professorship. Groomed to be an old style "exceptional" woman whose activities were subordinated to civic needs and politics, Bassi seized the opportunity her status offered to become a genuine and modern scientist—and an early career woman. She proved that women had agency, and could use it to their own end. She also created a precedent which the Italians, proud of their 'exceptional women', should not forget.

April 3, 2013

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My deepest thanks go to Béatrice Craig who gave me a copy of Gabriella Berti Logan's Master's Memoir, a copy of her over 700 page doctoral dissertation, and encouraged me to write the book. Dr. Craig read the manuscript in depth and provided excellent suggestions regarding historical accuracy, the importance of chronology, and ideas on the organization of the manuscript. I am most grateful for her patience and her vast historical experience. Another person who contributed ideas and historical information, and whose friendship I cherish, is Professor Marta Cavazza at the University of Bologna.

I take the opportunity to thank my husband Peter Frize who read several drafts patiently and offered excellent editing advice. I also thank Cristina Trevisan at Carleton University who checked my summary of the Italian letters and provided a summary for some of the others. I am grateful to Maria Grazia Bollini, librarian at the Biblioteca dell' Archiginnasio in the Sala dei manoscritti e dei rari, who guided me through the complicated process of visualizing the rare and precious documents of the Bassi-Veratti family in a most efficient and pleasant manner. It was an amazing feeling to look at and touch (with gloves) the certificates and papers that had belonged to Laura Bassi. My sincere thanks are also for Dr. Cristina Bersani who arranged the transfer of illustrations from the Archiginnasio, and to Dr. Elizabetta Ariotti at the Archivio di Stato di Bologna. I owe much gratitude to Dr. Caterina Cinti at the Bononia University Press for the permission to use the beautiful illustration for the cover of this book. I am also very grateful for the assistance I received from the librarians at Carleton University, to obtain the rare documents I needed to write the book; in particular, I personally thank Janet Hempstead and Christine Taylor for their help! I truly hope all readers of this book will enjoy discovering Laura Bassi as much as I have!

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Introduction

My inspiration for writing this book first appeared when I discovered how unique Italy had been in the eighteenth century, especially when I read a short piece on Laura Bassi in Londa Schiebinger's *The Mind has no Sex?* (Schiebinger 1989). But the most important information on Bassi came from Gabriella Berti Logan who I met when I came to Ottawa as a Visiting Professor from the University of New Brunswick for 10 months during my sabbatical leave (1996–1997). Gabriella, formerly a graduate in science, had completed a Master's degree in History at the University of Ottawa in 1991; her memoir was titled: *Laura Bassi Verati: An Eighteenth-Century Humanist Turned Professional Scientist* (Logan 1991). She then worked on her doctoral thesis, also in the History Department at the University of Ottawa. The topic of her Ph.D. dissertation, completed on 14 October 1999, was titled: *Italian Women in Science from the Renaissance to the Nineteenth Century* (Logan 1999). Gabriella Berti Logan also published articles on her two dissertations. Unfortunately, after a long and exceptionally courageous battle with cancer, Gabriella passed away on 6 November 2009, at the age of 62. It is my fervent wish that she be remembered for the amazing quality and depth of her research on the topic of women in science, leading us to discover the especially interesting circumstances of women in Italy, several of whom were quite famous in their day, but have largely been ignored by historians after their death. This contrasts greatly with the memory kept alive of several men who lived in her era such as Luigi Galvani and Alessandro Volta. Everyone around me who I queried about their knowledge of scientists of the period could recall the names of the men mentioned above, but none could say they had heard about Laura Maria Caterina Bassi-Veratti.

While working on her two theses, Gabriella Berti Logan visited no less than 25 Archival Centres and Libraries in Italy and found many primary sources for her studies. She also read countless books on the topic of women in science. I wish I had met her more than once to discuss these fascinating findings. But when we met, the responsibility of the Academic Chair I held on women in engineering and science was focused on contemporary issues in Canada, which was far from the situation in Italy and Europe and earlier historical periods. It was later, between

2001 and 2009, when I wrote the book, *The Bold and the Brave: A History of Women in Science and Engineering* published in 2009 by the University of Ottawa Press (Frize 2009), that I discovered how different Italy was from the rest of the world in the eighteenth century for women in science. I devoted a few pages on Italy in my first book with the intention of writing an entire book on the Italian experience. My first book provides information about the views of the intellectual abilities of women throughout the ages and how this impacted on the poor education offered to girls in all ages until late in the nineteenth century.

I thank Gabriella Berti Logan for all the rich information she left us to work with. This new book would not have been possible without access to Gabriella's Master's Memoire, her articles, and her doctoral dissertation. Although I cite others who wrote on some of the aspects of the story, much of the material has come from Gabriella's research and publications. I also wish to thank Béatrice Craig, a professor of History at the University of Ottawa, who supervised the two theses of Gabriella and who provided excellent ideas to make the book more pertinent, interesting, and accurate. It is my hope that everyone who reads this book will remember Gabriella and the story she inspired me to write on Laura Bassi and on other wonderful women in science and mathematics in Italy.

This book reads as a story, but references are included for readers who wish to go more deeply into the subject. Historians have found important documents, letters, and other materials that inform us about Laura Bassi, her life, and her work. Among the principal sources I found, in addition to the writings of Gabriella Berti Logan, are articles by Marta Cavazza on Italian women in science in the eighteenth century, Paula Findlen's articles, as well as the inventory made by Patrizia Busi of the papers of the Bassi-Veratti family in the archives of the Biblioteca Comunale dell'Archiginnasio at the University of Bologna. Some biographical information about Laura Bassi can be found between the time Laura Bassi was born in 1711 and today. A main source remains the *Elogio de la dottoressa Laura Maria Caterina Bassi Verati* by Fantuzzi (1778) in Italian, which includes the oration by Matteo Bazzani in Latin. This source provides facts, events, names of participants, but does not include many details on Laura Bassi's work and how it connected to the life of the Bolognese.

Ottawa, April 2013

Monique Frize

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Chapter 1

An Extraordinary Event in 1732

It was April 17, 1732 and a very special day in the Papal City State of Bologna. The event attracted an enormous crowd gathered in the Sala degli Anziani of the Palazzo Pubblico, the residence of the gonfaloniere Filippo Aldrovandi, Head of the Senate, the City's governing body. Many of the leading authorities of the City of Bologna and of its University were present: the Vice-Legate, the Cardinal Legate Girolamo Grimaldi, the Archbishop Prospero Lambertini, the Cardinal Melchiorre de Polignac, representative of the King of France (Louis XV) at the Holy See visiting Bologna while travelling from Rome to Paris. Also in attendance were senators, women and men from the nobility, priests, professors, and lecturers. A large audience of citizens, who sometimes could be rowdy, was allowed to attend (Fantuzzi 1778, 6–7; Cenerelli 1885, 15).

All had gathered to witness the defense of a series of Theses which, if successful, would earn the candidate a degree of doctor of philosophy. This particular candidate was about to defend 49 Theses, six of which were on logic, sixteen on metaphysics, nine on topics related to the nature of Being, Reason, God, and the Angels, also the nature of the mind and of the soul, which today would be related to the nature of the brain. The largest number, 18, were on physics; they included topics such as the nature of matter, motion, and meteors (Logan 1994, 90).

Eighteenth century Theses were not pieces of original research as they are now, but answers and a discussion on a set of questions the candidate prepared ahead of time. The candidate first produced written responses in Latin to the questions posed by the professors, which were then read by a committee, and finally defended orally. This particular examination was quite out of the ordinary. Students normally defended their Thesis at the university in the presence of the teaching staff, definitely not in the presence of such a large and prestigious public as was the case on this day. The uniqueness of this event is explained by the fact that the candidate was not a young man, as we would expect, but a young woman, 20 year old Laura Bassi. The other surprising fact is that Laura was not of the nobility. Unlike Elena Lucrezia Cornaro Piscopia, daughter of a nobleman's family in Venice and the first woman in the world to be awarded a doctorate in Padua in 1678, Laura was the daughter of a Bolognese lawyer of modest means. Because of her sex, Laura had to perform in a very public manner in order to

obtain recognition of her abilities and knowledge. Laura Bassi was already a local celebrity and famous for her intelligence, so the choice of this candidate was bound to be successful. On March 20, 1732, 3 weeks before her defense, Laura was invited to join the Academy of Sciences of Bologna as a member. This honour had been bestowed upon Laura Bassi in recognition of her extraordinary talent, which had been displayed on numerous occasions through disputations on science and philosophy at her home in front of powerful and eminent men (Cenerelli 1885, 14; Logan 1991, 13).

One may wonder why this extraordinary event happened in Bologna. The City of Bologna was part of the Papal States and the second city after Rome at the beginning of the sixteenth century. It was governed by the representative of the Pope (the Cardinal Legate), and by the Senate composed of the City's aristocracy. The University of Bologna, founded in 1088 and believed to be the oldest in Europe, had been quite prestigious in the Middle Ages and the Renaissance. However, during the seventeenth century, the prestige of both the City of Bologna and of its University was in serious decline. Both were therefore in need of reinvention to retrieve their previous glory and status (Cavazza 2009, 280). The City authorities had a plan: they would hold a highly public defense with a brilliant candidate. This would result in great fame for the candidate, but more importantly for the University and the City. The choice of a female candidate was so unusual and unique that it was sure to capture attention, not only in Bologna, but elsewhere in the Italian Peninsula, and even in Europe. The rarity of finding so much knowledge in a woman was bound to create awe and excitement at the planned public demonstration (Fantuzzi 1778, 6).

The entire day was orchestrated to the minutest details: The dress that Laura would wear, the use of the gala carriage of the gonfanoliere to carry her to the great hall, the choice of two ladies to escort her: the Countess Ranuzzi and the Marquioness Ratta. The order of the interventions, the discourses, and the thanks were also pre-arranged (Fantuzzi 1778, 8).

Laura was questioned by seven examiners, of which five were regular lecturers and two were professors: Doctor Iacopo Bartolomeo Beccari, professor of physics at the Institute of Science, and Doctor Gabriello Manfredi, mathematician at the Institute (Fantuzzi 1778, 6; Logan 1991, 13). As expected, Laura's rare talent and brilliance in fields of knowledge mainly tackled by men were displayed with much grace, naturalness, and without arrogance, qualities that were profoundly admired in her (Fantuzzi 1778, 7).

The plan succeeded and Laura was granted the degree in grand pomp. Following the defense, Laura was taken to the Sala d'Ercole where she was proclaimed Doctor in philosophy by the Chancellor of the Studium (University), Alessandro Formagliari, and by the President of the College of Philosophy and of the Institute of Sciences of Bologna, Dr. Matteo Bazzani, who conferred the degree upon her. Bazzani gave Laura the symbols of her degree: a book, a silver crown of laurels, a ring, and an ermine mantle. The silver jewel-encrusted crown of laurels, a gift of the Countess Ranuzzi, replaced the traditional beret of male graduates. Matteo Bazzani delivered an oration in Latin, praising the new graduate

for the display of such talent and compared Laura to famous Greek and Roman women. (Cenerelli 1885, 18–19). After the ceremony, Laura and eminent women were taken in the gonfaloniere's carriage, accompanied by numerous carriages through the City of Bologna, to the applause of people all along the way (Fantuzzi 1778, 8–9). They all gathered in the apartments of the cardinal legate where a great crowd enjoyed plentiful refreshments (Cavazza and Bertucci, Classics Online).

Bologna could talk of nothing else. The ceremony had diverged in several important ways from the usual form used for male students. Laura received her degree without having to pay the regular fees or offer presents and banquets that candidates usually gave their professors and patrons. Rather than the student providing gifts, she was herself the recipient of lavish presents: A medal was struck for the occasion and poems written in her honor. Three official miniatures were commissioned by the Senate to memorialize the most important event of 1732 (Cavazza 2009, 283).

The next day, the Marquess Ferdinando Monti held a splendid banquet where the eminent Cardinal Polignac had the opportunity to meet Laura. The prompt and ingenious answers to the arguments made by the young woman that evening impressed the guests and reminded them of dinners in ancient Greece or of conversations in Ancient Rome (Fantuzzi 1778, 9).

The city's elite took several steps to ensure her fame would spread. On May 12, 1732, Laura Bassi was again in the public eye, attending a ceremony that formally conferred on her the Doctoral Degree in Philosophy. This was again in the presence of many members of the elite that included Cardinal Polignac. On this occasion, three volumes of poetry were published in her honor. They included works by Francesco Algarotti, Giampietro Zanotti, Flaminio Scarselli, and Marquioness Bianca Sacrati (Elena 1991, 511).

A final ceremony was held at the Archiginnasio, the seat of the University, on June 27, 1732. This time, Laura Bassi had to defend twelve additional Theses, on the nature of water as a natural element and as a part of the universe. The plan was to encourage the University to give Laura a *Cattedra* (a lecturer position), but to obtain this position, Laura would have to go through another public defense. The arguments were posed by five famous public lecturers at the university: Doctors Matteo Bazzani, Marc' Antonio Laurenti; Antonio Stancari, Gaspare Lapi, and Antonio Felice Fantini. The room was again filled with government officials, university professors, the Cardinal Legate, Cardinal Lambertini, and attended by Andrea Toschi (from Imola), prior of the College of Artists, University presidents Francesco Mazzanti (from Forlì) and Gioseffo Plessi (from Modena), the Gonfaloniere, the Podestà, and the Anziani (elderly members of the College) (Cenerelli 1885, 19). The five professors would later accompany Laura at her lecture at the university on October 20, 1732. It was on her birthday, October 29, 1732, that the university appointed Laura formally as lecturer with an annual stipend of 500 lire (Fantuzzi 1778, 10–11).

A silver and pewter medal was created on the occasion of Laura's first official lecture (after her appointment) at the Archiginnasio at the University of Bologna on December 18, 1732. This was the work of the Bologna sculptor and jeweller

Antonio Lazzari. On the back, there was a bust of Laura Bassi with the symbols of her graduate status (crown of laurel and ermine) and a text in Latin with her name, her title of collegiate doctor, her public readership, her membership of the Institute of Sciences, her age (20), and the date. On the front we find a young woman (Laura Bassi herself) with a large book under her arm, the laurel crown in her other hand, and a map of the world at her feet, a symbol of natural philosophy. This was surmounted by a little owl watching Minerva, who is handing Laura a lantern and is brandishing her shield with the Gorgon. Around all this we find the Latin text dedicating the medal “to the only one who was allowed to see Minerva”, i.e. to the only woman who had been able to access knowledge (Cavazza 2009, 283; Busi 2001, 296–297).

Laura Bassi’s Growing Fame as a Prodigy

Before the defense of her forty-nine Theses in 1732, Laura had been demonstrating her great talent and knowledge through disputations in her home on many topics in the presence of important men. Some of these men were Members of the Academy of Sciences of Bologna, such as Beccari, Bazzani, Manfredi, and Balbi whom we meet later when discussing Laura Bassi’s career and correspondence. One of the most eminent men who attended these soirées was Cardinal Prospero Lambertini, the future Pope Benedict XIV. All were extremely impressed by the knowledge and disputing skills of this young woman (Cenerelli 1885, 14).

Laura’s fame grew, not only within the City of Bologna, its Academy, and University, but spread to many other parts of Europe. Throughout her life, Laura corresponded with philosophers, writers, and scientists, and received many letters from them. The correspondence includes discussions on various topics in science. A few letters appeal for help from her supporters and patrons to eliminate some of the obstacles put in the way and enable her to perform her professional duties of teaching and research.

Factors that Led to the Extraordinary Event of 1732

This extraordinary event in the *settecento* (eighteenth century) raises many questions: Why was Laura Bassi given this opportunity more than 100 years before women in general were being admitted to university? Why did the Bolognese elite and the Churchmen believe this display of knowledge was not only acceptable, but would benefit the city and its university?

It is evident that there was a political purpose behind the public ceremonies described above. In Bologna, the knowledge of a young woman was celebrated and rewarded with titles and honors that throughout Europe had been reserved exclusively for men. Was it because a new view arose in eighteenth-century Italy

that would allow all women to be highly educated? Or was it a way to uphold the principle that women like Laura were exceptional, thus reinforcing the view that an extensive education could only be the preserve of men and of a small number of women carefully chosen? Would this not maintain the status quo regarding the education of all women, as the example of the University of Padua confirms? After Elena Cornaro Piscopia was awarded her degree in 1678, the University of Padua enacted a rule that lasted for 200 years, refusing to award any more degrees to women.

There was another reason why the City of Bologna, its university, and Church authorities supported the very public events in Laura Bassi's case. Over the past couple of centuries, Italians had come to believe that some women were 'exceptional', that they had abilities beyond what was normally found in other women, and their existence reflected favourably on their family and their community. Exceptional women broke away from the inferiority that was believed to be the norm for women. These women usually belonged to the ruling families, urban aristocracy, or the professional elite. They received instruction in Latin, often in Greek, history and philosophy, and would be familiar with the Roman and Greek classic literature.

But the promoters of the events of 1732 in Bologna did not intend to extend the access to learning and to educational institutions to women in general. On the contrary, they stressed the unique nature of the Bolognese example which had managed to attract the attention of cultured Europe through a sensational event, adding some renewed gloss on the fame of the city and its ancient university. The young Laura was the instrument of a plan thought up and carried out by teachers, senators, and prelates, all male patriarchal authorities. During all of Laura's youth, her father had invited several important men to his house to hear Laura's disputations, and this certainly contributed to her growing fame as a prodigy. The result was also extremely positive for Laura's future.

Women had varied success in obtaining a degree and recognition, and politics played a role in their success or lack thereof. In 1722, 10 years before Laura Bassi's defense and degree, the case of Maria Delfini Dosi, also in Bologna, turned out quite differently than for Laura Bassi, in spite of the public spectacles organized by her father, Count Delfini Dosi. In 1722, Maria Vittoria Delfini Dosi defended theses in Law in the prestigious Collegio di Spagna in the presence of Queen Elisabetta Farnese. An engraving by Domenico Fratta showed the young woman supported by Felsina Minerva who personified wisdom and learning. The defense was accompanied by parades of carriages, lunches, gifts for people, and the publication of a book of celebratory poems and a volume on the university degree obtained by Bittisia Gozzadini (1209–1261). These activities were all promoted by Maria Vittoria's father, Count Delfini Dosi. In spite of all this display, the Count lost the battle to obtain a university degree from the College of Jurisprudence for his daughter. In reality, the objectives of Count Dosi had been to reinforce client ties of his important family with the ruling class in Bologna (Cavazza 2009, 281–283).

No matter how successfully women defended their Theses, it was the authorities who decided which woman would be recognized and admitted into their male bastion and which would not. There was political reasoning behind the choices, likely focused on who could bring the most fame and status back to the city and its university to reverse the decline that both had witnessed in the past 100 years or so.

Since the founding of the University of Bologna in 1088, the oldest in the world, a few other women had obtained a degree and a few women were said to have taught occasionally at the university. Edwards mentions that Bittisia Gozzadini (1209–1261) is said to have received a degree in law and philosophy in 1237 and to have taught from time to time at the University of Bologna. Edwards also suggests that Novella Calderini gave some lectures on Law in Bologna, replacing her husband when he was away in service to the papal curia (Edwards 2002, 9). Logan also mentions Gozzadini's degree (Logan 1994, 790).

It is difficult to know what is factual and what is not with regards to early examples of educated women, as they became semi-legendary with time. Cavazza notes that the lawyer Alessandro Macchiavelli, author of a work titled *Bitisia Gozzadina seu de Mulierum Doctoratu* (1722), published under his brother Carlo Antonio's name, cited medieval precedents for women graduates and/or teachers at the ancient University of Bologna. His main example was Bittisia Gozzadini, whose degree in law, he noted, was backed up by documentary proofs. But it is possible that the documentary proofs were false and perhaps even forged by him (Cavazza 2009, 281). Falsehoods and myths are easily propagated from one author to another over many centuries.

However, in spite of the controversy regarding Gozzadini, there are other examples of women involved in science or mathematics in earlier times: Laura Ceretta (1469–1499) studied mathematics and astronomy and made astronomical observations with her uncle. Olimpia Fulvia Morati (1526–1555) was educated on natural philosophy, and Margherita Sarrocchi Birago (1560–1617) had extensive knowledge of geometry in addition to natural philosophy (Logan 1994, 789–790).

In conclusion, the success of Laura Bassi's defense and obtention of a degree was quite different from Maria Vittoria Dosi's case. One reason could be that Dosi's father was so obviously seeking his own fortune and fame. Another reason could be that Maria Vittoria may not have been displaying her knowledge in front of eminent men for several months prior to her formal defense and so she may have been completely unknown to them. In Laura's case, the previous knowledge by important men of her talent, many months before her defense, seems to have been a determining factor for her success. Several of these men had strongly supported her nomination to become a member of the Bolognese Academy of Sciences, which was an excellent step just prior to a defense carried-out in the presence of many of the same men.

The next chapter presents debates on the question of the education of women in the Italian Peninsula. This is followed by a chapter on women in science and medicine prior to the eighteenth century. In the following chapter, we meet Laura and her family.

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Chapter 2

‘Querelle des femmes’ and Debates on the ‘Woman Question’

This chapter presents two major formal debates which occurred in the Italian Peninsula: The first debate arose through written publications, beginning with Giuseppe Passi’s outrageous views in a 1599 article, and Lucrezia Marinelli’s response. The articles were published between 1599 and 1645. The second debate was in the form of public presentations made by Giovanni Volpi and Guglielmo Camposampiero, in 1723, at the Accademia dei Ricovrati in Padua. This second debate was followed by a publication some years later that included the voice of two women: Aretafila Savini de’ Rossi and Maria Gaetana Agnesi. Before presenting these two debates, the chapter begins with an examination of several centuries of writings by men and women in the Italian Peninsula on the ‘woman question’; the key points address how each writer viewed the importance and type of education women should receive and women’s role in society.

Throughout the ages, Italians were as inclined as the rest of Western Europe to view women as less capable, less rational, and less able to govern themselves than men. This destined women to spend their lives within the confine of the domestic space, raising children, taking care of the household, and helping their husband in his activities. But during the Renaissance (fourteenth century) Italians began to assimilate the concept of the ‘exceptional woman’ into their culture. The term referred to a woman who transcended the weaknesses of her sex and was more like a man than like a woman. The notion that some women could make themselves like men was partly the result of the culture of competitiveness in Italian society. The Italian Peninsula was divided into a dozen or so States, some of which were republics governed by a small group of leading families, while others were principalities or dukedoms ruled by a family with a short pedigree; their ancestors had conquered the territory and turned it into a Sovereign State. Or, like the Medici, they were a leading family of bankers gaining hereditary control of the State; later the Medici became the Dukes of Tuscany. The Pope controlled a large section of territory in the central part of the peninsula called the Papal Estates which included Bologna in some periods. The States and the families ruling them competed with each other for pre-eminence. Competition was military, economic, artistic, architectural, and cultural. Some families distinguished themselves by the intellectual brilliance of their members and thus brilliant women reflected favourably

on their clan. Men were very proud of their 'exceptional women' who were as brilliant as the most brilliant men. Whenever they could, these women's knowledge and abilities were displayed publicly to enhance the prestige and reputation of the family, the community, and the City or State.

In the rest of the world, since Antiquity, Western cultures had defined women as inferior beings, only fit to be wives and mothers. In all ages, there have been men and women on both sides of the question: those in favour of women's education and those against. The Greek philosophers, in particular Plato (429–347 BC) and Aristotle (384–322 BC), are famous for their stance on this question. In Plato's *Republic*, able women could be guardians equally with men if they received the same education as men. But women were nonetheless considered lesser human beings than male guardians. For Aristotle, women were 'deformed males' and inferior in mind and body and it is his view that has been predominant over the past two thousand years. In fact, in the twelfth century, Thomas Aquinas (1225–1274), an Italian Dominican, sought to reconcile Aristotle's thoughts with the Christian doctrine. He had translated several of Aristotle's works including the *Generation of Animals*. Christianity, throughout the ages, have viewed women as the Daughters of Eve, the original temptress responsible for humanity being expelled from the Garden of Eden.

The widespread belief in the moral and intellectual inferiority of women was publicly challenged in the late Middle Ages by Italian born Christine di Pisan (1363–1434). Her vigorous defence of women was the beginning of the 'Querelle des femmes', a debate over women's education and social role. Christine grew up at the Royal Court in France where her father was physician and astrologer to King Charles V. He ensured that she was well educated, and that she had access to the vast library available at the Court.

Di Pisan took up the battle against the misogynistic depiction of women in the thirteenth century medieval poem: *Roman de la Rose*. The first part of this poem, written by Guillaume de Lorris (circa 1230) was an allegorical novel glorifying courtly love; the second part, added in 1275 by Jean de Meung, was a vicious, bawdy attack on women (Stock 1978, 41). When she read the *Roman de la Rose*, Christine Di Pisan was shocked by its systematic denigration of women and of marriage, an attitude which was fairly common among Churchmen like de Meung (Stock 1978, 42). Her first response was a poem titled *Epistle to the God of Love* (1399) in which the character Cupid presents to the other gods a women's petition asking for an end to the outrages they were forced to bear (Stock 1978, 42). Meanwhile, she engaged in a public debate over the value of the *Roman*. She was severely attacked for her audacity to criticize 'a great work of literature' (*Roman de la Rose*), the clergy, and men in general. However, she did receive support from men like Jean Gerson (1363–1429), a famous French theologian, scholar, educator, reformer, poet, and Chancellor of the University of Paris. He defended Christine and called the *Roman de la Rose* immoral for disparaging marriage and women.

Subsequently, she published *The Book of the City of Ladies* in 1405, depicting the lives and accomplishments of several women, including natural philosophers (persons involved in science) and inventors. In this book, di Pisan demonstrated

that women could be as learned as men. She imagined a world, a 'city of ladies', where women could be whatever they wanted to be.

The dispute helped to establish di Pisan's reputation as a female intellectual who could assert herself effectively, and defend her claim to the male-dominated literary realm. As a widow with three children, Christine Di Pisan supported herself and her family with her pen. She continued throughout her life to counter the abusive literary treatment of women. The debate initiated by di Pisan quickly spread to Italy where the Renaissance was beginning to flourish under the influence of humanists (Frize 2009, xi–xii).

Italian Humanism and the Emergence of the 'Exceptional Woman'

Humanism was a reaction against the ossified teaching of the universities which frequently degenerated into formulaic arguments. It was sparked by the desire to study Ancient literature directly from original texts, and so emphasised the thorough study of classical languages and authors. The new learning quickly moved out of universities, which remained faithful to the old liberal arts curriculum (grammar, rhetoric, logic, arithmetic, geometry, astronomy and music). Princely courts became the new seats of knowledge and culture, with mixed gatherings of men and women. Humanism and courtly culture helped legitimize women's education. Most humanists believed education would make women virtuous. But this development did not prevent the issue of the education of women to be debated for several more centuries, especially regarding the type of education women should receive. Was the purpose to make women better wives and mothers or to be better guests or hostesses at evenings in aristocratic homes? Was it to add prestige to the men? Or was the purpose to prepare these women for the governance of the State or a real career? Likely it was all of the above, except for the last point, since it was widely agreed that women should not play a public role; (although in practice a few of them did).

Italian attitudes towards women's education present similarities and differences with what was taking place in the rest of Europe. In City States like Florence, hundreds of men were involved in governing a small population (90,000 in 1338). Italian civic humanists believed that the education of women could serve the needs of the community and should be focused on that goal. Edwards agrees that women should be educated so that they might be of greater value to the state as prospective brides, wives and household managers, and as mothers and educators of children (Edwards 2002, 2–6).

In those Italian States, a small number of intellectually gifted women deemed 'exceptional' were encouraged to study Latin, Greek, grammar, philosophy, and classical literature (Roman and Greek). In addition to these subjects, men were encouraged to study arithmetic, geometry, music, and astrology. A few women

studied mathematics and science, which mostly focused on cosmology, astrology, and botany. Edwards argues that the literacy rate in Florentine Italy was much higher than in England, and Florentines were significantly more educated than the English. Moreover, education in England centered almost exclusively on Christian texts and religious studies (Edwards 2002, 6–7).

In the fifteenth century, before the invention of the printing press, men provided advice through letters written in Latin to the boy or girl to be educated. For example, there were letters of advice provided by Leonardo Bruni (1370–1444) to Battista Malatesta da Montefeltro (1384–1447), Lady of Pesaro in Urbino. Bruni, in his *De Studiis et litteris liber* (1424) advised Battista to put religious and moral studies first, as all good women should, but also expected her to study grammar and read the best Latin texts by Cicero, Virgil, Livius, Sallust, Tacitus, and Caesar. He also encouraged Battista to study some geometry, arithmetic, astrology, and rhetoric. However, he did not expect her to become too deeply involved with any subject as she was not likely to use these in a public role (Logan 1999, 65–66).

Another philosopher, Lauro Quirini (1420–1475), guided the studies of Isotta Nogarola (1418–1466) who belonged to the aristocracy of Verona. He addressed Isotta as if she were a man and encouraged her to read several works of Aristotle before she was to move to the study of mathematics and natural philosophy. He also recommended that she study Arab philosophers, in particular Avicenna and Averroes.

In some instances, the students wrote letters to their teacher or to famous philosophers. For example, in 1488, Laura Cereta (1469–1499), a well-educated writer and philosopher, wrote a tract in which she profiled contemporary women as well as women from a recent past, which she sent in a letter on January 13, 1488 to Bibulus Sempronius. In her publication, *The Defense of the Liberal Instruction of Women* (1488), she profiled Isotta Nogarola of Verona (mentioned above) who, with her older sister Ginevra, studied Latin grammar, rhetoric, poetry, history, and moral philosophy. These two sisters had written letters to some of the famous classicists of the day and Isotta had tried to be recognized officially as a humanist by obtaining the approval of one of her previous tutors, Guarino da Verona (from Verona). But he did not reply. In her second letter to him, she complained that his silence gave her much suffering and that she was deeply saddened to be jeered by people throughout the city of Verona. Isotta complained to Guarino that even the women were mocking her. Guarino da Verona replied: “I believed and trusted that your soul was manly. But now you seem so humbled, so abject, and so truly a woman that you demonstrate none of the estimable qualities I thought you possessed” (Web: Women philosophers). So he did not support her in obtaining some recognition for her work and talents.

Included in her 1488 publication, Laura Cereta presented Cassandra Fedele (1465–1558) who was the most renowned woman scholar in Italy during the last decades of the Quattrocento (fifteenth century). Fedele was born in Venice to Barbara Leoni and Angelo Fedele. Her father took a great interest in his daughter's education, perhaps seeking to advance his own reputation. When Fedele reached fluency in Greek and Latin at the age of twelve, she was sent by her father to

Gasparino Borro, a Servite monk who tutored her in classical literature, philosophy, the sciences, and dialectics. In 1487, at twenty-two years of age, she achieved success in Italy and abroad when she delivered a Latin speech in praise of the arts and sciences at her cousin's graduation at Padua. Her speech, *Oratio pro Bertucio Lamberto*, was published in Modena (1487), in Venice (1488), and in Nuremberg (1489). From 1487 to 1497, she exchanged letters with prominent humanists and with the nobility throughout Italy and Spain (Web: University of Chicago, Fedele).

Cassandra Fedele achieved her fame through her writing, oratorical abilities, and elegance. In addition to her letters and orations, a volume of 123 letters and three orations were published in Padua in 1636. She is said to have composed Latin poetry, although none of this work survives. She participated in public debates on philosophical and theological issues with influential humanists and was asked to speak in front of the doge Agostino Barbarigo (1420–1501) and the Venetian Senate on the topic of the higher education for women. In a letter to Lorenzo de' Medici (the ruler of Florence), Angelo Poliziano (1454–1494), a famous Florentine writer and tutor to Lorenzo de' Medici's children, praised Fedele for her excellence in both Latin and Italian, as well as for her beauty. Fedele wrote little during the sixty years that followed her marriage in 1499. She seemed to believe that a woman had to choose between domestic duties or study and writing; but they could not do both. This is unfortunately the advice she gave other women (Web: University of Chicago_Fedele).

Laura Cereta, like other women of her time, initiated intellectual debates with male counterparts through her letters. Given the difficulties women had in earning recognition in the educational arena, many of Cereta's letters went unanswered (Rabil 1981). Despite these obstacles, she continued her education with diligence. Through her letters, she questioned women's traditional roles and attempted to persuade many to alter their beliefs about the role of women and education (Rabil 1981).

In the sixteenth century, several men published treatises on education which had a wider circulation since they were now in printed form. These provided advice to men and women who could read in the vernacular. The Siennese Alessandro Piccolomini (1508–1579) was a member of the Academy of the Intronati of Siena and of the Inflammati of Padua; both academies provided translations of classical authors for women and men who had no knowledge of Greek or Latin. In his 1542 treatise written in the vernacular *De la institutione di tutta la vita de l'huomo nato nobile*, Piccolomini discussed the concepts of happiness, friendship, love, marriage, family, and he provided advice for the care and education of aristocratic children, from birth to adulthood. However, he still maintained that the role of women was subordinate, not as a servant but as a companion to her husband, and that she should remain confined to the home. He believed women were more gullible, religious, and compassionate than men, that their body was weaker than men's, but that women could be as gifted as men in their soul. Although his treatise was written for Alessandro Colombini, the son of his friend Madonna Laudomia Forteguerra of Siena, it could apply to any family who could read Italian. In spite of the traditional role he assigned to women, Piccolomini was

a humanist and therefore conceded that in some cases, women were wiser than their husband and should be well educated and rule the man. He also expected aristocratic women to be fairly well educated (Logan 1999, 69–70).

Piccolomini also started a new genre of scholarly writing to make it accessible to a larger public; he wrote in Italian instead of Latin, and used very little mathematics. His book on cosmology, astronomy, and natural philosophy was written as a discussion between teacher and pupil, a style later imitated by Bernard le Bovier de Fontenelle (1657–1757) and by Francesco Algarotti (1712–1764). But Piccolomini was far less patronizing to a female audience than Algarotti was in his book *Newtonianismo per le Donne* (*Newtonianism for Ladies*) published in 1737.

Silvio Antoniano, a musician, canon lawyer, priest, and later cardinal published a treatise on education in three volumes. *Tre libri dell' educazione cristiana de' figliuoli* was published in Verona in 1583, discussing the christian education of children. Antoniano was much more restrictive than many of his contemporaries, as he did not approve of aristocratic girls learning languages, rhetoric, and poetry like the boys. In his view, girls from the lower class need not learn to read; those of middle class suffered no harm if they could read; and girls from the nobility could learn to read, write, and basic arithmetic; however their reading should be limited to the lives of saints and spiritual books. In spite of his traditional ideas, he was aware that some fathers provided far more education to their daughters than what he prescribed (Logan 1999, 70–71).

Antoniano's attitude was similar to that of Juan Luis Vives whose book (1523) was dedicated to Catherine of Aragon, the first wife of Henry VIII of England. Vives set the tone for his treatise by noting that innumerable things must be taught to men, who are active at home and abroad. Although Vives found no defects in women's ability to learn, he believed that girls only needed to learn cooking, spinning, and their letters and be concerned only with honesty and chastity (Stock 1978, 52; Frize 2009, 124–125). Vives agreed with Erasmus that women should not be teachers. His attitude to women's learning shows clearly in his treatise when he wrote that a maiden cannot be chaste if she thinks of knights in shining armour. Vives believed that educated women were morally suspect, but they would not be harmed by knowledge if fenced in by holy counsel (Stock 1978, 52; Frize 2009, 75).

Although conduct books were initially directed at royal and aristocratic women, they gradually filtered down to other social classes and Vives' work became a popular conduct book, with forty editions, and appearing in several languages. The conduct books, aimed at a middle-class audience, insisted that female learning had one goal: make them better mothers and wives.

Gian Michele Bruto (1517–1592) published *La Institutione di una Fanciulla Nate Nobilmente* (*The Mirrhor of Modestie*) which stressed the importance of traditional female virtues such as chastity, piety, and humility. Bruto, like Vives, reserved his greatest opprobrium for chivalric fiction and plays. The Bible, the teachings of the Church fathers, and narratives of virtuous women were judged appropriate reading material to impart male constructs of female virtue to women (Frize 2009, 124–125).

Stefano Guazzo (1530–1593), founder of the Academy degli Illustrati in Casale Monferrato, wrote *Civile Conversation* in 1574. The book stressed that a woman's education was to fit her subordinate role within the family. But he admitted that this role did not fit everyone; that some women could be instructed in science, and the manner of educating daughters could vary from one region to another. For example, in the region of Piemonte, in Casale Monferrato, and in Siena, daughters and wives had more freedom, as opposed to Roman wives whose life was more reclusive. Some daughters were only taught to spin, sew, and govern a house, while others learned to read, write, poetry, music, and painting. He also believed the future role of the woman would dictate her education. For example, if she was to live at Court, she needed a broad education. If she married a merchant or artisan, then accounting would be added to reading and writing. He educated his own daughter Olimpia who married a lawyer like himself (Logan 1999, 71–72).

As mentioned previously, Italians cultivated the memory of the 'exceptional woman', and this in turn made it possible for them to accept those contemporary women deemed to be 'exceptional women'. For example, in 1729, Guglielmo Camposampiero, a patrician from Padua, stated being most impressed with Elena Cornaro Piscopia (1646–1684) who had received a doctoral degree from the University of Padua in 1678. Elena had studied Latin, Greek, music, theology and mathematics and eventually learned Hebrew, Arabic, French, English and Spanish. She also studied philosophy and astronomy. By the time she was 17 years old, she could sing, compose, and play instruments such as the violin, harp, and harpsichord.

Camposampiero was also in favour of admitting women to the study of science and the arts and used examples of highly educated women to argue this point. He added Clelia Borromeo (1684–1777) to his list of erudite women. Clelia had founded the Clelia Academy of Milan and was knowledgeable in science, mathematics, mechanics, and language (Logan 1999, 2).

In the Italian City States, there was a long tradition where some academies involved women either as members or as participants in the evening discussions. Some academies were even created by women, whereas in all other parts of Europe and America, academies were a world without women. In the Italian Peninsula, gatherings began in *Salons*, much earlier than in France or elsewhere in Europe, encouraging conversations between gentlemen and ladies on various subjects. Several of the early academies were started as a 'conversation club'. An example is the Academia degli Intronati in Siena and the Academia degli Illustrati in Casale di Monferrato. These early academies were fairly informal. Academy members, their wives, and friends would meet at the house of an academician or at a lady's house to discuss literature, philosophy, and to play word games. By the turn of the century (early 1600s), some women were associated with the Academy of the Incogniti in Venice and in Rome (Logan 1999, 82–83). Margherita Sarrochi (1560–1617) created an academy in her Roman home. She even had Galileo Galilei as a guest in 1611 during his stay in Rome. She helped found two academies in that city: the Academia dei Umoristi (1603) and the Academia dei Ordinati (1608) and was a member of the latter. Another academy with some

interest in science, Brescia's Academy Mondella, was attended by Laura Ceretta in the late 1490 s. However, the Academy dei Lincei, a science-based academy in Rome, did not admit any women. Its founder, Federico Cesi, organized the academy in a manner similar to a religious order, so this would definitely not make it amenable to admitting women members, no matter how qualified women were (Logan 1999, 154). Like the Lincei in Rome, the Napolitan Academy of Sciences founded by Celestino Galiani (1681–1753) did not accept women as members (Logan 1999, 83, 87).

The Genoan philosopher and mathematician, Paolo Mattia Doria (1667–1746) supported the participation of women in intellectual discussions. He founded the Academy of the Ozioso in 1734 in Naples which accepted women members. Doria wrote on science and mathematics in a way that women could understand. He approved of meetings and conversations between men and women who had received a virtuous education. Doria believed such conversations would improve society and he believed that women could understand science; however, he doubted greatly that they could create it. At a time when science was becoming more popular and important for society, it made sense to teach these subjects to girls and women, although this was probably kept at a fairly elementary level (Logan 1999, 85).

In the eighteenth century in Bologna, several women became members of the Academy of Sciences in Bologna. The sisters of the founder of the *Accademia dei Inquieti* in 1690, Eustachio Manfredi, were members of that academy which eventually evolved into the Academy of Sciences of Bologna. Laura Bassi and Maria Gaetana Agnesi were added to its membership in the eighteenth century. Similarly, the Academy of Sciences of Padua, evolved from the *Accademia dei Ricovrati*, had two women members: Elena Cornaro Piscopia in the seventeenth century and Cristina Roccati in the eighteenth.

None of the other academies in Europe had women members. The Royal Society in London was created in 1662 and l'*Académie royale des sciences* in Paris in 1666. There were around seventy academies in Europe by the year 1700, but none admitted women. On the other hand, the Academy of Sciences of Bologna invited women from other countries, and particularly from France, to become members. These women could not join such a body in their own country. Several academies in other Italian City States had women members, but these were not science-based; they were focused on the Arts and the Humanities.

[Note: In London, it was not before 1945 that two women, Kathleen Lonsdale and Marjorie Stephenson, were elected as full members of the Royal Society. It was much later, in 1979, that the *Académie des Sciences* in Paris admitted its first woman member, Yvonne Choquet-Bruhat] (Schiebinger 1989, 20; Frize 2009, 62).

The discussion in the previous pages demonstrates the long history of debates on the issue of the education of women taken-up by several men and some women throughout the fourteenth, fifteenth, and sixteenth centuries. The treatises, publications, and letters to students made recommendations on what to teach boys and girls, and some were even specific on what was appropriate for the various social classes. However, the concept of the 'exceptional woman', and the participation of

these brilliant women in some of the academies from the earliest time of their creation showed that men encouraged these women to study, to join the academies, and in a few rare cases, to acquire a degree. However, the integration of 'exceptional women' in these intellectual activities did not open the door to all women and the seventeenth and eighteenth centuries were witness to two major debates in the Italian Peninsula. These two debates were eventually to have some positive impact for the general education of women in Italy. The earlier debate occurred in 1599 when Giuseppe Passi published his extreme misogynistic views, which was followed by the sharp and spirited response from two women: Lucrezia Marinelli and Moderata Fonte. The second public debate in 1723 was organized by the Academy of the Ricovrati with two men debating the question of the education of women and their social role.

The Earlier Debate: Passi and Responses by Marinelli and Fonte

For the *Roman de la Rose*, published 200 years before Passi's polemic, the response came after 100 years from the pen of Christine Di Pisan. Allen and Salvatore (1992) argue that in the last decade of the sixteenth century and the beginning of the seventeenth, the misogyny in the literature was particularly violent. Women were seen as sinners and to have a devilish nature. (1992, 2) In 1599, Giuseppe Passi published a tract titled *I donneschi difetti* (The defects of women), a deeply misogynistic tract. Passi's piece had two major points: "first, the deflation of female endeavour in the field of learning, pouring scorn on the possibility of women challenging classical male models, and second, the repetition of the dictum that women should be silent" (Kolsky 2001, 975). In this way, Passi was assuming women would remain silent and omit to challenge his views. He must have been highly surprised by the immediate and vigorous response from two women. Passi's work was an onslaught on women who refused to be controlled and subjugated by men. He argued that ideally women should be locked up in their home under the surveillance of their husband; he also warned young men against women's wiles. He was quite scathing about women who dared write poetry, believing these activities to be the preserve of male scholars. Passi reiterated the most extreme form of Aristotelian arguments about female weaknesses, inferiority, and inadequacy. The spirited response to Passi's diatribe by two educated women must have confirmed his notion that women should not be heard nor seen (Kolsky 2001, 975–976).

The first response to Passi came from Lucrezia Marinelli Vacca, a writer from Venice (1571–1653). Lucrezia was the daughter of Giovanni Marinelli, a physician who came from Modena and a man who greatly admired Aristotle. Lucrezia was taught Latin and she had access to her father's well-stocked library; she was also quite familiar with her father's writings. She was also aware of other women

writers like Cassandra Fedele and Isotta Nogarola which helped to form her knowledge on gender issues. (Allen and Salvatore 1992, 3) Lucrezia was most enraged by Passi's publication and she wrote a powerful rebuttal titled: *La nobiltà e l'eccellenza delle donne e i difetti e mancamenti degli huomini* (On the nobility and excellence of women, and the defects and weaknesses of men) in which she rejected the Greek biological theories on women, and particularly Aristotle's. She claimed that women's inferior position was due to historical conditions and not to physical causes and she argued that if boys and girls were taught the same things, girls would learn faster than boys. Lucrezia responded to each example used by Passi and rejected every single one of his arguments one by one. She claimed that women were superior to men and demonstrated this through her own choice of examples. Her tone was uncompromising and provocative. She provided a 'genealogy of misogynous thought' from Boccaccio to Passi which, she said, needed to be destroyed. Lucrezia also argues that anti-women thoughts originated with Aristotle (Kolsky 2001, 978).

The publisher, Giovanni Battista Ciotti, who had links to one of the two Venitian academies, gave Lucrezia only two months to compose the rebuttal if it was to be published in his next issue. Passi had published his piece with the other Venitian academy. Ciotti knew well Lucrezia's abilities as a writer since he had already published some of her work (Kolsky 2001, 975–976). Lucrezia's piece was a departure from her previous writings which had been quite conventional and different from this feminist piece. Later, in 1635, Marinelli published an epic poem, *L'Enrico*, which was another exception to her conventional writings. It contained some hint of the arguments she had used in her earlier polemical treatise on women.

The second rebuttal to Passi's tract was authored by Moderata Fonte, a pseudonym for Modesta Pozzo (1555–1592), the Venetian author of a romance and of some religious poetry. Ciotti published Moderata's response to Passi with the title *Il merito delle donne* (The Worth of Women) in 1600, eight years after her death in childbirth. Ciotti decided it was a most fitting piece as a response to Passi. It is not sure why Moderata's piece was not published earlier, before her untimely death. But it is certain that Ciotti knew about it and he decided that it was a good fit to respond to Passi. In her rebuttal, Fonte asserted the nobility and superiority of women to men and she presented the negative side of marriage and the pitfalls of love. She portrayed men in a very negative light. But her tract was more ambiguous in its conclusions than Marinelli's, as she presented both sides of the question. It was also less biting and hard-hitting. Together, the two texts provided a powerful response to Passi's extreme negative views of women (Kolsky 2001, 975–979).

Lucrezia Marinelli published a second edition of her rebuttal in 1601 in which she added ten chapters, including many more examples and much stronger arguments. Unfortunately, in 1645, she undermined some of her previous arguments in a new work titled *Essortationi*. For example, she had said formerly that men wrongfully shut women in their home without contact with the outside world. But in this new work, she considered 'seclusion' as a positive value. Further along in

this piece, she satirically portrayed the closed world of male literary circles, but she did not challenge them, nor did she defend the usefulness of having women included in them (Kolsky 2001, 982–983).

Passi also backtracked to some extent in another text published in 1601 titled *Dello stato maritale* (On the marital state). In this piece, he seemed obsessed with clarifying his position and retreating from his previously extreme statements. He claimed wanting to correct the impression that he was anti-marriage and suggested being a misunderstood victim. But he maintained his position that most women were evil and the weaker sex (Kolsky 2001, 985).

In this period, there were other detractors who were opposed to women getting involved in intellectual debates and conversations. Clerics saw danger in conversations between men and women and felt that public discussions by women contravened the Pauline Edict which imposed silence for women in public places. Canon Antonio Francesco Ghiselli (1670–1730), a member of the Bologna Academy dei Gelati, was particularly vociferous in his attack of women, claiming they were wasting time in frivolous conversations instead of concentrating on their religious and household duties. Paradoxically, he was full of praise for Vittoria Delfini Dosi who defended a thesis in law in 1722 at the Real Collegio Maggiore of Bologna. According to Ghiselli, Dosi provided a public example of knowledge at a time when women were mainly concerned with pleasure and entertainment (Logan 1999, 84–85). The year following Dosi's thesis defense in Bologna, the second major public debate occurred.

The Famous 1723 Debate at the Accademia dei Ricovrati in Padua

The Academy of the Ricovrati was founded in 1599 in Padua by Venetian nobleman and Cardinal Federico Baldissera Bartolomeo Cornaro (1579–1653) and by the famous natural philosopher, Galileo Galilei. At the end of the seventeenth century, the Academy of the Ricovrati was one of the few academies which had women as members, but only as honorary ones; women could not vote, hold administrative positions, or address the assembly except on rare occasions when invited to do so. Of the twenty-six women admitted to the Ricovrati prior to the 1723 debate, four were Italian. The others were French, so did not attend meetings of the Academy in person due to the distance to travel. One of their members was Elena Lucrezia Cornaro Piscopia, the first woman in the world to be awarded a doctoral degree. She defended her Theses on June 25, 1678 when she was 32 years old. The Ricovrati also had women members from France: Anne Dacier (née Le Fèvre: 1654–1720) was invited to be a member in 1679, and Madeleine de Scudéry (1607–1701), a prolific writer, joined in 1685. An Italian poet, Maria Selvaggia Borghini (1656–1731) was made a member in 1689 (Messbarger and Findlen 2005, 126).

In 1722, the newly elected head of the prestigious Academy dei Ricovrati, Antonio Vallisneri (1661–1730), a natural philosopher and chair of medicine at the University of Padua, wrote a letter to his friend, the librarian at Modena Ludovico, to present his plan for a reform of the academy. He wished to replace what had become frivolous conversations in academy evenings by serious intellectual debates. Vallisneri planned to start with a critical re-examination of the issue of the education of women. His proposal appears to have been stimulated by ideas generated during the early Italian Enlightenment period and by the consideration of ethics regarding the treatment of women (Messbarger and Findlen 2005, 67–68). The centuries of discussions in the Italian Peninsula and elsewhere in Europe about the 'woman question' were bound to culminate in this important debate and this was a good opportunity for Vallisneri to launch his new plan.

Prior to the debate of June 1723, the Academy had debated the 'woman question' in a theoretical and formulaic manner. It had asked: (1) whether it is better for those who serve women to win their hearts by enduring or by resenting women's amorous injuries; (2) what would be more laudable, to exclude women from government as the Romans did, or to admit them as did the Greeks? (3) Which would be more desirable: a government led by a woman, a woman dedicated to arms, or to letters? Vallisneri judged these questions to be unrealistic, irrelevant, stereotypes, and wished instead to discuss the question of women's education in practical terms. He was responding to the bitter, vigorous complaints and harsh disputes made by illustrious, noble, and spirited women who had been denied admittance to the study of science and the arts. These women were challenging men concerning their exclusion (Messbarger and Findlen 2005, 69–70).

Prior to discussing the elements of the 1723 debate, it is important to mention that negative attitudes toward women were still seriously entrenched, so dismantling them would take a monumental effort. Four main issues had formed the debate until this time: (1) The issue of chastity; (2) the issue of power; (3) the issue of speech in a public space; (4) and the issue of the acquisition of knowledge (Messbarger and Findlen 2005, xxv). This new debate would be focused on one specific issue. At nine o'clock in the evening of June 16, 1723, the intellectuals and social elite of Padua met to discuss the following question: Should women be admitted to the study of the sciences and the liberal arts?

The debaters were two men: Guglielmo Camposampiero (1691–1765), poet, scholar and Chief librarian at the University of Padua, was supposed to make the case for the education of women. On the other side was Giovanni Volpi (1686–1766), a scholar, publisher, and professor of philosophy, Greek, and Latin at the University. In their arguments, the two men divided women into social and economic groups.

In his presentation, Camposampiero used examples of many accomplished women. He also used arguments from patriarchs whom he judged to be sympathetic towards women. But he added that it would be absurd to think of educating all women; he even questioned whether elite women, worthy of this privilege, should be taught.

For his part, Volpi reiterated the old argument: "fluids women require to perform their primary reproductive function leave their physical fibers too weak and

flaccid to sustain concentrated activity in the brain, thereby precluding women from serious thought and analysis” (Messbarger and Findlen 2005, 71).

In view of the many elite women present in the assembly, both men added some pro-women arguments in their presentation. For example, Volpi restrained somewhat his misogynistic comments. Women were quite incensed that only men took part in a debate concerning them. The opportunity for a public response by women came six years after the debate. In 1729, Volpi prepared a publication to present the main arguments against the education of women he had put forward in the 1723 debate. However, in this new publication, he both defended and disclaimed his position against the education of women, so he continued to show an ambiguous position. This volume finally included the voice of women. Volpi published a supplement that contained refutations of his ideas by a woman, Aretafila Savini de’ Rossi (1687-?), and by a girl of eleven, Maria Gaetana Agnesi (1718–1799). These two rebuttals pleaded in favour of the education of women. Aretafila contributed in two ways: First, she challenged each of Volpi’s arguments in terse and sarcastic footnotes. Secondly, she wrote *An Apology in favor of studies for women, against the preceding discourse by Signor Giovanni Antonio Volpi, written to a gentleman by Signora Aretafila Savini De’ Rossi, a Sienese Lady*. De’ Rossi’s piece was written in the form of a letter using examples of contemporary women to illustrate her arguments about women’s abilities and the need for their education. She argued that serious study of science and other subjects made women less idle, better partners and managers of homes, as well as better educators of children. However, she did not challenge the social role of women.

The second text was by Maria Gaetana Agnesi who had disputed on this subject in Latin for the Milanese nobility in 1727, two years before the 1729 volume was published by Volpi. Now eleven years old, Agnesi wrote her text based on the ideas she had disputed in Milan when she was nine years old. In her tract, Agnesi’s eloquent and sometimes ironic style challenged Volpi’s views on social custom, female incapacity, and the fear of social disorder, arguments he had used to proscribe women’s learning (Messbarger and Findlen 2005, 17).

In spite of its equivocal message, the debate did contribute to the evolution of the question during the Enlightenment era. It opened the door to revisiting the issue and the arguments, for and against, on the role of women in the public arena and in the home. The debate of the two men in 1723, and the subsequent publication in 1729 with a supplement written by women, must have had some positive impact on the extraordinary event of 1732.

Consequently, we can see that it made sense for the Bolognese and their University to showcase a particularly ‘exceptional woman’, one who happened to have an interest in science. Showcasing exceptional people was part of the culture, what Marta Cavazza calls the ‘spectacularization of female knowledge’ (Cavazza 2009, 280). Initially, Laura Bassi was expected to do what exceptional women always did: come out and perform when called, stay home otherwise, and write command pieces of literature when asked. It was probably assumed she would remain single, or sink back into obscurity if she married as her predecessors like Cassandra Fedele and others had done. To be truly exceptional, a woman had to

'make herself like a male' and that meant renouncing her sexuality as Elizabeth I had done in England in the sixteenth century, deliberately defining herself as a 'Virgin Queen'. Laura Bassi was faced with the same dilemma very early in her career: should she marry or should she remain the 'virginal Minerva' consumed solely by the love of science and of God? If she married, who would be an appropriate husband? Would he support her work and career? Laura fell in love with science, as many men did in the eighteenth century; she was determined to use her position as an 'exceptional woman' to continue her studies and to pursue a career in science. Her strategy would require a careful negotiation within existing gender norms, but she succeeded. This 'exceptional woman' became Italy's first woman appointed as a university lecturer with a salary.

By 1700, there was still dualism of thought from most authors on the question of the education of women and many continued to make misogynistic statements about women's abilities. However, several writers advocated for a more general access to education by women. In the past, it was only the exceptional woman who was encouraged to study. A major influence on this changing trend of the eighteenth century was the more prevalent association of women with the academies. This is an important difference between the Italian Peninsula and the rest of Europe. Contact with men in these institutions exposed women to greater knowledge in their fields of interest and men were exposed to bright and intelligent women's discourses and disputations.

The debate continued in the eighteenth century with Diamante Medaglia Faini (1724–1770), a poet and intellectual from Brescia. Diamante became a member of several academies: Agiati of Rovereto, Arditi of Brescia, Orditi of Padua, Unanimi of Salò, and the national academy of the Arcadia. During the last ten years of her life, her interests became focused on science and on philosophy. She championed the education of women and proposed a curriculum that included science, philosophy, religious history, logic, mathematics, and physics. This was most unusual, as the feminine curriculum was normally made up of poetry and composition. However, she favoured the new knowledge in science and philosophy, not for its own sake, but again, like Aretafila, to enhance women's domestic skills and Christian modesty (Messbarger and Findlen 2005, 144–145).

The next chapter presents examples of women who were involved in science prior to the eighteenth century.

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Chapter 3

Women in Science and Medicine in Europe Prior to the Eighteenth Century

This chapter provides examples of women who were seriously involved in science activities. Women's interests covered a wide variety of topics, among which were mathematics, astronomy, natural philosophy, alchemy, natural history, botany, and medicine.

In Europe and in the Italian Peninsula, before Laura Bassi's time, several women were involved in science and medicine in spite of the fact that formal education in these fields was prescribed only for boys. In addition to women being actually involved in science and medical work, other women were patrons of natural philosophers, or translators of works in science or mathematics. Some women collected data and made observations, while others were practitioners and even harbingers of a new approach to science. One reason which favoured the involvement of women was that, for centuries prior to the eighteenth, science was a fairly informal activity. Most work was done by people with leisure as a sort of hobby, because of their interest in the subject. Science was still poorly regarded by scholars in the sixteenth and seventeenth centuries. Since it was considered as a minor field, it was perceived as more accessible to women. This is evident when we consider the numerous women astronomers in that era. In Germany alone, in the seventeenth century, 14 % of the astronomers were women, which is probably more than what we see today (Schiebinger 1989, 66).

The period of scientific development in the sixteenth and seventeenth centuries did not happen overnight. The mathematicians, philosophers, astronomers of the sixteenth and seventeenth centuries built on previous knowledge, and on the science developed in Ancient Greece, Rome, the Middle East, and in Europe during the Middle Ages. An interesting question is: What role did women play in this era of intense scientific activity? In spite of their exclusion from formal education and scientific associations such as academies, some women's work contributed to important discoveries and scientific achievements. When women were provided with a good education, tools, and the support of a male relative such as husband, brother, or father they could do serious science.

As the enterprise of science became organized into formal bodies in the latter part of the seventeenth century (such as Academies, from which women were excluded with the exception of a few cases in the Italian Peninsula), it became

more difficult for women to engage in science. Most of the discussions, debates, and publications on science moved from Salons to the Academies. The main obstacle for women to participate, in addition to their exclusion from university education and membership in these academies, was their lack of access to the scientific instruments necessary for the practice of science such as telescopes, microscopes, the vacuum jar, or the electricity machine. Women also found it difficult to publish their articles, reports, and books; this explains why many women adopted male pseudonyms. In spite of these obstacles, some women found ways to study and get involved in scientific work, write, and get published. Common factors that enabled women to achieve some measure of success and recognition were: their genuine interest in science or mathematics; their abilities in these subjects; and almost always the support of men who encouraged them to pursue their interests in spite of social convention. We can only imagine what these women could have achieved if they had been allowed free rein and the same access as men to all that was needed to work in science (Frize 2009, 99–100).

Hildegard of Bingen (1099–1179) is said to have formulated a heliocentric hypothesis three hundred years before Copernicus, and speculated about universal gravitation four hundred years before Newton; she composed numerous pieces of music, and wrote on medicine and natural history. Hildegard was prominent in the hierarchy of the church. Also in the Middle Ages, Trotula of Salerno (eleventh century) is thought to have practiced and taught medicine at the famous Medical School of Salerno in the Kingdom of Naples. At that time, schools of medicine would not have been organized with professors, classrooms and students; they were places where men and some women would do an apprenticeship. Several written works came out of the School of Salerno where Trotula is said to have been a physician. Several of these works are attributed to her; there is no evidence that she wrote them, or that several people wrote these texts, except for the name given to them: one work titled *Passionibus Mulierum Curandorum* (*Diseases of women*) is sometimes referred to as (*Trotula major*). The document has 63 chapters; it provides information on menses, conception, pregnancy, childbirth, and on general diseases and their treatment. The majority of remedies recommended were herbs, spices, and oils from animals. The book claims that both men and women could have physiological defects affecting conception, an idea quite contrary to the beliefs of the time and for centuries beyond (Wikipedia_Trotula). Although a few men in the Middle Ages conclude that Trotula was a man with a female pseudonym, it is unlikely that a man would have written about a weakness in sperm leading to conception problems.

In Salerno, medical licences were granted by royalty and not by church officials, which facilitated the licensing of women as physicians. Logan mentions the Pseudo Apuleo Herbarium Manuscripts of Florence and Vienna which confirm the presence of women physicians associated with the Medical School of Salerno in the thirteenth century. The illustrations in these manuscripts show both women and men as physicians, using similar gestures and having similar attributes. These physicians are shown treating both women and men for cases of poisoning, burns,

insomnia, hemorrhage, intestinal and urinary tract diseases, among others (Logan 1999, 110).

Later on, in the late fourteenth and early fifteenth centuries, Dorotea Bucca or Bocchi (1360–1436) is said to have held a chair of medicine and philosophy at the University of Bologna from 1390 to 1430. Her father had previously held the same chair. Other Italian women whose contributions in medicine have been recorded include Abella, a fourteenth century Roman physician. During the mid-fourteenth century, she taught general medicine at the Salerno School of medicine. She lectured on standard medical practice, bile, and women's health and nature. She published two treatises: *De atrabile* (English: *On Melancholia*) and *De natura seminis humani* (English: *On the Origin of Human Nature*), which did not survive (Ogilvie and Harvey 2000, 4).

Jacqueline Felice de Almanica (Jacobina Felicie) is thought to have originated from Florence. She was active as a physician in Paris in 1322, belonging to the small number of licensed female doctors of her time. In 1292, there were eight female doctors registered in Paris. However, in 1322, Jacobina was put on trial for unlawful practice. During the trial, there were many testimonies stating she had cured patients where other doctors had failed and given up hope of their recovery. According to one witness, she was reputed to be a better medical doctor and surgeon than any of the French doctors in Paris. Despite the testimonies that she was able to cure people whom male physicians had not been able to help, the court reasoned that it was obvious that a man could understand the subject of medicine better than a woman. She was banned from practising medicine and threatened with excommunication if she ever practiced again. This decision is said to have barred women from academic study in medicine in France and for obtaining such licenses until the nineteenth-century (Wikipedia_Jacobina).

Alessandra Giliani (1307–1326) was an Italian anatomist at the University of Bologna serving as the first female prosector (preparing dissections for anatomical study) in the Italian Peninsula. Alessandra Giliani is believed to have been born in 1307 in San Giovanni in Persiceto in the Italian province of Emilia-Romagna and that her death was likely due to a septic wound, at the age of 19. She worked as the surgical assistant to Mondino de' Liuzzi (d. 1326), a world-renowned professor at the medical school of the University of Bologna. Alessandra is said to have carried out her own anatomical investigations, developing a method of draining the blood from a corpse and replacing it with a hardening coloured dye, possibly adding to our understanding of the coronary-pulmonary circulatory system. Alessandra Giliani's short life was honoured by Otto Angenius, also one of Mondino's assistants and probably her fiancé, with a plaque which describes her work in the Church of San Pietro e Marcellino in Rome. She is also mentioned by the nineteenth-century historian Michele Medici who published a history of the Bolognese school of anatomy in 1857 (Wikipedia_Alessandra_Giliani).

Mercuriade, in the fourteenth century, was a student at the University of Salerno; she belonged to the minority of female students of her time period and was the author of several medical works on "Crisis", "Pestilent Fever", and "The Cure

of Wounds” (Wikipedia_ Mercuriade). Constance Calenda and Calrice di Durisio, in the fifteenth century, were Italian surgeons specializing in diseases of the eye.

There are also records in cities like Siena, Florence, and Venice of women practitioners belonging to guilds and listed on tax rolls in the Middle Ages. The School of Salerno became a formal Medical faculty in the late 1300s and from then on women began to be excluded. But in the Kingdom of Naples, women continued to be licensed to practice medicine. There is evidence that there were twenty-four women surgeons in Naples between 1273 and 1410, thirteen of them licensed to practice on women. These women do not appear to have had a connection to a university or to have left behind writings on the subject (Green 1989, 442; Logan 1999, 111). In medicine, some women practiced for profit, but others wanted to help people in need. An example of the latter is Francesca Bussa dei Panziani (1384–1440) who became Saint Francesca Romana. She is said to have been a skilled medical practitioner, using ointments, plants, plasters and even sutures to heal wounds.

During the sixteenth century, in many Italian cities, it became very difficult for women to obtain a license after the development of medical boards responsible for the licensing of medical arts. The tendency was to license women for midwifery or for applying external remedies to women (Logan 1999, 112). An example is Lavinia Olimpì from Bologna, licensed in 1638 to apply remedies to men and women for various diseases. In the Italian Peninsula and elsewhere in Europe, some women had extensive knowledge of herbal medicines; some became pharmacists and others practiced low-level medicine in towns and country areas without a license. They would only come to the attention of the medical boards if there were complaints against them (Logan 1999, 112). In the same vein, women acquired knowledge about plants (botany). Alchemy was also quite popular at that time.

It must be remembered that many women were tortured and killed for their knowledge in science or medicine in the Middle Ages. The European witch hunt, which resulted in the imprisonment and death of many women (Noble 1992, 208), began with the Catholic demonization of witchcraft through a papal bull issued by Innocent VIII in 1484, and was particularly intense in the sixteenth and seventeenth centuries in France, Italy, England, Germany, and beyond. The feminization of witchcraft effectively removed women from the roles they had played in medicine, alchemy, and other sciences. Noble (1992, 210) writes: “Physicians played a prominent role in the witchcraft persecutions and the attack on the alchemists, perhaps in order to eliminate competition from lay healers and midwives.” A few male alchemists suffered the same fate as women, but the persecution overwhelmingly affected women (Noble 1992, 208; Frize 2009, 57–58).

Women's Contributions in European Science in the Fifteenth and Sixteenth Centuries

Scientific discovery, even in the early modern era, was rarely the achievement of a single person. Behind the person who was given the credit, both then and now, were many artisans and assistants, women and men, who contributed to the work. Women involved in scientific work in early modern Europe were predominantly from the nobility or the bourgeoisie, assisting brothers, fathers, or husbands. Men provided access to equipment such as telescopes, and women provided assistance in the work itself, not only by collecting data and making observations, but by contributing to the development of mathematics and astronomy. Many of the women about whom information became available worked in astronomy and several made important contributions to that science. Although their lives and achievements still remain relatively invisible, development of women's studies programs and of the World Wide Web helped to uncover and disseminate information about them (Frize 2009, 63–66). The section below provides a few brief stories of women who succeeded in being seriously involved in science.

Sophia Brahe (1556–1643) was the youngest of ten children of Otto Brahe and Beate Bille Brahe. Her oldest brother Tycho Brahe (1546–1601) was an astronomer. Sophia became passionate about astronomy at the age of ten while assisting her brother in his observatory, Uraniborg, on the island of Hven. Their parents provided her with a private tutor in mathematics, music, alchemy, and medicine, but her work with Tycho was interrupted by a forced marriage in 1576, when she was twenty, to thirty-three year old Otto Thott of Eriksholm in Scania. They had a son in 1580. After her husband's death in 1588, she rejoined Tycho and together, over many years, they recorded the positions of planets and stars, and made computations to predict eclipses and comets. Sophia was also a horticulturist, a healer, a historian, and became something of a legend in her own lifetime. Although she collected a great deal of data and made observations, often on her own, it is her brother who is still generally credited with their work and who is the subject of numerous books. A planetarium in Denmark was named after him (Frize 2009, 64; Ogilvie and Harvey 2000, 170).

In Germany, Maria Eimmart (1676–1707), working in her father's observatory, prepared 250 drawings of the phases of the moon in a continuous series that laid the groundwork for a new lunar map. She also made two drawings of the total lunar eclipse of 1706 and may have written the whole or parts of a paper about the sun that was published under her father's name. Maria married Johann Heinrich Muller in 1706, and he inherited her father's observatory. She continued her work in astronomy after her marriage, but her career was cut short when she died in childbirth in 1707 (Schiebinger 1989, 81).

Marie Cunitz (1610–1664), born in Silesia, was the daughter of a doctor who taught her six languages (Hebrew, Greek, Latin, Polish, Italian, and French) in addition to their native German. She also studied music, mathematics, and medicine. After her marriage to a local doctor, she was involved in history, poetry, painting,

and music, as well as her principal interest, astronomy. Her translations and modifications of Kepler's laws, published in *Urania propitia tabulae astronomicae mire faciles* (1650) made Kepler's work more accessible to scholars, and became the main ones available for many years after her death (Schiebinger 1989, 80). Although Maria Cunitz's work is highly regarded by some, she was severely criticized many years after her death for neglecting her womanly duties because of her work in astronomy.

Maria Winkelmann (1670–1720), born near Leipzig, assisted an astronomer, Christoph Arnold, before marrying another, Gottfried Kirch, who was some thirty years older than herself. She helped her husband with calculations, observations, and the making of calendars, and in 1700 moved with him to Berlin. In April 1702, she discovered a previously unknown comet, which should have secured her a position in the astronomical community, especially as her husband's own position was partly based on his discovery of a comet in 1680 (Schiebinger 1989, 85). Unfortunately, the report of her finding and a subsequent publication regarding this discovery bore only her husband's name. In 1710, Kirch himself recorded in his notes that his wife had discovered the comet while he was sleeping. Historians studying the original document continue to attribute the work to her husband. Another of Maria Winkelmann's contributions was the prediction of the appearance of a comet in 1712 achieved through observations and accurate calculations. After her husband's death she continued as assistant to her son Christfried, again at the Berlin Academy into which she was never formally admitted. Instead, she was forced out on October 21, 1717, because she had not heeded warnings to retire in the background when visitors came and to leave the talking to the men. However, the Academy did not want her to give up her duties as a mother and expressed the hope that Maria "could find a house nearby so that [her son] Herr Kirch could continue to eat at her table" (Schiebinger 1989, 97). Maria's daughters Christine and Margaretha were also competent astronomers, but their role was restricted to assisting their brother. Londa Schiebinger reports that, unlike their mother, the daughters "did not ask for official positions. Nor did they exude the fire of their mother, badgering the academy for housing or greeting foreign [male] visitors" (Schiebinger 1989, 99).

In an entirely different field of interest, Margaret Lucas (1623–1673) continued her intellectual development after her marriage to William Cavendish, Duke of Newcastle-upon-Tyne, who had some knowledge of mathematics and science. The publication of her numerous books was financed by her husband, who added a laudatory verse to each of them. They include *The Philosophical and Physical Opinions* (1655), *Natures Pictures Drawn by Fancies Pencil to the Life* (1656), *Observations upon Experimental Philosophy* (1666), and *Grounds of Natural Philosophy* (1668). Margaret Cavendish participated in discussions with well-known philosophers on subjects such as matter and motion, the existence of the vacuum, the nature of magnetism, life and generation, colour and fire, perception and knowledge (Schiebinger 1989, 47). She was also the first woman to visit the Royal Society, an incident that created a huge controversy since women were barred from membership. Interestingly, Cavendish does not mention the visit in

her autobiography, as the experience had been less than positive: it is said that she was demeaned and ridiculed during her visit. In her writings, her approach to nature was quite opposite to that taken by the famous male philosophers of the period and she rejected the concept of a sharp distinction between animate and inanimate nature; this position led her to reject the Cartesian imperative that expected man to become master and possessor of nature through science (Schiebinger 1989, 52). She also made bold criticisms of Hobbes, Descartes, and others. She was severely criticized by many, and her response to these attacks was to apologize for her lack of a formal education (Frize 2009, 66).

A final example is the extraordinary life and work of Maria Sibylla Merian (1647–1717), a leading entomologist of the late seventeenth and early eighteenth century. She is said to be the daughter of artist and engraver Matthäus Merian the elder in Frankfurt am Main and to have learned the techniques of illustration, drawing, mixing paints, and etching copperplates as an apprentice to her stepfather, guild painter Jacob Marell, and his apprentice Abraham Mignon in her own home. Her father had died when she was three years old. She was trained in oil and water colour and sketched flowers, fruits, birds, worms, flies, mosquitoes and spiders. Her future husband, Johann Graff, studied in Frankfurt and in Rome, travelling from workshop to workshop. In 1665, Merian married Graff and they moved to Nuremberg where she established her own business instead of working for her husband's. She sold silks, satins, and linens that she painted with her own design of flowers. She had women as assistants and apprentices. Merian published her book *Wonderful Metamorphosis and Special Nourishment of Caterpillars* (1679), a work which had demanded years of observation and research. She drew the life cycle of each insect on copperplates, from egg to caterpillar, to cocoon, to butterfly, capturing each change of skin and hair. Her five-year study was of interest to people in the silk-worm business (Schiebinger 1989, 68–71).

Women in Science in the Italian Peninsula

In spite of the difficulty of finding information about early examples of educated women in science or mathematics, there is some evidence that a few women were associated with universities in the Italian Peninsula in the Middle Ages, especially in the field of medicine, law, botany, alchemy, and even in mathematics, astrology, natural philosophy and natural history.

Some learned women in the Renaissance (fourteenth to seventeenth centuries) and Early Baroque (early to mid-seventeenth century) were involved in astrology (a relation between the planets and events in the world) and cosmology (the origin of the universe). Others with more knowledge of mathematics studied astronomy (the study of the motion of celestial objects). Some women learned physics. These women expressed their knowledge through literary means like orations, dialogues, poems, letters, and in tracts written to defend the right of women to be educated. A few examples are provided below.

In addition to her philosophical writings, it is said that Laura Cereta (1469–1499) was a practicing astrologer, carrying-out this work in a private capacity, not at court as men did. Born in Brescia to Veronica di Leno and Sivestro Cereta, a lawyer and magistrate, Laura was the eldest of six children in an aristocratic family. She was educated in a convent between the age of seven and eleven, and then at home where she learned Greek, Latin, and mathematics, but it is not certain who her teacher was. She may have been self-taught in some of these subjects (Logan 1999, 137–8). At fifteen, she married a merchant, Pietro Serina, who shared her love of learning, but who died eighteen months after the marriage of a form of plague. Childless, she concentrated on her writing and on meetings with groups of scholars. She never remarried (Encyclopedia_Laura_Cereta).

It is through some of her letters that Laura Cereta's knowledge of astronomy and astrology is confirmed: There was a letter to Alberto de Albertis with an article titled *On the Correlation of Heavenly Bodies with the Birth of Man*; and a letter to Regimundo Fortunato with *The Influences of Planets on Living Things* (Logan 1999, 138). Laura made use of an astrolabe to make her astronomical observations. She was attempting to measure the dimensions of the universe, and that required some knowledge of trigonometry and geometry. Laura stopped looking at the future through astrology when her husband died in 1486 (Logan 1999, 140).

In the sixteenth century, another woman involved in science was Sister Fiammetta Frescobaldi. Born in Florence on January 17, 1523, one of the six children of Lamberto Frescobaldi and Francesca Morelli, Brigida took the name Fiammetta when she entered the Dominican convent of San Jacopo di Ripoli in Florence in 1536. She learned Latin with books from the convent's library which is said to have been better than in many other convents since it had been the site of one of the first printing presses in Florence in the 1470s. Fiammetta was very interested in astronomy and her first knowledge in that subject came from Piccolomini's 1561 book on Aristotlean-Ptolemaic cosmology: *La Sfera dell'universo* (*Sphere of the Universe*) and from his book on star gazing (*On the Fixed Stars*). She wanted to learn about the heavens, their motion, the fixed stars, the planets, the celestial circles and zones. In her own work *La Sfera dell'universo*, she adapted Piccolomini's work and divided it into three parts: (1) she described the sphere of the world; (2) the different celestial circles that explained celestial motions; (3) she discussed the forty-eight constellations, the different stars and their magnitude. In this last part, she included the distance from the centre of the earth to various spheres that had been calculated by Piccolomini. In her writing, Sister Fiammetta avoided some of the detailed information provided by Piccolomini and focussed on the main points, which made her text easier to understand. Her other volumes pertained to geography, describing lands, places, people of Europe, based on Pope Pius XI's *Cosmography*; on Africa, from Giovanni Lioni's *Africa*, Asia and the Occidental Indie, based on works by Amerigo Vespucci, Fernando Cortes, and Francisco Pizzaro, among others. She also argued that the discovery of America by the Portuguese was an indication that Ptolemy's knowledge was imperfect. This was before Galileo's challenge of the Ptolemaic theory (the earth being the centre of the universe and not moving). The ban by the Church of the

Copernican system, and the harsh judgment of Galileo by the Church, may have dampened somewhat the interest of women and men in the Italian Peninsula from being involved in the field of astronomy. This contrasts of course with the situation in Germany mentioned previously (Logan 1999, 146–147).

In Sister Fiammetta's *Diario dell'anno 1575 fino al 1586 e varie memorie* (Diary from the year 1575 to 1586 and various memories), there were convent news and events in Florence, interspersed with her own notes on eclipses of the moon and sun, the position of the sun in the zodiac, the appearances of meteorites and of the comets of 1577, 1580, and 1582. On March 7, 1584 (Florentine dates), she recorded a very unusual event and described what today is called sunspots. She did this before the invention of the telescope in 1609 by Galileo Galilei. Her meteorological observations were done before the invention of the thermometer, barometer, and seismograph; she recorded in a qualitative manner the intensity and frequency of earth tremors and the weather for the period covered in her diary. This enabled Fiammetta to predict a very hot weather for the year 1582, contrary to the prediction for a very cold one made by the physician and philosopher Baldassare Pisonelli of Bologna. She was right; 1582 was an unusually hot year in Florence and the heat lasted well into December (Logan 1999, 147).

A major difference between the women and the men who studied science and mathematics in these earlier centuries was that women who wrote texts on these subjects did not make them available to a large public by publishing them, whereas men published and distributed theirs widely. Sister Frescobaldi used her text *Sfera del Mondo* within the confines of her convent. Teodora Danti's commentary on Euclid was used to teach her nephews and younger brother. Of course women published works that were literary or philosophical, but it seemed that when science and mathematics were the subjects, women refrained from publishing their work. Publishers may also have been reluctant to publish scientific or mathematical works by women. Women may also have wanted to stay away from becoming involved publicly in a major controversy, considering what happened to Galileo Galilei in 1633.

Two other women were involved in astronomy in this period: Virginia (Sister Maria Celeste), eldest illegitimate daughter of Galileo and of Venetian Marina Gamba, was born in 1600 and became a nun of St-Claire in 1616. Galileo's second daughter, born in 1601, was also placed in this convent and became a nun in 1617. Galileo raised his son Vincenzo who was born in 1606. Galileo sent Maria Celeste some of his work *The Assayer* which dealt with the nature of comets, the workings of the telescope, the structure of matter, the nature and speed of light, the multifarious sources of sound, relations of the senses to physical phenomena, and other similar topics. These works contained geometrical demonstrations in optics and several passages in Latin were from Orazio Grassi's work, which Galileo was contradicting in his piece. Galileo also sent instruments to the convent. While her father was being questioned by the Inquisition, Maria Celeste was able to get the copies of Galileo's papers that may have compromised him. She circulated a selection of his papers to some of his and her friends (Logan 1999, 158).

The other woman was Sister Arcangela Tarabotti (1606–1652). Born in Venice, she was forced to enter a convent at an early age. She became associated with the Venetian Academy of the Incogniti and with its patron Giovanni Francesco Loredan. In 1651, she published *Che le donne siano delle spezie degli uomini* (That women are the spice of men). This work attacked Galileo's discoveries and ideas on cosmology. It is not certain if she truly believed what she wrote and she was wrong in her stance, but her publication made her part of the discussion and showed that Galileo's works were circulating in some convents. Writers in the Italian Peninsula were quite cautious when discussing astronomy topics in the years between 1633 and 1657 (Logan 1999, 159).

The Eighteenth Century Brings Change

Of course, as science became more formal and controlled by academies, it was more difficult for women, except in Italy, to be seriously involved in science. To be a serious scientist, one had to have access to equipment for experiments and research. New work would be presented at academy meetings and published in academy journals. Women and men in past centuries had been able to be involved in science and mathematics in a less structured environment. All they needed was some interest in these subjects, a solid education in Latin, Greek, and mathematics, as well as the resources to perform the observations and studies in astronomy, botany, natural history, among others. In 1700, academies became the centre of scientific knowledge and women were formally excluded from all but a few in the Italian Peninsula. Some women like Émilie du Châtelet created their own academy, but this was still marginalized from the academies created by men for men. The other means of disseminating information was through publishing books and a few women succeeded to do this under a masculine pen name, but eventually some women were able to reveal their identity after the publication of several successful editions.

In the section below, we take a look at the continuing debate on women's rights to education and to hold public positions, taken up again by a few women and men throughout the eighteenth century. Even though some of the 'battles' occur after Laura Bassi's death, the information below provides an overview of the gender issues in the century when Laura Bassi lived.

In England, in 1739, an author known only as "Sophia" (the ancient Greek for "wisdom") published an essay, *Woman Not Inferior to Man*, in which she argued that women were slaves, who had achieved less than men only because they had been given less education. Sophia argued that women should be allowed an independent role in society. In her opinion, they could become doctors, lawyers, teachers, even soldiers, if they were not limited to household duties and if they received a good education. Sophia's piece made little impact, but in the latter part of the eighteenth century, advocates for the education of girls, including Mary Wollstonecraft, defended the concept of universal education. In France, the

mathematician and pioneering social scientist Marie Jean Antoine Nicolas de Caritat, marquis de Condorcet (1743–1794) advocated for universal education for the rich and the poor, and for girls and boys alike. In his *Lettres d'un Bourgeois de New Haven à un Citoyen de Virginie* (1787), he also argued that all professions should be open to both sexes. In his article *Education for Women in the eighteenth century*, Condorcet believed that a similar education should be provided to women and men in order to prevent inequality between the sexes within the family, and for the sake of simple justice. He felt that women had the same right to public education as men did. Later, supporters of the concept of universal education used some of Condorcet's arguments, but it took almost one hundred years to rediscover his specific reasoning on the education of women. The French Revolution, whose banner proclaimed "Liberty, Equality, Fraternity," did not apply these principles equally to men and women in France. This can be seen as a missed opportunity to bring equality to all citizens. In England, at around the same period, Catherine Macaulay (1731–1791), a writer and historian, published her *Letters on Education* (1790), in which she dismissed accepted views on the inferiority of women. She recommended that girls and boys be educated together, do the same physical exercises, and study the same school subjects. She demanded political rights for women, and wanted women to use their education and talent to win in a man's world, just as she felt she had done herself (Frize 2009, 94–95).

Some of the women who supported the education of women believed that any difference between exceptional women and ordinary ones and between men and women would greatly disappear if all persons received similar instruction. This belief was put forward in other centuries and geographical regions, by Marie de Gournay in France in the sixteenth century, by Bathsua Reginal Makin and Mary Astell in England, and by Maria von Shurmann in The Netherlands in the seventeenth century, among others. However, it was only in the Italian Peninsula that some women accessed the privileges accorded to men in the sciences: a degree, lectureship, having access to equipment, membership in the Academy, presenting their work and publishing in the highly regarded academy journal. Laura Bassi is one of the best examples of this type of scientific achievement and commitment which we discover in the next several chapters.

In eighteenth century Europe, the University of Bologna and the University of Padua were unique in that they held doctoral defenses with a few women candidates and awarded a degree to those they judged to be successful. The topics of the Theses were mainly in philosophy, law, and natural philosophy (science). What was even most unusual in Bologna was the offer of a lectureship to a few women and eventually a Chair (professorship) to Laura Bassi. There seemed to be a more tolerant attitude in certain parts of Italy towards the participation of women in intellectual activities, and this is particularly true in Bologna. In Padua, as mentioned previously, the situation was different, as the university decided against admitting more women for over two hundred years after the successful degree obtained by Elena Piscopia. A positive development overall was that women who studied, took part in debates, carried-out research, and published were no longer a source of derision as in the past. Recall the story of Isotta Nogarola who had been

the laughing stock of Verona in the fifteenth century. Now, erudite women became the focus for prestige and social decorum for their family and their city. A few women even managed to hold a lifelong career in science like Laura Maria Caterina Bassi and Cristina Roccati.

Although a similar attitude of tolerance towards learned women also flourished in France at this time, especially in Paris, it did not translate into the awarding of degrees, lectureships or a membership in the French academies. Women in France, Germany, and England could be educated and make serious contributions in science or mathematics, but they had to obtain their knowledge through personal tutors, or they were self taught. Some examples are Gabrielle-Émilie du Châtelet in France, and Maria Winkelmann in Germany. Most of their learning occurred at home, and they never received formal recognition for their learning. Even though women in the Italian Peninsula were also mostly educated at home with tutors, like Laura Bassi in Bologna and Maria Gaetana Agnesi in Milan, their acquired knowledge and didactic abilities were displayed publicly and their reputation grew widely, not only with the governing men in their city, but reaching an international audience of famous men like Voltaire, Father Nollet, and others. The fact that a few women in Italy received a doctoral degree like men was unique and unheard of in the rest of the world.

There was a long tradition in some parts of Italy of women formally associated with universities and with academies. Italian women had been interested in astronomy, medicine, and natural history in the Renaissance and Baroque periods and some examples were provided in a previous chapter. Some form of scientific knowledge had always been part of the Italian learned woman's cultural baggage for centuries, and this provided important precedents to the woman attempting to carve a place for themselves in science in later centuries. As mentioned previously, Italian men had created a two-tier system for the education of women: the top was for the exceptional woman, one with male virtues who could learn and work in science. At the bottom were the ordinary women who would never be allowed to enter the male domain, but who could learn elements of science to become better mothers and help educate their children. Francesco Algarotti's *Newtonianismo per le dame* (Newtonianism for ladies) published in 1737 is an example of a book on the science of optics written in simple terms and with little mathematics for women in the bottom tier. In his book, Algarotti included explanations on matters of general interest such as rainbows, tides and comets. But the exceptional woman had to be proficient enough in Latin and in mathematics to go directly to the original source of Newton's works and so would not have recourse to this elementary, patronizing explanation of physics. Algarotti's book was placed in the Index of restricted books by the Vatican two years after its publication and several of his subsequent editions suffered the same fate because of the inclusion of the Copernican solar system. So now, ordinary women only had access to the original book by Newton in Latin, difficult to understand, so in reality, no longer access to Newtonian physics.

The next chapter presents Laura Bassi, her education, and her marriage.

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Chapter 4

Laura Bassi: Her Education and Her Marriage

The chapter presents Laura Maria Caterina Bassi as a young girl receiving a solid education in languages, philosophy, logic, metaphysics, and science. We follow Laura as she becomes a most erudite woman, disputing with philosophers and academicians in her home and City of Bologna. The chapter presents Laura's dilemma concerning marriage and her decision. We examine the impact of her decision on her studies and her career.

Laura was born in Bologna on October 29, 1711, the single surviving child of Rosa Cesári, about whom little is known, and Giuseppe Bassi, a lawyer from Modena employed in Bologna as governor and chancellor for estates and houses of several of Bologna's senators and vice-legates. Laura's father, a man of modest means, was in frequent contact with members of the City's aristocracy through his work.

When she was five years old, Laura began to study Latin, French, and arithmetic under the supervision of a cousin, Father Lorenzo Stegani. Although her future serious involvement in science was not yet envisaged, a solid knowledge of Latin was definitely an important part of her education since most publications and books on science were still written in that language in the early part of the eighteenth century. Laura would have been unable to write and defend Theses if she had not been able to understand and express herself in Latin. Few women were proficient in Latin, so this again marked the difference between Laura Bassi and others of her sex, even if the latter were educated women. Most women, including those belonging to the nobility, did not master Latin. In fact, the Marchioness Elisabetta, who was present at Laura's defense, admitted not having understood any part of the debate (Logan 1991, 13; 1999, 494).

By the age of thirteen, Laura was studying philosophy under the tutelage of Gaetano Tacconi, the family doctor who had degrees in philosophy and medicine. Tacconi lectured at the University of Bologna on anatomy and medicine and he was a member of the Academy of Sciences of Bologna (Logan 1994, 786). After having observed Laura's great intellectual abilities, Gaetano Tacconi broadened her curriculum and began to teach her logic, metaphysics, and some science that included elements of Newton's *Opticks*. Laura's interest in Newton's theories was already visible at this early stage.

Between the ages of thirteen and twenty, Laura was given the opportunity to participate in many disputations on philosophical topics in her home in the presence of the most noted natural philosophers in Bologna, including several members of Bologna's Academy of Sciences. It was soon obvious to her tutor, to her family, and to several members of the Academy that she absorbed all knowledge with ease and debated with brilliance. Her reputation as a prodigy spread quickly and, in 1731, even Cardinal Lambertini, the future Pope Benedict XIV, began to attend evenings at the Bassi home. The Cardinal was most impressed by the young woman's extensive knowledge and by her debating abilities and he soon became her most important supporter and patron (Logan 1994, 787, 1999, 494). By this time, Laura had also mastered Greek, French, and Philosophy, and her house was the scene of intense philosophical debates involving Bologna's most prominent intellectuals (Elena 1991, 511). If we look at the topics of her Theses, they continue in the same vein as her studies. Eighteen of her doctoral Theses were on physics; Aristotelian influences can be detected in Thesis IX on the physics dealing with motion, whereby the surrounding medium was viewed as having the capability to impart movement to the object. Cartesian influences can be detected in *De causis*, also in Thesis IX, whereby no second cause had such a force that it could act at a distance. Other Cartesian influences are found in the physics section, particularly in the concept of extended matter. Paracelsian influences are apparent in the physics section in *De meteoris*, Thesis XIII, on thunder and lightning. (Note: Born in Switzerland, Theophrastus Philippus Aureolus Bombastus von Hohenheim (1493–1541) was an alchemist, physician, astrologer, and philosopher.) Laura Bassi's Theses X and XI in the physics section show an influence of Galileo and Torricelli [Evangelista Torricelli (1608–1647), an Italian physicist and mathematician, was a pioneer in the study of the motion of fluids] in *De motu*, claiming that the motion of liquids was dependent on gravity. Thesis V of the section *De anima* illustrates Newton's influence, specifically his theory on light and color (Logan 1994, 790).

Laura's choice of material for these Theses shows a definite interest for the subject of physics. Whereas her studies with Tacconi had mainly centered on Aristotelian, Cartesian, and Galenian philosophy, and only a little on Newton, it is interesting to note that Laura added Newton to her studies. It is at this point, the defense of a second set of Theses that Laura began to distance herself from her teacher Gaetano Tacconi. He had insisted that she present this second set of Theses on the subject of Ethics, but Laura objected as she felt this would take her away from her strong interest in natural philosophy (science). In this decision, she was supported by Cardinal Lambertini who forced Tacconi to back-off and abandon his suggestion (Logan 1994, 793). After her defense and her separation from her teacher, Laura spent several years to study advanced mathematics (calculus) and Newtonian physics with Gabriello Manfredi (1681–1761), a mathematician and professor at the University of Bologna (Fantuzzi 1778, 12).

In spite of her fame and reputation, the fact remains that Laura, being a girl, depended on being taught at home, by men who had a connection with her family, as was common practice in her time everywhere in Europe. However, the majority

of girls in the eighteenth century learned sewing, household duties, the basics of reading and arithmetic, and were provided books that encouraged virtue and piety. On the other hand, Laura's education consisted of subjects considered masculine such as Latin, Greek, French, as well as Aristotelian, Cartesian philosophy, and Newtonian physics, the latter being an exceptional choice. Few women received an education in science, mathematics, and philosophy at that time. Examples in the Italian Peninsula at the time were Maria Gaetana Agnesi (1718–1799) in Milan, and Cristina Roccati (1732–1797) in Rovigo and Bologna. In France, Émilie du Châtelet was also highly educated in science and mathematics. Laura, Maria Gaetana, Cristina, and Émilie, although sharing a real love of advanced mathematics and science, and becoming quite adept in these subjects, followed a different path in their life and work than Laura Bassi. [Chapter 10](#) presents a short biography of these other women involved in science in Laura's time.

It does not seem that Laura Bassi's mother played a role in her scientific education. A mother's role was usually to provide guidance to daughters on activities such as sewing, housekeeping, and other so-called womanly tasks. Her father obviously encouraged her education by providing tutors from a very tender age. He was also willing to have eminent men attend evening disputations with Laura in his home. He realised early how talented she was and how easily she acquired all the knowledge imparted to her. This middle class lawyer would have been pleased to see many eminent men impressed with his daughter. Documents and letters in the Bassi family archives do not mention any obstacle posed by her father to the plans of the authorities of the City to make Laura Bassi a model of erudition, an exceptional woman.

Some fathers of bright young women tried to profit from the fame of their daughters, to advantage themselves and their family. Examples of these are Giovanni Battista Cornaro Piscopia, the procuratore of San Marco in Venice and the father of Elena Lucrezia Piscopia who was awarded a degree in Law and Philosophy at the University of Padua in 1678. Elena's father benefited greatly in his City of Venice from the fame acquired by his daughter's great learning and by the very public and brilliant defense. Another example is the case of Pietro Agnesi, a rich merchant in Milan and father of the mathematician Maria Gaetana Agnesi. This does not appear to have been the case for Laura Bassi's father as he seemed to have played a minor role in the public displays of his daughter's knowledge. These 'spectacles' were arranged by the City of Bologna and its University. Her tutor, Gaetano Tacconi, played a major role in these plans, preparing Laura for the important events of 1732. In the early months of 1732, before her formal defense on April 17, Gaetano tested Laura with disputations in her home in the presence of several members of the Academy of Sciences of Bologna, including its president, Francesco Maria Zanotti, and the Archbishop of Bologna Prospero Lambertini. These brilliant displays were arranged so that Laura Bassi would be invited to become a Member of the Academy of Sciences of Bologna (Logan [1991](#), 12). This actually happened on March 20, 1732, just three weeks before the first public defense of her Theses. It was an extraordinary step, but really critical if Laura was to become a scientist, a researcher, and an academic like the men around her.

Members of the academy were expected to make presentations (also called disputations) during academy meetings and to publish papers on their scientific work in the journal of the Academy, which was shared with the Institute (Istituto delle Scienze). The journal of the Bologna Institute was called *De Bononiensi Scientiarum et Artium Instituto atque Academia Commentarii* and will be referred to as *Commentarii* throughout the rest of this book. Laura Bassi should have been able to participate in the meetings and activities of the Academy of Sciences of Bologna, but several members of the Academy voiced their disapproval and wanted her membership to be purely honorary. Laura was not expected to attend meetings and she would not be asked to make presentations or to publish in the journal. This was contrary to Laura's own expectations and plans, so in the years to come she developed strategies to achieve her goals.

So a young Bolognese, Laura Bassi, gifted with a capacity for learning considered so extraordinary in a woman, was awarded an university degree in philosophy, was appointed as a member of the city's Academy (Istituto delle Scienze), was provided admission as an honorary member of the college of doctors of philosophy, and was given a lectureship at the City's University (Cavazza 2009, 283). What is most extraordinary about Laura Bassi is that she actually turned her education and honorary appointments into a real lifetime career, something that only men had been able to have up to that point in time. She was determined to become an active scientist, teacher, and researcher and to be considered and respected as such by her peers.

Marriage to Giuseppe Veratti (Also Spelled Verati)

While Laura was single, gossip grew about her meeting men, even if the object was simply to be involved in intellectual debates and discussions on philosophy and science. In spite of having obtained a degree and a university position, her sex, and the fact that she was a single woman, presented major obstacles to her career, obstacles that did not exist for the men. The gossip created a real dilemma for Laura: Would marriage stop the gossip that she was meeting men for assignations of a womanly nature, while all along she only did this to pursue her work in science? The other issue was that many of the men who had supported her in getting a degree and a lectureship believed an 'extraordinary woman' should remain single and virtuous, and if she did get married, she should abandon her studies and intellectual activities, as so many women had done before her.

If Laura had remained single, the defamatory comments and the gossip would probably have continued. But if Laura decided to marry, she needed to find a husband who would understand and support her commitment to science. Of course, if she married, she was bound to have children and be burdened with many chores that had little to do with science. Laura must have given serious thought and weighed the benefits and costs of her decision. Marriage would likely stop the

gossip, but she would lose the image of a virginal virtuous woman totally dedicated to her learning. Laura opted for marriage.

Laura Bassi married Giovanni Giuseppe Veratti (1707–1793) on February 7, 1738, in the Basilica San Petronio in Bologna. Giuseppe was fourth of the nine children that Francesco Veratti (1661–1716) and Rosalia Calvoli had. A former student of Iacopo Beccari, Giuseppe had graduated in natural philosophy and medicine in 1734. Although his degree was in medicine, he was more interested in physics, which was a point in common with Laura. In 1737, just before his marriage, Giuseppe was appointed lecturer in physics at the University of Bologna.

Giuseppe's father was also a physician. When Giuseppe's father died, he left his house in Ravenna to his four sons (Ferdinando, Giuseppe, Giovanni Pietro, and Giovanni Battista). But since Giuseppe worked in Bologna, he moved in with Laura and her parents after their marriage. He had no home of his own in that City (Logan 1991, 25–26). Laura eventually inherited her parents' house. Later, she also inherited from a cousin, Carlo Filippo Bassi, so she had greater financial assets than her husband.

Giuseppe was a Member of the Academy of Sciences of Bologna and had presented six dissertations before his marriage: One in 1733 on the aurora borealis, three in 1734 on medicine, and two others in 1735. He began to be known in science circles, but much less than his wife who was already quite famous by the time they were married. Her fame was not yet based on her scientific achievement, but rather on the public display of her prodigious talent, thought to be uncommon for her sex; and it was also due to the support she received from powerful men (Logan 1991, 26).

The marriage succeeded in putting an end to the gossip and made it easier for Laura to attend meetings of the Academy. She attended most of these in the company of her husband, but she also went without him when he was away (Logan 1994, 795). But her attendance provoked mixed reactions. Giampietro Zanotti, President of the Academy of Sciences of Bologna, wrote to Padre Giampietro Riva on March 7, 1738: "She took a young strong husband...she has shown that philosophy had not been enough, and she decided to take, what other women without learning, desire ardently...Perhaps you would have preferred to have seen her as a virgin, what is one to do, there is no more remedy" (Logan 1991, 25).

The reaction of Giovanni Bianchi (1693–1775), a physician from Rimini, was one of the most positive. He wrote to Laura on April 13, 1738: "As you can see, I am not one of those rigid men, who ominously interpreting matters, might almost condemn your marriage as a sign of remission from studies" (Logan 1991, 25).

A less positive note was written by Giacomo Amadei, recorded in *Diario di Bologna dal 1732 al 1743*: "This marriage does not fill with satisfaction the citizens, who did not mince words in declaring it (so), not only because of the bridegroom, who is a man of half merit, but more because of the bride, who might have done better if she had remained virgin in any retreat" (Logan 1991, 25).

The most negative comment was an anonymous letter thought to have been written by Alessandro Macchiavelli. Although he had written several essays in

defense of the education of women, most people at the time believed that marriage and intellectual life were mutually exclusive. The letter said:

In the year of our Lord 1738, 7th of February, Laura Bassi, doctor of philosophy and member of the Academy of the Institute of Sciences, chosen public lecturer in our ancestral Archiginnasio... having (so far) despised the weaknesses of the flesh, the whole town was asserting that she was about to be consumed solely by the perpetual love of science and of God, unexpectedly with feminine deliberation, she changed the virginal decency into conjugal bonding when 26 years old...and in hated secret...she was married to Giovanni Giuseppe Veratti, doctor of philosophy, public lecturer, moreover of little fame in Italy, works and science...You have stained your glory (Logan 1991, 25).

The letter reverts back to the patriarchal and conservative view that women should remain single and virtuous if they were to be involved in study and intellectual activities, like the virginal Minerva. It seems that whatever decision Laura made on whether to marry or not, there would be complaints and criticisms.

Laura felt she had to justify her marriage to men who had expended so much effort to support her Theses defense, the obtention of an university position, and a membership in the Academy. On April 26, 1738, she explained to Giovanni Bianchi:

My domestic circumstances have induced me to change my mind, and take this resolution, as I am sure to have found in you one who can estimate things as they are, you will be incapable of condemning it (the marriage) as an almost total detachment from these studies I am under obligation to profess and to which I have indeed expected to be able to quietly attend in this life, and therefore I have chosen a person, who walks the same path in the arts and through long experience, I was certain would not deviate me (Ceranski 1994, 224–225; Logan 1991, 23).

In her letter, Laura mentions her domestic circumstances, which referred to society's expectation that unmarried women should not attend meetings with men, even if this was to participate innocently in discussions on science and the exchange of knowledge. Laura also reassured Bianchi that she would not abandon her studies. She also wanted to justify her choice of Giuseppe Veratti as her partner, explaining that he was also involved in intellectual pursuits and would support the continuation of her own work. Laura felt she had an obligation to fulfill, which she meant to honour, due to the salary attached to her lectureship. She seriously continued her studies in view of eventually reaching her goal: a career in research and teaching.

The marriage between Laura and Giuseppe can be viewed as a scientific partnership between two people sharing a common interest in the science of electricity, magnetism, heat, and medicine. Laura had far more knowledge of mathematics than Giuseppe and higher intellectual abilities. She was involved in physics, especially in mechanics, hydraulics, and optics; Giuseppe was more knowledgeable in medicine (Logan 1999, 501–2). On the marriage, Cavazza writes:

Her knowledge of literary culture, i.e. Greek, Latin, French, in addition to Italian, was also greater than his (Giuseppe) and she composed highly appreciated occasional verse in the Arcadian fashion. Thus, all the conditions necessary for a relationship between equal

partners, in terms of family life and scientific collaboration, were present in the life of the Bassi-Veratti couple. This was not only unusual, but almost inconceivable in the social, judicial, and cultural context of the eighteenth century, and much less so in the Pontifical State (Cavazza 2009, 116).

The marriage was a positive move for Laura. She could now attend meetings of the Academy more comfortably. Without her presence at these meetings, it would have been difficult to remain up-to-date in her scientific work. The marriage enabled Laura to escape from the ornamental role the authorities in Bologna had expected her to play. Without the status of a married woman and the moral support of her husband, she would not have been as free to carry out her research and teaching (Cavazza 2009, 117).

Of course, pregnancies and children were a consequence of marriage. There is no agreement about the number of children the couple had. In 1782, her first biographer, Giovanni Fantuzzi (1778), claimed she had twelve children (seven boys and five girls). There is documented evidence for nine children (five boys and four girls), of which four boys and one girl survived infancy (Busi 2001, 258). It is possible that three additional pregnancies did not lead to live births and so may not have been recorded. The nine children whose existence is documented are: Giovanni Francesco (1738–1800) became a canon in the parish of San Petronio and a professor of theology in the Collegio Montalto; Caterina was born and died in 1739; another Caterina was born and died in 1742; Ciro (1744–1827) married Maria Anna Margherita Cappi in 1772; a third Caterina was born and died in 1745; Giacomo (1749–1818) also became a canon; a fourth Caterina (1750–1768) took the veil and died fairly young; Flaminio was born and died in 1751; and the last child, Paolo (1753–1831) married Maria Marchesini in 1781. He was a physician like his father and his main interest was in experimental physics like his mother. He is the only one of the Bassi-Veratti children who had children: three boys and a girl and another child who died in infancy (Busi 2001, 258).

Laura and Giuseppe earned a fairly modest living. In that period, it was common for middle class families like the Bassi-Veratti to have servants. Logan mentions the family had three female servants who lived with Laura's mother until the latter's death. In spite of this help, there would have been much for Laura to do as a mother of several children; there would also be the trauma of losing four babies in infancy and the physical demands of nine (or twelve) pregnancies. It is remarkable how Laura pursued her work in science and manage to accomplish original work in spite of the burdens of womanhood and the presence of detractors all along the way. But, it took several years for Laura Bassi to be able to teach and present her research work in her field of choice: experimental physics. In the next chapter, we examine the slow development of Laura's career and discuss the views of men who supported her and those of her detractors.

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Chapter 5

The Slow Start of Laura's Scientific Career and the Bolognese Community's Response to her Work

This chapter explains how eighteenth century society viewed the role and intellectual work of 'exceptional women'. This view restricted Laura to the world of literature in spite of her overwhelming interest in science and mathematics, between the years 1732 and 1745. We examine how Laura felt about the role imposed upon her. The chapter discusses why her career in teaching and research in science was slow in getting started. Yet we see that she continued to develop her knowledge in the fields she loved. The next section looks at the few classes Laura was allowed to give and how she managed to increase her teaching. The chapter ends by presenting views of the men who were opposed to Laura's participation in the scientific community and of those who supported her role and development in that community.

In the humanistic tradition, presented earlier in this book, society expected 'exceptional women' to concentrate their intellectual efforts on literary works. The elite society of Bologna was no exception, and this was a determining factor in what happened to Laura Bassi after she obtained her degree. However, this view differed radically from Laura's own interests and plans.

In spite of the obstacles put in her way, Laura was determined to pursue her scientific studies and to be taken seriously by the men in her sphere of work. The honorary role they had in mind for her, between the 'spectacles' in which she was expected to perform, was far from her own views. She managed eventually, step by step, to achieve her ultimate goal: to become a part of the network of natural philosophers, debating current science questions with them, and performing original work which eventually became part of her teaching and of her scientific presentations at the Academy. But it took much patience, time, the help of powerful patrons and supporters, as well as her clever strategies for Laura Bassi to succeed in achieving her ambition.

Some of the elite men of Bologna had a plan in view of Laura's extraordinary talent and knowledge. Giampietro Zanotti wrote to a colleague (Padre Giampietro Riva) on June 22, 1732, referring to the defense of the second set of Theses: "The exercise was to enable Bassi to ask the Senate of Bologna for a lectureship at the University" (Logan 1991, 13). Everyone was aware that Laura, as a woman, would not have obtained a degree and could not claim an academic position unless her

abilities and knowledge of philosophy and science were clearly demonstrated, widely known, and respected. Each of the public events in which she was involved were carefully planned and orchestrated by the elite men of Bologna. Each of these events marked important steps for Laura and her future career. As mentioned previously, the disputations in her home prior to the first Theses defense led to the invitation to become a member of the Academy of Science of Bologna (March 1732). The defense of the first set of Theses resulted in a doctoral degree. The defense of the second set of Theses led to an appointment as Lecturer at the University of Bologna with a yearly salary of 500 lire. The fact that she was a prodigy and an 'extraordinary woman' reassured the men of Bologna that each of the public displays would be extraordinarily successful. After obtaining a degree and a lectureship, Laura would have been called upon to teach students on a regular basis, perform research at the Institute and present scientific results at the Academy's meetings, if she had been a man.

But Laura was a woman, and in spite of having the degree and a confirmed appointment as lecturer on October 29, 1732, the university administration did not expect Laura to give regular classes to male students. The City, the Academy of Sciences, and the university's governing body, which had so spectacularly recognized her talents a few months before, now expected her to be content with honorary appointments and to perform the roles they set for her when needed. Even the Academy, which had invited Laura to become a member, did not expect her to present her scientific work at their meetings, publish in their journal, or even to attend meetings.

Laura had become quite famous after the public defenses and the ceremonies that followed, and the City of Bologna and its University had both improved their image and reputation. The spectacles involving Laura Bassi as the main character worked well for all except for her.

A Commissioned Author (1732–1738)

There were several reasons for the slow start of Laura Bassi's scientific and academic career: (1) The restrictions put on her teaching of science and philosophy by the University's officials; (2) the opposition from members of the Academy of Science of Bologna to her active participation and her attendance at their meetings, even after her marriage; (3) the culture of the time which expected intellectuals, and especially 'exceptional women', to be humanists, to write poetry and sonnets, especially when requested to do so by important citizens of the City.

Laura Bassi's fame inevitably led to frequent requests to write such pieces for weddings, births, and many other types of special events in the City. Her contemporaries expected her to be a woman of letters, not one involved in science. Thus Laura was coerced into literary activities by her social obligations to fulfill the expected role of an 'extraordinary woman'. Her attempts to put an end to this type of writing before her marriage failed. After receiving another request, from a

countess to commemorate a niece's wedding, Laura complained to Giampietro Zanotti in a letter on February 9, 1737: "Despite my most fixed intention, which I have repeated a thousand times, of no longer composing poetry, I have to bother you again with one of my sonnets" (Logan 1991, 20–21). From that statement, it is easy to conclude that Laura found these requests a burden that distracted her from the subjects she was determined to pursue: science, mathematics, and philosophy.

Laura thought little of her literary works. Laura's friend, Flaminio Scarselli, representative of the Senate of Bologna in Rome, asked her to send him a list of her works in his letter of July 20, 1743. Laura's response to Flaminio in August mentioned the two sets of Theses defended in 1732 and the special lectures on philosophy and science she had been asked to give at the University in December 1732. In the list of works provided in her letter, she omitted to include any of her poems or sonnets. When Flaminio wrote back to her, he scolded Laura for ignoring these works (Logan 1991, 21; Cenerelli 1885, 14–16). In spite of Laura's indifference to her literary works, they were actually published more frequently than her work in science, even though the latter occupied most of her working life. She persisted in her literary writings until 1745 when a major event occurred that changed her life and her work.

In the meantime, while engaged in responding to requests for literary works, she continued to study science, especially experimental physics and the new mathematics (calculus). In the summer of 1737, her mentor and friend Giovanni Bianchi advised Laura to learn English rather than Greek, and he presented her with a book of English grammar. Bianchi also encouraged her to abandon the writing of poetry and keep more time for her work in science, particularly on her study of Newtonian concepts and experiments. With the publication of Newton's major work, *Principia*, Laura could now dwell in greater depth into Newtonian concepts to add to her previous knowledge of his work on optics.

Laura Bassi, a Teacher of Science and Mathematics

Laura's formal appointment as a lecturer at the University of Bologna was an important step in her growth as a scientist, even if she was not expected to teach classes on a regular basis. Elena mentions that Laura gave an inaugural lecture on June 27, 1732, titled: *De aqua corpora naturali element aliorum corporum parte universi*, which was published with the same title (Elena 1991, 512). It is later that year that Laura was formally appointed as a Leturer; as mentioned previously, it was in minutes of a meeting on October 29, 1732, that the academic Senate granted Laura a salary of 500 lire per year and the title, but defined her duties restrictively. The University wanted to inscribe her in the roll of Professors of Philosophy without Laura exercising this commitment (Logan 1991, 14). The dates for lectures that Laura was to give were to be determined jointly by the papal legate and the gonfaloniere (Findlen 1993, 450). The schedule of classes (*rotuli*) at

the University of Bologna did announce lectures by *Dottoressa* Laura Bassi. It is likely that Laura lectured at the Archiginnasio, but less frequently than her male colleagues. We can assume that classes given by a woman with an extraordinary reputation in her City would have aroused great excitement in the intellectual milieu of Bologna. These classes were not Laura's only scholarly work; she also undertook intensive teaching at home and created a laboratory in which she continued her work in experimental physics for many years, especially after her marriage to Giuseppe Veratti (Elena 1991, 512).

In a letter to Flaminio Scarselli in 1743, Laura described the two lessons she had given at the University on December 18, 1732. The first lesson dealt with the need for moderation in philosophical studies and the second was on logic. These were appropriate topics for someone with a lectureship in Universal Philosophy (Logan 1991, 19). But Laura Bassi's classes remained irregular.

Beginning in 1733, Laura was called upon to argue on anatomical lessons given by others at the university. These were attended by several officials, rendering them more formal than regular lectures would have been (Logan 1994, 20). The anatomical lessons in the Archiginnasio were a tradition that began early in the fourteenth century and was still very much in vogue in Bologna during Laura Bassi's time. Every December, public dissections of human bodies were performed in a theatre, attended by eminent men of the city and of the university. It was a sort of carnival, an occasion to celebrate. In addition to the dissections, lectures were given and debates were held. The public could attend, both women and men, which seems to have made Laura's role more acceptable than teaching all male student classes at the University. As usual, the administration of the university made sure Laura's lectures and debates were highly public affairs. This reaffirmed their intention to make their University and City famous by showing off their prodigy, their 'extraordinary woman', to the world. Laura was not necessarily comfortable with these spectacles, but she knew what was expected of her and she complied.

Between the years of 1732 and 1738, Laura continued to be invited to debate on topics of philosophy and science in the City's patrician houses as well as in her own home. Foreigners heard of her fame and several were keen to meet her and to dispute with her (Cavazza 2002, 283). Her public teaching remained sporadic and occurred just when she was called upon by the authorities. As mentioned previously, she was unable to present her ideas and work at the Academy because of the strong opposition to her participation by several of the members, again because of her sex. Laura had hoped that after her marriage she would be able to concentrate uniquely on her scientific studies and research. She was keen to justify the salary she received from the University, so she continued to provide yearly disputations and lectures at the carnival-like anatomy lectures in the *Teatro del Archiginnasio* at the University. She began to be involved with these special lectures in 1734, while the respected anatomy professor Domenico Maria Galeazzi dissected the body of an executed criminal.

It was only in 1737 that the University's administrative body (*Assunteria di Studio*) officially announced that, in spite of her sex, Laura Bassi could give a

lesson in each academic semester (Logan 1991, 20). In 1739, Laura requested a pay increase, referring to the several lectures she had given at the Archiginnasio, especially at the dissection events. The University administration responded by increasing Laura's salary by 160 lire per year and gave her the official permission to teach regular classes (Logan 1991, 28). However, it is likely that the formal lectures given by Laura Bassi to male students remained sporadic. An important factor to consider is that Laura was mainly interested in the new science, which was based on performing experiments to demonstrate physical concepts. But the curriculum at Bologna University and in many others concentrated on Cartesian and Aristotelian concepts and remained fairly theoretical. Another obstacle to her teaching at the University occurred when the Spanish Troups arrived in the Italian Peninsula and Bologna became part of the invaded territories. This resulted in a serious disruption in the governance of the City and led to the temporary closure of the University. More disruption occurred in Laura's teaching activities because of illness, as noted by Laura herself in a letter to Flaminio Scarselli. She explained to her friend that both the new Legate (Alberoni), appointed between 1741 and 1743, and herself, suffered from serious illnesses (Logan 1991, 29).

After the political and military disruptions were over, her former mathematics teacher, Gabriello Manfredi, tried to have Laura regain permission to teach at the University, but this did not happen. However, in 1749, with pressure from a new Cardinal Legate, and the shortage of teachers in the subject of anatomy, Laura Bassi was given permission to give anatomical classes. But these classes were not held on a regular basis in spite of the pressure exerted on the administration by the Cardinal Legate and Laura's own determination to earn her salary. Unfortunately, the lectures were not on experimental physics, her chosen field of interest (Logan 1991, 29).

For all these reasons, Laura established her own school at home, where she could teach theory and conduct experiments with her students, thus training them in the new scientific method. It was quite common for university professors to supplement their teaching at the university with classes in their home. In Laura's case, this was especially important for several reasons: first, because the university had not invited Laura to give regular lectures; second, the lectures would enable Laura and Giuseppe to convey the results of their research in experimental sciences and teach the new theories that explained them.

Laura's first attempt to give lectures twice a week at her home on philosophy and geometry initially failed. The reasons for this are not explicit, but it can be assumed that her sex again would have prevented students and others to take her classes seriously. However, she tried again later, in 1744, this time with her husband, and the classes were now very well attended. Giuseppe taught experimental physics and Laura taught mathematics; the couple divided the work between themselves. By 1749, Laura's course on experimental physics that complemented the theoretical lectures given at the university was well established. The course was very successful and continued to be offered for around thirty years, until the day of her death in February 1778. Even though both Laura and Giuseppe shared the load of teaching, the course was mostly her responsibility. Participants

were men from Bologna, two of her children (Paolo and Giovanni), and included some foreigners (Logan 1991, 27).

As Laura explained to Flaminio Scarselli in a letter dated June 14, 1755:

It is six years since I began giving private physics classes in my house daily, for eight months of the year. I support these [classes] myself, paying for all the necessary equipment apart from that which my husband had made when he was lecturing in philosophy. The classes have gathered such momentum that they are now attended by people of considerable education, including foreigners, rather than by youths. (Elena 1991, 513)

At the time, the teaching of experimental physics at the Bologna Institute of Sciences was the responsibility of one man, the head of the physics section, who decided the content of what should be taught. As Laura explained to Scarselli, this curriculum was narrow and did not provide a sufficient variety of courses in experimental sciences. By teaching in her home, as others did at that time, Laura was able to cover the topics she considered most important, interesting, and promising, especially since the subject of experimental physics was becoming an important topic and an essential element of modern science (Logan 1991, 28).

The Laboratory at the Bassi-Veratti Home

For a successful establishment of classes in physics, mathematics, and experimental physics in their home, Laura and Giuseppe needed to acquire instruments and develop a well-equipped laboratory. The teaching of experimental physics comprised theory, followed by a series of experiments and demonstrations that provided evidence for the concepts taught in the lessons. This meant that the Bassi-Veratti family had to spend a lot of money to equip a suitable laboratory. At the time of their marriage in 1738, Laura and Giuseppe acquired several instruments for their experiments and demonstrations for the students enrolled in their classes at home. The couple's main preoccupation was to mount a well-equipped laboratory with instruments that were in line with the main topics they would teach. In addition to the instruments purchased by the couple, they acquired many others through gifts. Laura was sent lenses, books, articles, and many instruments by famous natural philosophers (scientists) like the Abbé Nollet and from instrument makers like Mr. Giuseppe Ortega from Spain. This certainly happened because of her fame and reputation as an excellent researcher and professor of experimental physics. For example, in 1753, Laura received from Giuseppe Ortega two prisms. Abbé Nollet also sent her a package containing two letters and a lens to focus refracted light.

In 1767, Abbé Nollet sent Laura more instruments and a letter in which he says: "Here are a few trivialities to amuse yourself, and that you can show to the physics amateurs who frequent your *Museum*." He was referring to her private laboratory which was being visited by several famous scientists. Nollet included a description of the composition, the use, and operation of a spectacular machine he had

invented, which could make light patterns in any form one wished using an electrical current and conducting and insulating parts. The current was sparking from metal to metal with insulators in between. He provided many figures explaining how to construct this type of machine (Cenerelli 1885, 99).

Throughout this period, Laura expressed some concern about the considerable expense of the equipment required for the courses. In her letter to Scarselli of July 16, 1755, she wrote: “As for my physical experiments, and in view of the fact that the continual expense that arises requires some form of assistance if I am to advance and perfect them, I am almost in despair” (Elena 1991, 514). The couple unsuccessfully petitioned the government to fund some of the equipment. However, it is possible that they received payment from the students and men who attended the classes in their home. The family did not seem to have severe money problems. In fact, in 1769, they could afford to buy a house and some land outside of the city.

A second function of the laboratory was to enable Laura and Giuseppe to conduct many research projects on the topics of mechanics, electricity, physiology, medicine, and eudiometry (assessing the purity of the air or the amount of oxygen in it; or measuring the change in volume of a gas mixture following a physical or chemical change). The electric machine acquired by the couple, a multi-globe machine, is believed to be an improved version of the Hauksbee model invented at the beginning of the eighteenth century (Cavazza 1995, 715). The other term for this machine is a Leyden jar. The Institute had acquired a single-globe machine in 1743. Electricity had become a hot topic in the middle of the eighteenth century and there were several opposing theories informing this debate.

In her article, *Laura Bassi e il suo gabinetto di fisica sperimentale: realtà e mito* (Laura Bassi and her laboratory of experimental physics: reality and myth), Cavazza lists an inventory of the equipment acquired by the Bassi-Veratti couple to establish a laboratory in their home. In addition to their research on these topics, they were able to do some demonstrations of the theory to students attending classes in their home (Cavazza 1995, 715–753).

Historically, laboratories in experimental physics began in England and Germany in the seventeenth century, but much development occurred after the work of Newton and Leibniz began to be known in Europe in the eighteenth century. In the Italian Peninsula, already in the academic year of 1715–1716, students at the University of Bologna could use the laboratory established by Iacopo Bartolomeo Beccari (1682–1766) at the Institute, for two hours a week, to complement his theoretical lectures. Beccari’s experiments were mainly focused on studies of the air. Another laboratory was established in Padua in 1740, a year after a Chair on this subject was created by Giovanni Poleni (1683–1761) at the University; this laboratory was called Teatro di Filosofia Sperimentale (Theatre of Experimental Philosophy). In the years that followed, physics laboratories and their related courses multiplied quickly. Father Jacquier (1711–1788) was in charge of teaching the subject between 1740 and 1750 and he established a laboratory on the top floor of Università della Sapienza in Rome. C.A. Guadagni was the first professor of experimental physics at the University of Pisa; he offered these courses, which

included a laboratory, beginning in 1746. He also taught on the topic of electricity in Florence. In Torino, Giambatista Beccaria (1716–1781) held the Chair on this subject in 1748 and he established a laboratory equipped with a rich inventory of instruments he had acquired from Father Nollet in 1739 (Cavazza 1995, 716–717).

More Teaching by Laura Bassi

In addition to her intermittent role at the University of Bologna, Laura was involved with one of its Colleges. In 1766, Alessandro Albani (1692–1779), Cardinal Protector of the Collegio Montalto, nominated Laura as preceptor in experimental physics for students of the College. The College, founded by Pope Sixtus V (1520–1590), was a free seminary for students of the Marche Province. Students ranged in age between eighteen and twenty-four, intending to obtain a degree in law or in theology and law. From 1704 onwards, science was added to the curriculum. Laura was one of the lecturers in science and held this position until her death in 1778. As for her classes at home, she taught by explaining the theory and demonstrating principles through experiments (Logan 1994, 788; 1991, 29).

Laura was seriously involved in scientific work at that time and aware of current debates in her field, which made her a good teacher of theoretical and experimental physics. Although some historians minimize the importance of her teaching, likely because much of it was done in her home, they fail to see that this situation provided more freedom for her to teach what she felt was important, such as Newtonian principles, the new mathematics, and experimental methods, while the university continued to teach mostly theory.

Laura eventually managed to receive the highest salary at the University of Bologna. By 1760, she earned 1,200 lire a year, a salary equivalent to that of Domenico Galeazzi, the most famous anatomist of the time. She earned more than some of the other famous scientists like Domenico Guglielmini, who earned 900 lire, or Iacopo Bartolomeo Beccari and Giampietro Zanotti, both earning 800 lire per year (Elena 1991, 514).

The Bolognese Community's Response to Laura Bassi's Work in Science

As we have seen previously, Laura was coerced into literary writings between 1732 and 1745. But she continued to study and develop her knowledge in mathematics and science, with a strong interest in the new science of Newton, while most of Europe and Italy still focused on Cartesian, Galenian, and Aristotelian philosophy. But Laura was still not integrated into the science world so well

guarded by the men. We now examine how the scientific community responded to Laura's wish to be a woman seriously involved in research and teaching in science and mathematics.

Although several men supported Laura's interest and work in science, there were persons who objected to the honours bestowed upon her. These men mainly objected to Laura actively pursuing work in science, but they had little objection about her literary work since she was expected to be a humanist like the other 'extraordinary women' before her time and in her era. Some of the men objected to Laura teaching male students at the University and many members at the Academy were opposed to Laura's participation at their meetings. They were most definitely against Laura presenting and publishing work in science.

During the first defense of forty-nine Theses, one of the friars involved in her examination voiced his opinion, stating that the nature of women had not changed since eternity and he would not accept wisdom that could be found in a young woman. Cardinal Lambertini, the future Pope Benedict XIV, silenced him and called him a dunce (Logan 1991, 14). Some women also responded negatively. The Marchioness Laura Davia called Laura Bassi's defense and the degree awarded to her ridiculous, and she objected to the special honours the City bestowed on Bassi. Davia herself had learned Cartesian philosophy from Giovanni Bianchi. It seems that Davia resented the special and differential treatment Laura Bassi received, compared to how other educated women in Bologna had been treated. Davia expressed her resentment in two letters she wrote to Giovanni Bianchi, one on June 14, 1732, and another on June 24 in the same year (Logan 1991, 14).

Her former teacher Gaetano Tacconi had been educated in Cartesian philosophy, whereas Laura Bassi had been increasingly interested in Newtonian theories by the time she gave her first lecture in December 1732 (Logan 1994, 792). After her refusal to present Theses on Ethics suggested by her former teacher mentioned previously, she became independent from him. He, on the other hand, took more credit than was his due for her education. Some poems lauded him for Laura's resounding intellectual success. Gioseppo Pozzi di Jacopo addressed a sonnet to Tacconi:

...And you, Gaetan, so happy of such deed, in others
(women) no longer look for such a strength, that perhaps
thrown to the wind will be your efforts. Of equal
virtue of such lofty mind, a woman you will not find. (Logan 1991, 16)

Gaetano Tacconi is said to have been a mediocre scholar who participated marginally in the scientific activities of the Academy prior to Laura Bassi's defense and her degree. Giovanni Bianchi and Iacopo Beccari thought Gaetano Tacconi claimed too much glory for himself for a job he had only started. He was quick to drop her and her family when she did not adhere to his wish on the second set of Theses topic. He may also have been upset and jealous that Laura befriended other men in science like Manfredi and Bianchi. Some form of reconciliation eventually took place, with much condescension on his part and much begging on

Laura's side (Logan 1991, 16). Gaetano Tacconi, in a letter to senator Aldrovandi on December 15, 1732, wrote that Bassi's success was due to his great teaching rather than to her own abilities (Cenerelli 1885, 183–184). In her article titled *The Desire to Contribute: An Eighteenth Century Italian Woman of Science*, Logan writes:

[Bassi] may have believed she was entitled to some intellectual independence from her teacher—an independence Tacconi might have been willing to accept from male students but not from a female, who had only been educated in science as a favor on his part. (Logan 1994, 793)

Giovanni Bianchi, who later became Laura's good friend and mentor launched his attack after her first public Theses defense. Although he had not yet met Laura, he read her Theses and he could not understand the fuss people made over a young woman who, in his own words:

[K]new no more than a great number of young men of the same age group, who had studied ordinarily under an ordinary teacher. As this young woman has claimed to distinguish herself from other women, attending to matters she had no business attending, she should have demonstrated to attend them in a distinguished manner. (Logan 1991, 15)

When Bianchi first read the Theses, he noted that Laura Bassi demonstrated some knowledge of Newton's *Opticks*. But at the time, he assumed her knowledge to be superficial. He met Laura at the beginning of 1733 and his opinion of her changed considerably. He saw a young woman with much talent, and he was very impressed when Laura debated and destroyed the Thesis on poisons and antidotes presented by Doctor Azzoguidi at the University of Bologna in June of that year. However, at that time, he believed like many others that her membership in the Academy and her lectureship at the University should remain honorary titles and not be acted upon (Logan 1991, 16). Giovanni Bianchi and Laura Bassi began to exchange many letters between 1733 and 1745 and a great respect grew in Bianchi's mind about Laura's extraordinary talent. In her letters, Laura discussed her studies and her work. In another letter she justified the decision to marry and the choice of her husband. Bianchi sent Laura some of his publications and offered advice for her development. In spite of his traditional attitude, in his correspondence Giovanni Bianchi encouraged Laura to persist in her chosen path. As early as 1733, Bianchi became a strong mentor and supporter of Laura and her work.

Men Who Supported Laura and Her Scientific Work

An advocate of Laura was Iacopo Bartolomeo Beccari (1682–1766), a professor of physics at the Institute of Sciences of Bologna and a man with an international reputation. Beccari was professor of experimental physics in 1728 and in chemistry in 1746 at the University of Bologna and at the Institute, thus he was a colleague of Laura and in her field. He had become a Fellow of the Academy of Sciences in Bologna in 1704 and of the Royal Society in London in 1728 for his

work on luminescence. He was famous for his work on phosphors and his work was said to have had much influence on English research (Cavazza 2002, 16–17). He was also known for having identified the protein *gluten* in wheat. Beccari was also the recipient of letters published in 1758 by Beccaria in a book on electricity; the publication was titled: *Dell'elettricismo: Lettere di Giambattista Beccaria dirette a I. B. Beccari* (Bertucci 2009, 18).

Beccari was a supporter of Newtonian philosophy and had been one of the examiners at Laura's first public Theses defense. In his correspondence with Laura, he mentioned being impressed with her abilities, and recognized that she had an obvious talent for learning mathematics and physics. Beccari encouraged Laura to continue in her chosen path of Newtonian physics and he insisted that she must not be forced to learn 'Galenic nonsense' (Logan 1991, 17).

The correspondence from Beccari to Bassi consists of three letters. In one letter with no date, Beccari asked Laura's opinion about his work on long fasts. He mentioned a visit by His Eminence Cardinal Lambertini to Bologna and that Dr. Bazzani and he (Beccari) were requested to provide an opinion on this subject to the Institute of Sciences of Bologna. But since Bazzani was ill, he (Beccari) would have to make the presentation. Beccari based his disputation on the dissertation he had written called *De longis jejuniis* which Cardinal Lambertini later inserted in his own work published by the Institute of Bologna in 1738. This letter shows how Beccari valued Laura Bassi's opinion on scientific matters.

In a second letter, also with no date, Beccari mentioned he was sending Laura a book on the story of the Académie royale des sciences published in the year 1702 containing a small article on the perpendicularity of plants. He suggested that this would help her to understand Dodart's system regarding this phenomenon. Dodart had written a work published by the Académie royale des sciences: *Sur la perpendicularité des Tiges des Plantes, par rapport à l'Horizon*. Beccari mentioned two other works by Wolf: *Horae su'isccirae Marburgenses* and *Cosmologia generalis* that he thought she should be aware of.

The third letter was written from Bologna on December 23, 1744. This letter was in response to a letter Beccari must have received from Laura, where she sent her best wishes and prosperity for the Holy Christmas. He was overcome by her kindness and extended, with devotion and reverence, his best wishes to her.

In the eighteenth century, much of the communication between people involved in science or philosophy occurred through letters. This is why the correspondence between famous men in science or medicine and Laura Bassi is such a strong indicator of her value and knowledge in these fields. In a later chapter, we examine the letters to Laura written by several other known men and what was discussed in this correspondence between natural philosophers (scientists).

Another supporter of Laura's chosen path was Gabrielo Manfredi who taught her the new mathematics (calculus) for three years (1735–1738), until her marriage to Giuseppe Veratti. These studies prepared her well for her future scholarly work in experimental physics and indicated her strong commitment to a career in this field. Gabrielo, in addition to teaching Laura, was one of her vocal supporters, pressuring the University for Laura to be allowed to teach regular classes.

Laura's greatest and most important patron was Cardinal Lambertini, a Bolognese nobleman who became Archbishop of Bologna in 1731 and Pope Benedict XIV in 1740. He was present at Laura's two defenses and at the related ceremonies. As mentioned before, he had frequently heard Laura dispute in her home on several topics; this was in 1731, prior to the public events of the following year. Lambertini encouraged Laura to continue her studies and he was a major influence behind the obtention of her position at the university. Cardinal Lambertini was a powerful man, protector, and patron who opened several doors for Laura Bassi. He also supported Maria Gaetana Agnesi and Anna Morandi Manzolini. It may also have been Lambertini who helped Laura obtain access to the works of Galileo, Descartes, Kepler, Copernicus, Fontanelle, and Algarotti. These works had been placed in the Index of the Vatican (*Index Librorum Prohibitorum*), which meant their access was restricted. Men involved in philosophy and science who were twenty-four years of age or older could obtain a permission to access these works. But no women, except for Laura Bassi, were allowed to see them. Clelia Borromeo and Francesca Manzoni had attempted to gain access to these works on natural philosophy, but permission was denied them. Laura was twenty four years old in 1735 when she obtained access to the documents. She had tried to see them earlier, but permission had been denied before she attained the age decreed by the Church (Logan 1994, 794–795).

Between 1732 and 1774, Laura Bassi was made a member of fourteen literary academies, another was on botanics, and one in science (Academy of Sciences of Bologna in 1732). The appointments of Laura Bassi to a number of Academies can be found in Appendix 1.

Laura and the Academy of Sciences of Bologna

Laura was the first woman to be admitted to this Academy. However, in spite of the fact that Laura was actually invited to join the Academy, a title which should have enabled her to deliver lectures and publish her work, several of the Academy Members assumed she would just enjoy the title and not participate in any of their activities. She was not even expected to attend their meetings. Little did they know her! She intended from the beginning to become one of their active members, to present her work and research results at meetings, and to publish some papers on her best work.

Laura did attend a few meetings at the Academy of Sciences of Bologna before her marriage, but she mainly debated with men involved in science and philosophy in her home, as she had done prior to her Theses defenses. Scientific pursuit requires the exchange of ideas and material and often involves working with collaborators, as was the practice in the Academy of Sciences of Bologna at the time; this is still true today. Scientific work cannot be done in isolation.

In the next chapter, we see how Laura finally reached her goal in the very special year of 1745.

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Chapter 6

A Transition from the ‘Old’ to the ‘New’ Science

This chapter discusses the transition from the ‘old’ traditional approach to science to the ‘new methods’ based on experiments that enable theories to be developed or verified. An in-depth discussion is beyond the scope of this book, but a short description of the institutions where this transition first occurred is presented. The chapter then examines how Laura Bassi’s life and work changed dramatically in 1745, when she could finally set aside her literary works and concentrate on science. The chapter ends by showing how Laura’s scientific work was on the pulse of things and how she made the transition from the old science to the new. Laura Bassi embraced the new methods and taught them to students at a time when universities were still mainly teaching theory and the traditional philosophy originating from Aristotle and Descartes among others.

In Europe, during the latter half of the seventeenth and first half of the eighteenth centuries, there was a transition from the old way to do science to the new methods that involved the use of experiments to explain the theories. Most of this transition occurred within science institutions such as the academies. Science, as it had existed for millennia, was based on natural philosophers speculating about nature, the world, and the universe, and developing concepts and theories without providing evidence for their theories through experimentation. René Descartes was a good example of a philosopher discussing his views of nature and of human nature. Cartesians deduced laws from rationally evident principles. The old science was largely based on Aristotelian philosophy and of course on the Ptolemaic system (the earth at the centre of the universe).

On the other hand, men like Galileo Galilei (1564–1642) in Pisa, Robert Boyle (1627–1691) and Isaac Newton (1642–1727) in England, carried-out experiments to support the theories they were working on. Galileo’s achievements include improvements to the telescope to make astronomical observations and his support of Copernicus’ theory. He is called the father of modern observational astronomy and of modern science. His contributions to astronomy include the confirmation of the phases of Venus, the discovery of the four largest satellites of Jupiter (named the Galilean moons in his honour), and the observation and analysis of sunspots. Galileo also worked in applied science and technology, inventing an improved military compass and other instruments.

Boyle, listed as a Founding Fellow of the Royal Society (joined April 22, 1663), is considered the first modern chemist and one of the founders of modern chemistry. He was also a pioneer of the modern experimental scientific method. He is best known for Boyle's Law, which describes the inversely proportional relationship between the absolute pressure and volume of a gas, if the temperature is kept constant within a closed system.

Newton described universal gravitation and developed the three laws of motion. His theories were dominant for three centuries. Newton showed that the motions of objects on earth and of celestial bodies were governed by the same set of natural laws. He showed that there was consistency between Kepler's laws of planetary motion and his own theory of gravitation, thus proving without any further doubt Copernicus' theory of heliocentrism. Newton built the first practical reflecting telescope and developed a theory of colour based on his observations that a prism decomposed white light into the many colours that form the visible spectrum. He also formulated an empirical law of cooling and studied the speed of sound. In mathematics, Newton and Leibnitz independently developed the new mathematics (calculus) (Wikipedia_Newton 2013).

Although the transition to the new science began through the work of some individuals, especially those connected to the scientific revolution, the main thrust was through the rise of the scientific academies and institutes, since they became the main channel through which science works were debated and disseminated. In addition to men of vision like Boyle, Newton, and Galilei, some of the scientific institutions in the latter half of the seventeenth and first half of the eighteenth centuries made experimentation a part of their philosophical approach. Two institutions are notable for their formal transition from the old to the new science; they were the Royal Society in England and the Accademia dei Cimento in the Italian Peninsula. The Royal Society was formally founded on November 28, 1660, but natural philosophers had been meeting informally since the 1640s to discuss the new philosophy of promoting knowledge of the natural world through observation and experiment.

In the Italian Peninsula, shortly after the death of Galileo (1642), his students Giovanni Alfonso Borelli and Vincenzo Viviani founded the Accademia del Cimento in 1657 under the patronage of Prince Leopoldo de' Medici and of the Grand Duke Ferdinand II de' Medici. It is considered by some authors as the first modern scientific institution. The motto of the Accademia del Cimento was *Provando e riprovando* (trial and error, a method based on experimentation). Their publication: *Saggi di naturali esperienze* (1667) describes the experiments performed at the Academy between its foundation (1657) and its dissolution (1667). The Accademia del Cimento emphasized the importance of experimentation and the avoidance of speculation. Moreover, it focused on the development of laboratory instruments and on the development of standards of measurements. Unfortunately, in 1667, several of the academicians of the Cimento looked for work in other parts of the Italian Peninsula. In spite of the effort of Prince Leopoldo to recruit more philosophers to replace those who were leaving, Florence did not maintain the reputation and position it had acquired during the Renaissance (Boschiero 2004, 1–13).

The Cimento's view on the importance of experimentation was adopted by the Academy of Sciences in Bologna when it was created forty years later. As academicians were leaving Florence, the senate of Bologna began to offer lucrative University positions to Italian mathematicians and philosophers. This City was already well known for its work in astronomy by men like Giovanni Domenico Cassini (1625–1712) and Buonventura Cavalieri (1598–1647). Geminiano Montanari (1633–1687) had already arrived in Bologna in 1664 after several years at the Court of the Duke of Modena, working with Cornelio Malvasia (1603–1664), a nobleman from Bologna and amateur astronomer. When Malvasia died that year, Montanari was given the Chair of mathematics at the University of Bologna. He established the *Accademia della Traccia* in 1666, which was also known as the *Accademia dei Filosofi*. This institution was to echo the experimentalist example of the Cimento. But the University of Bologna had a financial crisis during the late 1670 s, so Montanari left his Chair there and accepted a position at the University of Padua (Boschiero 2004, 10–11). Padua and Bologna, attracted philosophers and men of science of high calibre and their universities were the first two in the world to award a doctoral degree to women. The first was the University of Padua, awarding a degree to Elena Lucrezia Cornaro Piscopia (1678), and the second was the University of Bologna giving a degree to Laura Bassi (1732).

The Accademia Degli Inquieti (1690–1714)

It was seventeen-year old Eustachio Manfredi, a self-taught astronomer and mathematician with a degree in law from the University of Bologna who founded the *Accademia degli Inquieti* in 1690. Eustachio and his friend Vittorio Francesco Stancari set up an observatory. Eutachio invited his two brothers and two sisters and other fellow students to meet at his home, to do some experiments and to make celestial observations. They constructed their own instruments and telescopes since they did not have much money (Boschiero 2004, 13).

The *Inquieti*'s membership grew substantially in the following years with the addition of philosophers, mathematicians, and anatomists. It eventually changed the meeting location to the home of Jacopo Sandri, a professor of anatomy and medicine at the University of Bologna. One of the wealthy supporters of the Academy was Ferdinando Marsigli (1658–1730) who helped to reorganize it, and meetings began to be held at his palace in 1705. In 1709, Marsigli requested some funding from the Bolognese Senate to establish an Institute of Science. He promised to donate his collection of books, instruments, and artifacts (minerals and fossils). The City suggested he ask the Pope, which he did, and funding was provided in 1712 by Clement XI. The Academy was renamed "*Accademia delle Scienze dell' Istituto Bolognese*" and was housed at the Palazzo Poggi. The *Inquieti*, and later the Institute, continued on the path of experimental science that had begun with the *Accademia del Cimento*. There was also a major shift of thought with men like Cassini, to a sun-centered universe, a controversial position

at the time. The academicians continued to think about theoretical concepts and concerns about the natural world, but they added experiments and observations to support their theories (Boschiero 2004, 14–16).

Laura Bassi's Transition from the Old to the New Science

Laura Bassi's first set of Theses was more a reflection of the interests of her teacher Gaetano Tacconi than her own. This is clearly illustrated in Laura's Thesis VI, in the metaphysics section (Cavazza 1990, 249–256; Logan 1999, 499). However, as early as 1732, there is evidence that Laura had embraced Newtonian philosophy. This was made clear in a poem written by Francesco Algarotti, published in honour of Laura's graduation, where he presented her as very knowledgeable in Newtonian physics. Her attraction to Newtonianism is also apparent from her lecture in December 1732 at the Archiginnasio where she said the philosopher's duty was to deduce laws of nature from phenomena that could be observed experimentally. There is further evidence of Laura's early embracement of Newtonianism in an additional set of 24 Theses found in her papers (dated in 1732), but they were not presented or published. The physics section of this series of Theses begins with Newton's three laws of motion and continues with several other principles enunciated by the famous philosopher. Logan argues these twenty-four Theses may have been part of those Laura would have liked to defend instead of the ones that her teacher Tacconi imposed upon her (Logan 1999, 499).

A few things changed for Laura after her marriage. She was able to attend many of the meetings of the Academy of Sciences of Bologna with her husband, which was deemed more acceptable than her attending as a single woman. The public debates in which she continued to participate with other intellectuals of Bologna were an excellent way for Laura to remain in touch with peers and for them to realise how she was committed to her scientific work. The Academy meetings enabled her to keep-up with developments in her field and identify key areas where science could contribute to the City and to society. But, until 1745, she was not allowed to present her work or to participate actively in the meetings of the Academy.

A Turning Point for Laura Bassi

All her determination to work in science and to be taken seriously by peers became a reality in 1745, a very special year for Laura Bassi. That year, Pope Benedict XIV, the former Cardinal Lambertini, decided to create a special group within the Academy and the Institute of Sciences of Bologna. He named the special group 'Benedettina' after himself. The move was to enhance the number and quality of the publications of the Academy whose output had fallen dramatically in

1741–1742 to four publications a year, down from fourteen publications per year in 1734–1735. By 1745, much of the equipment belonging to the Institute was either broken or not available, and the attendance of the members had become sporadic (Logan 1991, 30). The Pope accompanied his new creation with a donation of extensive material to the Institute of Sciences of Bologna and proceeded to the selection of 24 of the best known members of the Academy for membership in the Benedettina. The members were to be paid 100 lire per year for this special membership and were expected to present one original work per year at a predetermined date. They also had to provide the written dissertation in Latin to the Secretary of the Academy on the day of their presentation. Some of the texts (not all) would be published in the *Commentarii*, the joint journal of the Academy and of the Institute. The members of the new group were required to attend three-quarters of all the academy meetings. With this move, the Pope ensured more regular attendance at meetings and expected a substantial increase in the original work presented and published at the Academy and the Institute in Bologna.

This is how the members were originally chosen in 1745: The Benedettina group was comprised of all Heads of Sections at the Institute, their assistants, the President and the Secretary; this added-up to 14 members; the next ten members were chosen by the original 14. The list was to be sent to the Pope for his approval (Logan 1991, 31).

Laura soon learned from one of the 14 members that her name was not among the ten chosen members, but that her husband's name had been retained. This was surprising since it was well known that her abilities, knowledge in science, and fame surpassed his. Her reaction was immediate. Here we see her acumen in understanding the politics involved. She appealed to her powerful patron, the Pope, though his Legate Flaminio Scarselli, a man who was very familiar with Laura's talent and knowledge. In her letter, she suggested that the Pope create a 25th position so that he would not have to remove one of the men already chosen in order to add her to the list. She provided the example of the extra lecturer position in Universal Philosophy created for her at the University of Bologna in 1732. Her strategy to appeal to the Pope through his Legate was quite clever; both men had been strong and powerful supporters of her career since 1731. Moreover, the new group was the Pope's creation, so surely he could decide to make the Benedettina a group of 25 members instead of 24. If she gained this privilege, Laura hoped this would succeed in putting a stop to the grumblings of members who tried for years to stop her from participating in academic affairs.

In her letters to Scarselli, dated April 21, May 12, and June 5, 1745, she explained that obstruction from members was a major reason why she had not given any dissertation up to that time. She argued that if she became a member of the Benedettina, she would have to present a dissertation once per year, and this would likely silence her opponents. In his response of June 12, 1745, Flaminio Scarselli confirmed to Laura that she had been added to the Benedettina (Logan 1991, 31–32; Cenerelli 1885, 104–126).

In spite of this great news for Laura, and the clear wishes of the Pope for her to be actively involved in Academy affairs, the grumblings did not stop when

members of the Academy heard about this. Even though this new appointment of Laura came directly from the Pope, some of the men continued to try to limit her role within the Benedettina. In a letter dated November 21, 1745, Laura explained to Flaminio Scarselli how some academics were attempting to pass a rule to deny her voting rights, rights she felt she had acquired at her induction into the Academy in 1732. This discussion happened during a meeting when she and her husband were absent because of bad weather. Flaminio Scarselli contacted the Head of physics at the Academy (Dr. Galeazzi) and suggested that if the academics had doubts about Bassi's voting rights, they were to contact the Pope directly for clarification on that point (Logan 1991, 32).

Laura subsequently received an interesting letter from Scarselli offering his opinion on the affair. He wrote: "Monsignor Leprotti and I remained surprised so as not to say nauseated by the extravagant difficulties of which the Institute has no reasonable foundation" (Logan 1991, 32). The exchange of letters between Flaminio Scarselli and Laura Bassi about her role within the Academy and the Institute shows how determined she was in pursuing her work in science, and demonstrates the successful strategies she used to attain her goals. She did not hesitate to contact her powerful patrons and supporters to eliminate obstacles placed in her path.

Becoming a part of the elite Benedettina at the Academy was pivotal in Laura's career as she would now be expected to attend most meetings and present an original dissertation once per year, which she did from 1746 until her death in 1778. By 1745, Laura had given birth to five children, but this did not prevent her from performing the academic activities she was now allowed to perform, and of course pursue her studies of physics and mathematics. She would now also be able to use the equipment at the Institute for some of her experiments (Logan 1994, 801). Financially, she received the 100 lire per year in addition to her university salary, and she was reimbursed for expenses for some of the materials she needed for experiments carried-out at the Institute. The expenses were not large, as she did not claim any in 1763, and she claimed just over 14 lire in 1776 (Logan 1991, 33). But this step helped to integrate her more closely to the Institute and confirmed that she belonged there, just like her male colleagues, with the same privileges attached to a membership in the Benedettina.

Laura Bassi's Presentations at the Academy

Laura presented 31 dissertations between 1746 and 1777, while she was a member of the Benedettina, and she would have deposited the manuscript for each of these on the day of their delivery. The list of the topics she presented and their dates have been recorded. Unfortunately, most of these manuscripts concerning her yearly presentations have been lost. However, a few manuscripts can still be found in the archives of the Institute of Sciences of Bologna. The *Commentarii* (the

Annals of the Academy and the Institute) published a few selected works, not all manuscripts deposited with the Secretary before verbal presentations.

In Laura's case, four of her manuscripts were published in the *Comentarii*. One reason why few of Laura's manuscripts were published in the Institute's Journal could be due to Laura lacking confidence in the quality and importance of her dissertations. Perhaps she felt they were not good enough to be published. The evidence for this can be found in a letter written by her husband Giuseppe Veratti, to Abbott Giovanni Amaduzzi, on March 28, 1778, shortly after Laura's death. Giuseppe explains:

...Few are the things sent to the press by the same (Bassi), and they are inserted in the Acts of our Academy, and many other opuscula exist pertaining to several subjects in physics, done and recited by her in public or private sessions of the same (Academy) and not yet published because on that point she was very difficult. I will communicate them to my friends in due time, letting them decide if they are worthy of being inserted in the Acts of the Academy (Logan 1991, 38).

Another reason for the low number of publications during Laura's very active scientific period, between 1766 and 1778, is that the *Commentarii* did not get published between 1766 and 1783. The publication of this journal resumed five years after Laura Bassi's death. Some of her best work on electricity was presented at the Academy after 1766, so manuscripts deposited to the Secretary would not have been published during those years. In fact, one of her best work on the action of gases in liquids was only published in 1791, thirteen years after her death.

We may ask, was the number of Laura's publications in the Academy Journal less than that of her male colleagues? Of the 75 authors who were published in the *Commentarii* during its existence, 55 of these authors had less than four *opuscula* (articles) to their name. Even Luigi Galvani (1737–1798), the most famous scientist at the Academy in the eighteenth century, had only three of his dissertations published as *opuscula*. The Journal did not appear frequently enough to publish all dissertations presented, so many were left out, particularly on the topic of electricity, because the timing coincided with the cessation of publication (Logan 1991, 38). However, some of the work on electricity done by the Bassi-Veratti couple became known through correspondence between them and men who worked on this topic.

Laura's connection to the Institute and her teaching represent only a fraction of her extensive scientific activities. Her correspondence with men involved in science, medicine, or philosophy demonstrates her deep knowledge of the scientific issues that were important and popular at the time; the discussions include topics that were controversies on various theories and her own views on these debates.

From the list of Laura's presentations at the Academy, it is clear that, as soon as she became a member of the elite Benedettina in 1745, she presented original work every year without fail! She had babies in 1749, 1750, 1751, and 1753, yet she presented original work in each of those years. Some of her pregnancies and deliveries were difficult and Laura was additionally burdened by illness at times. But none of this stopped her from the responsibility of yearly presentation at the

Academy, which showed her serious commitment to science and to her professional obligations. Her performance served the additional purpose of demonstrating that women, in spite of the physical burdens imposed by nature, could be as dedicated and hard-working scientists as men.

Some of her presentations were delivered in Latin, such as the one in 1750. The list of her talks showed that her reports on electricity began around 1761. Prior to this, she worked on science topics that were important for the City of Bologna. In 1775, she worked on fire, another topic that was of great interest in France with work done by Gabrielle-Émilie du Châtelet and Voltaire.

In his eulogy on Laura Bassi after her death in 1778, Fantuzzi wrote that the paucity of her publications was due to domestic cares, illnesses brought about by difficult childbirths, and constant occupation with the course in experimental physics (Fantuzzi 1778, 17). Fantuzzi's statement to excuse the paucity of publications by Laura Bassi does not make much sense, since she published as many articles as her colleagues, and more than many (including her own husband). Fantuzzi's comment reflects how men perceived women's roles at the time. It does not seem that Laura's productivity was affected by her pregnancies and domestic chores. She remained active in her teaching for nearly 30 years, until the day of her death, and she was involved in research throughout her entire career. Laura had three female servants and lived with her mother until the latter's death. In spite of her nine childbirths and probably twelve pregnancies, Laura met all the expectations of the Benedettina elite group without fail. As mentioned previously, most authors in the *Commentarii* had less than four *opuscula* (articles) to their name. Moreover, the journal was not being published at the time when her main work on electricity was carried-out.

The list of Laura Bassi's presentations at the Academy are found in the Catalogo dei lavori dell'Antica Accademia raccolti sotto i singoli Autori à cura di Domenico Piani (Prepared in 1852, 15–17; Logan 1991, 64–65). The list provides an excellent example of the type of work Laura Bassi did in the field of experimental physics and mathematics (See Appendix 2).

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Chapter 7

Scientific Works by Laura Bassi and Giuseppe Veratti

In this chapter, we examine the scientific work of Laura Bassi and of her husband. We examine the type of work they did independently from each other and the work they did in collaboration. In the case of collaborative work, the topic was mainly on electricity. In the eighteenth century, this was a topic of great interest at the Academy of Sciences of Bologna and for several scientists in France, England and America. A number of debates were raging on the nature of electricity, that which occurred naturally and that which was artificial (human-made). At that time, there was also great interest on medical applications of electricity. The last section of the chapter presents the various debates as well as the champions of opposing theories. Laura and Giuseppe were substantially involved in these discussions as we see below.

Regarding their scientific work, there was a delicate balance to maintain for Laura and Giuseppe between working collaboratively and meeting the obligation of presenting original work each year at the Academy as members of the *Benedettina*. Throughout their life together, Laura and Giuseppe managed to keep the independence expected of them. Laura Bassi was an independent researcher in her own right. However, it must have been exciting for Laura and Giuseppe to compare notes and to have each other to validate ideas and to discuss results of their experiments. For their presentations at the Academy, they carefully divided the topics between them.

Laura's interest in science covered a broad range of topics; however she was very much engaged in experiments and research that helped solve some of the problems facing the City of Bologna. One of the main concerns of the city and its region at that time was water, since much of Bologna's industries such as paper, hemp, and silk depended on the use of water. Canals and dykes were needed to bring drinking water from local rivers to the city, so the study of fluid mechanics could be quite useful to the City of Bologna. Laura's interest in issues related to water was already evident in the second set of Theses she defended in 1732 in the presence of five professors, among whom were Matteo Bazzani, Marc'Antonio Laurenti, and Giovanni Antonio Stancari. She had explained the corpuscular structure and fluidity of water, the stages of its passage from the liquid state to ice and steam. Her interest in the science of fluids was in the vein of work that had also interested famous men such as Giovanni Domenico Cassini, astronomer, mathematician, cartographer and engineer; Domenico Guglielmini (1655–1710), a

mathematician; Gabriello Manfredi, her former teacher of mathematics; and Giovanni Antonio Stancari (Logan 1991, 33).

For many years, Giuseppe's work concentrated on medical topics. He became interested in electricity around 1748, but it was especially to study its effect on animals and on the human body. He presented work on this topic in 1748, 1750, 1752, 1754, 1769, and 1770. In 1754, he presented a different type of work on electricity (on lightning). In the same year, he again made a presentation on medical applications of electricity. In 1758, he reported the results of other experiments on electricity and on electrical matter; and in 1759, he spoke on magnetism. In 1762, his topic was on the magnetic properties of iron. Some of Giuseppe's topics moved closer to the physics of electricity after 1754, but he also continued to present its medical side in 1769 and in 1770. (See Appendix 3 for a list of Giuseppe Veratti's presentations.)

The titles of Laura's presentations on the topic of electricity (see Appendix 2) are vague, but we can assume that they were different from her husband's. She presented results of experiments on electricity in 1761, 1768, 1770, and on *vindex* electricity in 1771. Although not a modern concept, the word *vindex* was used at that time by Beccaria who would not admit electrical action-at-a-distance, so he supplied this deficiency with a complicated scheme of electrical atmospheres and "vindicating," or regenerating electricity. These ideas, which found their expression in Beccaria's *Electricitas vindex* (1769), subsequently led Volta, while seeking alternatives to them, to invent the electrophorus (web: Beccaria).

In 1774, Laura presented a disputation on Haller's experiments. After this, she focused on fire and flames. Her last presentation, on June 5 1777, discussed various bodies which retain more heat than others; she made an analogy with electrical properties of the materials regarding their conductivity. Without access to the original documents, most of which are lost, it is not possible to provide more details on the topics presented by Laura and by her husband. But we can be assured the presentations by the couple were different from each other according to the rules for the members of the Benedettina.

During this period, Laura's presentations were mostly on physics and mathematics. This approach clearly separated her work from her husband's. Sometimes the couple's interests were blurred. One example concerns the testing of the theory of irritability that had been presented by Haller in 1752 at the Göttingen Royal Society of Sciences. Haller's theory became a central debate in Europe with several famous persons on both sides of the argument.

Although Laura's main presentations on the topic of electricity began around 1761, she had helped Giuseppe in the experiments he carried-out for his 1748 book on this subject. As an experimental physicist, Laura had been quite interested in this topic as early as 1748. In her paper *De aere in fluidis contento* (On air contained in fluids), discussing how air bubbles form in various liquids contained in vases of different shapes, which she presented at the Academy in 1748. She began with an analogy between the behavior of air and of light, and she observed that both obeyed the laws of attraction and repulsion, like electricity which tends to accumulate in the extremities and corners of bodies.

Early Work on Electricity by the Bassi-Veratti Couple

In 1745, Pope Benedict XIV had donated pieces of equipment to the Institute, several of which were designed for experiments in electricity. This would enable the Institute of Sciences of Bologna to catch-up with other European Academies in the field of electrostatics. By 1746, Giuseppe and Laura had acquired their own machine that produced electrostatic electricity. The Bassi-Veratti home was the only private laboratory with an electricity machine at the time of its acquisition. The study of electricity was one topic where the Bassi-Veratti couple worked together for a long period, extending from the early discussions on this subject in 1747 to the end of the 1770 s, just prior to the release of Galvani's theories on animal electricity (Cavazza 2009, 117).

Several famous men visited the laboratory established by the Bassi-Veratti couple in their home. Some visitors wanted to view experiments done by Laura or Giuseppe; at other times they performed experiments with the couple on interesting problems of the day. Laura debated with men on several of the ideas that were of prime interest in her time, especially those regarding theories of electricity, gases, and water. Giuseppe studied the potential therapeutic effect of electricity on animals and on the human body. Before discussing their collaborative work on electricity, the section below describes the scientific content of Laura's articles published in the Journal of the Institute, the *Commentarii*.

Of the 31 presentations Laura made at the Academy between 1746 and 1778, ten of these dealt with hydrometry, measuring the specific gravity of fluids; hydrodynamics, the science of fluids in motion; and hydrostatics, the studies of pressure and equilibrium of fluids at rest. Fantuzzi states that Laura Bassi left all the manuscripts of her academic presentations with the archives of the Academy. Unfortunately, only a few can be found in the Academy's archives. Two of Laura's treatises that appeared in the *Commentarii* of the Academy were *De problemate quodam hydrometrico* (the problem in hydrometrics); another was *De problemate quodam mechanico* (the problem in mechanics) (Fantuzzi 1778, 17). For the first article mentioned above, four presentations had been given: 1753, 1754, 1755, and 1756. The article concerned the flow of liquids through holes and appeared in *Commentarii*, Tomo IV, 1757, pp. 61–73. About this work, Logan writes:

A technician, knowing the dimensions and positions of two and more openings in a canal, would have been able to calculate the position and size of another opening of similar shape under the water, using the method established by Guglielmini and Zedrini, which estimated the average velocity and quantity of water going through these holes. However, this method, which led to an equation with two unknowns, required some simplification. This simplification was provided by Bassi when she reduced the equation to one unknown by the analytic method (Logan 1991, 34).

Laura also provided a table giving all possible values of “p”, the rational number used in place of one of the unknowns in the estimations. Elena only mentions that Bassi considered a problem already studied by Guglielmini and Zedrini and he omitted to mention that Laura provided an elegant simplification to

a complicated equation (Elena 1991, 515). This excellent work was lauded by one of Laura's contemporaries after her death in 1778. The compliment is recorded in a letter dated April 22, 1778, from Pio Fantoni to Giovanni C. Amaduzzi (Logan 1991, 34). At the Academy, the members of the Benedettina had to present original work once a year, so there had to be an original component to Laura's paper; and there was.

Laura's second article concerned a problem in classical mechanics; this was also published in the same volume of the *Commentarii* (pp. 74–79). Logan describes the work:

In this *Opusculum* [article], Bassi used differential calculus to determine the motion of the centre of mass of two or more bodies moving along any curved paths in a plane. If the motion of the two bodies was rectilinear rather than curvilinear, one was then confronted with the case stated by Newton in his *Principia Mathematica*... This work by Bassi signals the beginning of a trend in dissertations concerning the classical mechanics given at the Academy (Logan 1991, 34).

The mechanical study by Laura clearly demonstrates that she was familiar with Newton's main work, *Principia*, at this later stage of her career, and of his *Opticks* earlier in her career (around 1732). Laura's work used mathematics extensively in her two articles, which is in stark contrast with the *opuscula* that survives from her husband, in which no mathematical calculations were used (Logan 1991, 34).

Two further works by Laura appeared in the *Commentarii*: one was a summary written by the Secretary of the Institute, Francesco Zanotti in 1745; the second was the article published 13 years after her death (1791). The first summarized Laura's research on deviations from Boyle's law. As mentioned earlier, Boyle's law (1662) stated that the product of the volume of an ideal gas and the pressure it exerts on a container at constant temperature is constant. However, Laura Bassi demonstrated that there were deviations from this law under certain circumstances. Laura did several experiments when the humidity in Bologna was very high and concluded that Boyle's law was not followed under these conditions. Galeazzi, in 1732, while testing deviations in the Amontonian thermometer which was based on Boyle's law, found that the deviations were caused by variations in the elasticity of the air caused by heat and various "humours" contained in it. Laura Bassi not only repeated the experiments in which the elasticity of the air was affected by barometric pressure and heat, but she added new variables. She regulated both the barometric pressure and the temperature, performing her experiments on a rainy day in the fall when the humidity was high. She found the air could not be shrunk to half its volume by doubling the pressure exerted on it. The same happened when the day was even more humid. Laura found that her experiments were in general agreement with Boyle's law when the weather was dry and the temperature was four degrees Centigrade. Thus Laura identified one of the deviants of Boyle's law caused by vapour; she did this well before scientists were acquainted with the behaviour of vapour under pressure. The experiment was considered important enough by her Bolognese contemporaries to be published in the journal of the Academy. In fact, the Institute's Secretary, Francesco Zanotti, was so impressed

by this work that he wrote a summary of Laura Bassi's results even before she had finished all her experiments on this problem (Logan 1991, 35).

The second article (1791) concerns the work she had presented in 1747 on the action of air when it is dissolved in various liquids, contained in glasses of different shapes, and when the pressure is removed. Laura discovered that air bubbles appeared more intense in narrow vases. There were many reasons for this phenomenon and the variables and quantities involved in the experiments were difficult to measure. The work is interesting on two counts: As early as 1747, Laura Bassi was aware that pointed objects attracted electricity, and this was approximately at the same time, if not earlier, that Benjamin Franklin explained the phenomenon in a letter to Collinson dated May or June 1747. Moreover, the publication of the paper, 13 years after Laura's death, indicates that the Academy possessed her dissertations in manuscript form. It is quite unfortunate that the majority of her 31 manuscripts have been lost (Logan 1991, 36).

Continuing to look at Laura's work at the Academy, we find more evidence of her contributions to science, in particular in physics. For example, according to Tommaso Laghi, who tested reddish ashes produced by burning two types of wood, one from the mountains and the other from a marshy area, Bassi had already tested them and found them to be rich in iron. Perhaps she and Laghi were likely hoping to get a pigment out of the ashes for making dyes. She presented the results of this work in a dissertation in 1769, discussing how to improve the art of dying.

From 1756 to 1761, Laura and Giuseppe helped and advised Gregorio Casali on two sets of experiments. The first set dealt with the force released by gun powder. Casali, like Bassi, Veratti and Beccari felt that the nature of the force was dependent on the elasticity of the air. The couple assisted Casali with the experiments. Before 1761, both Veratti and Bassi were Casali's assistants in gathering data from a series of experiments dealing with the shattering of glass. Casali subsequently published his results on the gun powder in the *Commentarii* (Tome V, parte 2^a, 1766, pp. 362–363, 371) and on the shattering glass in the same volume (p. 184) (Logan 1991, 37).

Important Scientific Debates on Electricity

The eighteenth century witnessed several emerging theories concerning electricity. Franklin's and Beccaria's theory of electricity clashed with Laghi's concepts; Fontana and Caldani disagreed with Laghi and supported Franklin, Beccaria, and Haller. Bassi and Veratti were active participants in several of these important debates; they supported Haller, Fontana, and Caldani, as well as Franklin. The debates are discussed in more detail below.

As mentioned in an earlier chapter, Giuseppe and Laura had acquired a machine to artificially create electricity in 1746. Giuseppe considered this a very important addition to their laboratory, as shown in the letter he wrote to Laura on November 26, 1746, while he was away in Ancona: "Remember the electrical Machine, the

love I feel for my Children and to Yourself, who are the greatest wealth I possess on this Earth” (Cavazza 2009, 117; Cenerelli 1885, 153–154). We begin this section by a short discussion on electricity, followed by a description of some of the work done in Italy in the eighteenth century to harness this type of energy, principally with the aim to use it for medicinal purposes.

Electricity has always existed in nature. In ancient times, it was observed either in the form of lightning, or emanating from certain types of fish like catfish and torpedo rays. From 2750 B.C., Egyptians had observed and recorded these phenomena. In Italy, ancient writers like Pliny the Elder and Scribonius Largus confirmed the numbing effect of electric shock delivered by certain fish and they understood that such shocks could travel along conducting objects. Patients suffering from ailments such as gout or a headache were instructed to touch electric fish in the hope that the powerful jolt might cure them.

Possibly the earliest and nearest approach to the discovery of the identity of lightning and of electricity from other sources like fish can be attributed to the Arabs who, before the fifteenth century, had an Arabic word for lightning (*raad*) which they applied to the electric ray.¹ The Greek Thales of Miletos made a series of observations on static electricity around 600 B.C. by rubbing amber with a cat’s fur. In 1600, William Gilbert in England made a careful study of electricity and magnetism, distinguishing the lodestone effect (a naturally magnetized piece of the mineral magnetite) from static electricity produced by rubbing amber. He coined the word *electricus* to refer to the property of attracting small objects after being rubbed. This association gave rise to the English words “electric” and “electricity”, which made their first appearance in print in Thomas Browne’s *Pseudodoxia Epidemica* (1646) (See Foot note 1).

Thus static electricity, originating from natural phenomena, was known for thousands of years, but it was only in the middle of the eighteenth century that humans began to create electricity (the static type, not what we use today in our houses and buildings) using the newly invented ‘electric machine’. The earliest machine, an electrostatic generator, was a mechanical device that produced a very high voltage and a low current. Electrostatic generators transform mechanical power into electrical energy by developing electrostatic charges of opposite sign which can be passed through conducting materials such as metals. The human body can also act as a conductor, although less well than metal conductors. Several men designed and improved previous designs between the earliest model constructed in 1663 by Otto von Guericke, up to the design of the Leyden jar by Pieter van Musschenbroek which he had achieved with his student and other collaborators in 1746 while a professor at the University of Leiden. In this latest model, Mussenbroek’s improvement was that the electric energy could now be stored for a future discharge. Soon after these developments, theories and experiments began to focus on two main aspects of electricity: its physical properties and its potential

¹ Wikipedia_Electricity: <http://www.wikipedia.org/wiki/Electricity>. Accessed March 2013.

medical applications. Intense discussions and debates took place all over Europe and America between 1747 and 1752.

One of the early debates started in the Italian Peninsula, involving primarily Gianfrancesco Pivati, Giuseppe Veratti, and Laura Bassi. Cavazza mentions that even the authoritative figure, Francesco Algarotti, would have been present for some of the experiments (Cavazza 2009, 119). Albrecht von Haller (1708–1777) in Switzerland, with his theory of irritability, was the prime mover of another debate that involved almost everyone at this stage, but specifically Abbé Nollet, Caldani, Fontana, Bassi and Veratti, but it was Giambattista Beccaria's work that was mainly responsible for the recognition of the Italian Peninsula as a main centre for the study of electricity in the eighteenth century.

As mentioned above, the earliest debate was raised by Giovanni Francesco Pivati (1689–1764) concerning 'medicated tubes'. Pivati reported that an electrified vase or tube could allow the vapours of the medicine to pass into the room and cure patients. Pivati's claims were supported by both Giambattista Bianchi in Turin and Giuseppe Veratti in Bologna. The second controversy was about the nature of electricity as it passed through the body; this issue was raised by Nollet and refuted by Beccaria and others. Nollet thought electricity was a double fluid that passed through the body through two holes. The third debate involved many of the scientists working on electricity; it was raised by Haller in Switzerland, supported by Caldani, Fontana, Bassi, Veratti and others, but it was opposed by Laghi. Haller's 'theory of irritability' was a physiological explanation of electrical phenomena in humans and animals, especially where nerves and muscles were concerned. More details are provided below on each of these scientific questions.

Several of the debates arose because of the serious preoccupation at the time on the use of electricity for medical therapy. In the Italian Peninsula, the discussions began after the appearance of the book *Dell'elettricità medica*, published in Lucca in 1747; the book was written by the Venetian Giovanni Francesco Pivati where he recounted the 'miraculous' cure of a severe case of arthritis of the 75-year-old Bishop Donadoni of Sebenico who could not move his hands, bend his knees or walk without support. Pivati filled a glass cylinder with an anti-apopleptic substance, placed two corks at the extremities to seal the tube, rubbed the glass surface with a leather skin and produced sparks to the suffering parts with the tube placed near the body. The Bishop could now open his hands and clench them; he felt like a young boy with vigorous strength (Bertucci 2005, 153–154). As was common in that period, Pivati's book was written in the form of a letter addressed to the Secretary of the Academy of Bologna, Francesco Maria Zanotti (Cavazza 2009, 118). Pivati was a member of the Bolognese Academy since December 1, 1746, following his suggestion to Zanotti of involving the academy in his dictionary project. At this time, Pivati was superintendent of the Venetian press and a secular censor (revisore) for the Venetian Republic (Bertucci 2005, 159).

The Academy became involved in the controversy and asked Giuseppe Veratti to carry-out experiments to verify the efficacy of the therapeutic method proposed by Pivati. For his part, Giambattista Bianchi (1681–1761), a professor of anatomy, medicine and surgery, produced further evidence to support the medicated tube

theory. He used various medications in the tube according to the disease he was trying to cure and reported that, when operating the electric machine, the healing virtue of the medication evaporated through the glass and cured his patients. Pivati was now called the inventor of medical electricity (Bertucci 2005, 154–155). The same claims had also been made by Johann Winkler in Leipzig, Germany.

Veratti's results appeared in a book titled *Osservazioni fisico-mediche intorno alla elettricità dedicate all'illustrissimo, ed eccelso Senato di Bologna* (Observations on the physical and medical properties of electricity, dedicated to the illustrious and exalted Senate of Bologna) published by Lelio dalla Volpe in Bologna in 1748. Veratti's book was later translated into French and printed in Geneva in that language in 1750. In this work, Giuseppe Veratti confirmed Pivati's claim, but he also added his own point of view which was that electricity, even without medicine, could help cure arthritis, rheumatism, headaches, and paralysis. Veratti also reported that the therapy was not effective on tumours and herpetic disorders (Logan 1991, 39). Veratti's book was read at the Royal Society in London and the theory of glass made porous by electricity was then attacked by Joseph Priestly, Benjamin Franklin and others (Logan 1991, 39).

On July 12, 1749, Giambattista Bianchi wrote to Giuseppe Veratti confirming the success of his experiments and especially to warn him that Abbé Nollet and the friar accompanying him on a trip to Italy insisted on declaring these experiments a fraud and an imposture. Bianchi added that his letter could be shown to Pivati. (Letter from Bianchi to Veratti, in Cenerelli (1885, 193–195). In his book, Giuseppe Veratti had also attacked the popular theory proposed by Abbé Nollet about electricity being made of a double fluid, which we know today to be incorrect. Perhaps this attack by Veratti on Nollet's claim spurred on the latter to become involved in the controversy created by Pivati and supported by Veratti and Bianchi. Later, in 1749, Pivati published a second work titled *Riflessioni fisiche sopra la Medicina elettrica* (Physical reflections on medical electricity) which was printed in Venice.

Attacks and counter-attacks have always been present in the world of science. On the subject of electricity, Abbé Jean-Antoine Nollet (1700–1770) was an important figure in France. A clergyman, he was a member of the Royal Society of London since 1734, and he was the first professor of experimental physics at the University of Paris. His initial work was in collaboration with Charles François Cisternay du Fay who had identified the existence of positive and negative charges and had noted the difference between insulators and conductors. In 1745, a year after the invention of the Leyden jar by Musschenbroek, Nollet sent an accumulated electric charge through one hundred and eighty royal guards. Later, he wired monks together in a periphery of one mile and discharged the Leyden jar again into this group. They all jumped at the same time from the electrical shock, so he concluded that electricity moved extremely fast, a theory which he called 'simultaneous affluences and effluences'. In this theory, he assumed that human bodies had two sets of pores through which the electricity flowed in and out, a theory which is not true according to knowledge acquired by others at the time and

in later decades. But he was right about the speed of travel of electrical charges. Nollet's theory was part of another debate discussed further below.

A year after the publication of Veratti's book (1748), Nollet joined the debate. In 1749, he wrote a letter to Francesco Zanotti, the Secretary of the Academy of Science of Bologna, expressing his desire to visit Bassi and Veratti. He left Paris on April 27, 1749, and toured Italy for nine months during which he made a visit to Giambattista Bianchi, and to Laura Bassi and Giuseppe Veratti. He planned to also visit Gianfrancesco Pivati and the Bolognese Institute. Nollet wanted to verify the Italian claims about medication passing through glass becoming porous by the application of electricity. However, in Venice, Pivatti did not allow Nollet to see his experiments, claiming that the temperature was too hot and there were too many people present. Later that evening, in the presence of a large company, Pivati admitted that the Bishop had not been cured and that he was now in the same state as he had been before the electrification (Bertucci 2005, 156–157). After his visit to Bologna in the summer of 1749, Nollet made a presentation to the Académie des sciences de Paris in which he confirmed accepting many of the claims of cures made by electrification alone, but he rejected the proposition that odours could go through electrified glass (Logan 1991, 40). Nollet, Franklin, Priestley, and others rejected outright Veratti's claim about this phenomenon.

Rumours about Nollet's criticism soon reached Bologna and left the impression that he was attempting to discredit the experiments conducted in the Bassi-Veratti home. This spurred Laura to write to Flaminio Scarselli informing him that she had helped Giuseppe for several of the experiments; she asked Flaminio to use her letter in their defense if the problem was raised with him. But, in his criticism, Nollet had been kinder to Veratti than to others (especially Pivati) because Veratti had been humble in the assumptions he made in his book; he had also mentioned that there could have been some errors in his experiments. Veratti's book did not mention Bassi even though she had helped him to perform this set of experiments. Perhaps she did not agree with his conclusions, or maybe she was concerned about keeping their work independent from each other.

If Laura had not been a member of the Benedettina, it is almost certain that people would have assumed she was her husband's assistant, like Marie Lavoisier (1758–1836) for her husband Antoine Lavoisier, and Maria Winkelmann (1670–1720) for her husband Gottfried Kirch. Laura, in her career strategy, made sure that the work she presented at the Academy was original and carried-out independently from her husband's. The same was expected of him; this may explain why her name was not included in her husband's 1748 publication.

A few years later, Benjamin Franklin carried-out his famous and dangerous experiment in 1752, holding a kite during an electrical storm, a test that could have resulted in his death. In the same year, at Marly in France, Thomas François Dalibard followed Franklin's instructions and erected a pointed, long metallic rod toward a group of thunderclouds. Approaching the rod with another conductor near the ground, he managed to extract sparks that appeared identical to those produced by artificial means with an electrical machine. So he concluded that natural electricity was the same as electricity created by humans with their machines.

When Veratti heard about this experiment, he was keen to replicate it (Bertucci 2009, 27). Bertucci mentions a comment made by Laura Bassi years later about the lightning rod experiments done by her husband in 1752 and the response from the City of Bologna:

In 1770 Laura Bassi told the musician Charles Burney, who was touring Italy, that since her husband replicated the Marly experiment on the observatory tower, demonstrating soon after Franklin the identity between lightning and the electric spark, no lightning rods have been erected in this town (Bertucci 2009, 30).

Laura was referring to the fact that, when the lightning rod was installed on the tower of the Institute, there were several protests from the town's people who feared that lightning might strike other buildings or their own. This forced the cancellation of all future lightning rod experiments in the City of Bologna.

The other Italian man for whom electricity was a major interest was Giambattista Beccaria (1716–1781) who was appointed professor of physics at the University of Turin in 1748. His first book on electricity *Dell'elettricismo artificiale e naturale* (Of artificial and natural electricity) was published in Turin in 1753. The book supported Franklin's theory of electricity and rejected Nollet's notion of a double fluid. Beccaria believed electricity to be one fluid with particles running through a conducting material whose flow could be stopped by insulating materials. Most of this theory was correct except that electricity is not a fluid. Beccaria's book presented his new theory clearly and logically, illustrating them with variations of Franklin's experiments, to which Beccaria added his own observations of the different appearances of discharges from positively to negatively electrified points. Moreover, he affirmed that meteorological and geophysical phenomena were manifestations of "natural" electricity. He also showed his skill in designing apparatus, including measuring devices like the electrical thermometer, whose invention is usually wrongly ascribed to Franklin's colleague, Ebenezer Kinnersley. Beccaria's book contained a long letter to Abbé Nollet who had raised objections against Franklin's system. The Parisian *franklinistes* supported the elements described in the letter, so they translated it into French and made Beccaria the leading champion of the new system.²

In 1754, two years after Veratti's lightning rod experiments, the Institute decided to support the experimental work of Beccaria, so the latter travelled to Bologna to perform experiments on the electricity of the atmosphere, but this was organised in the countryside, not in the City. The experiments were done by a group of members of the Institute of Sciences who had encouraged this type of research. They also offered to publish Beccaria's next book, written in the form of letters on natural electricity addressed to Jacopo Bartolomeo Beccari, the former president of the Institute; it was published in Bologna in 1758. *Dell'elettricismo: Lettere di Giambattista Beccaria dirette a I. B. Beccari* (On electricity: Letters from Giambattista Beccaria to I.B. Beccari) was translated into several languages

² Web_Beccaria: <http://www.encyclopedia.com/doc/1G2-2830900323.html>. Accessed March 2013.

(Bertucci 2009, 18). Two-thirds of this book was devoted to natural electricity, particularly of the atmosphere, which Beccaria and his students tirelessly probed with metal poles, kites, and even rockets. There were many valuable observations of cloud formation, thunderstorms, and the accompanying electrical states of the lower atmosphere. The first seven letters on man-made or artificial electricity summarize, extend, and modify Franklin's system. The book also deals with insulating materials other than glass with which Beccaria constructed parallel plate capacitors to store electrical charges. Beccaria's book was a precursor to Alessandro Volta's invention of the battery.

On Physiological Explanations of Electrical Phenomena in Animals

The Swiss physiologist Albrecht von Haller (1708–1777), and his teacher at the University of Leiden, Dutch physician Hermann Boerhaave (1668–1738), drew parallels between the operation of electricity and the conveyance of motion through the nerves. By the 1750s, Haller had rejected the supposition that electricity was synonymous with a nervous fluid (Elliott 2008). Haller's theory claimed that there were irritable parts in the body which contracted when touched (muscles) and non-irritable parts which, when touched, transmitted the impression to the mind (nerves). In 1756, Tommaso Laghi (1709–1764), a member of the Academy of Bologna, presented the results of a series of experiments which rejected Haller's theory (Cavazza 2009, 119). Laghi believed that the movement of an organism was the effect of spirits which flowed along the nerves. He also proposed that nervous fluid was electrical in nature and that muscular contraction was caused by electricity passing from the nerve to the muscle (Logan 1991, 42).

Many Italian scientists criticized Laghi's position. Fontana and Caldani planned and carried-out experiments at the Bassi-Veratti home, using the couple's electricity machine, in the presence of the authoritative figures of Laura Bassi and Giuseppe Veratti. The two researchers, Felice Fontana (1720–1805) and Leopoldo Marco Antonio Caldani (1725–1813) considered that electricity was capable of arousing reactions in tissues and irritable organs, and they both rejected the notion that nervous fluid was the same as an electrical one (Cavazza 2009, 119). Fontana used cats, calves, and a large number of frogs as test animals. The two men subsequently wrote to Haller, informing him of their results, and confirming the participation of Bassi and Veratti in these experiments. This research was very important as it laid the ground work for the future experiments of Luigi Galvani on animals and electricity. Although Caldani eventually left Bologna for Pavia, he continued to correspond with Bassi and Veratti for many years. It was in 1789 that Galvani reported how the brain sends electrical messages to muscles and nerves, which is the correct interpretation according to current knowledge.

Electricity Became a Priority Subject at the Institute

The Institute of Sciences of Bologna considered the topic of electricity very important, especially after the flurry of experiments and debates that had been occurring since 1746. Now the Institute added another aspect to work they wanted done by their members: They wanted to find analogies between electricity and various other physical phenomena. Giuseppe Veratti proposed an analogy between magnetic virtue, electrical virtue, and fire in his presentations of 1758 and 1759. In 1777, Laura Bassi argued that there was an affinity between bodies that retain heat and those that retain electricity. In 1786, Luigi Galvani, elected as a member of the Institute in 1782, hypothesized that there was a similarity between the flame, respiration, and electrical vapor. In 1791, Galvani released publicly the results of his experiments that proved the existence of electricity in animals; he argued this was the same as what was commonly called the electrical fluid (electricity artificially produced by humans). There is no doubt that some of Galvani's and Volta's work was informed by previous work accomplished by Beccaria, Bassi, Veratti, Caldani, and Fontana (Cavazza [2009](#), 119).

An Academic Promotion for Laura Bassi

The last part of Laura's career was glorious. The Chair (a professorship in physics at the University of Bologna that had been held by I.B. Beccari) was taken over by Domenico Gusmano Galeazzi (1686–1775) in 1734. Galeazzi was later replaced by Paolo Balbi. But these last two men had more interest in medicine than in physics and did not have a vast foundation in mathematics, so their work was concentrated mostly on the medical aspects of physics (Cavazza [1995](#), 717). When Balbi died in 1776, the Chair of the Physics section was split into two positions for the first time since its existence. One position was in experimental physics, to which Laura Bassi was appointed, with her husband as assistant. Laura had been requesting this position from the Institute since 1773. Her husband Giuseppe, having been the assistant to Balbi, was temporarily appointed to this Chair in physics in 1772 when Balbi became ill. It was expected that he would be appointed to the Chair when Dr. Balbi died, but he had apparently been unable to teach experimental physics and theoretical aspects of physics, which were important parts of the responsibility of the Chair; moreover, his knowledge of mathematics was not sufficient for this role (Logan [1994](#), 799). Since these were subjects that Laura Bassi knew very well, her appointment to this physics Chair was a good decision. The appointment finally gave Laura the opportunity to teach public classes, something she had wanted to do during her entire professional life! But it was unfortunately for only two years, until her death in 1778. Her husband then replaced her in the Chair.

The second position of the new split chair was in physical mathematics, which consisted mostly of mechanics; this was given to S. Canterzani, the current Secretary of the Institute. G. Bonaccorsi was named as his assistant. It is said that there were disputes between Veratti and Bonaccorsi and the latter complained about not having access to the laboratories. Logan says that most of Bonaccorsi's dissertations (which were not published) were in the biological sciences rather than in physics and she argues that the splitting of the physics section chair may have been a means to keep the peace at the Institute (Logan 1994, 799).

The next chapter discusses one part of the correspondence to and from Laura Bassi. This period related mostly to her literary work, and to some of the strategies she used to develop her career in science.

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Chapter 8

Laura Bassi and her Networks (1732–1745)

In this chapter, we examine the correspondence between Laura and powerful and famous men during the thirteen years between her degree (1732) and the year when she was admitted to the Pope's special group at the Academy, the *Benedettina*, which opened up the opportunity for a real career in science (1745). The first part describes the laudatory writings after Laura's degree. The second part summarizes the content of letters between Laura and Flaminio Scarseeli, a friend and mentor; some of the content has to do with obtaining the support of the Pope for her admission to the *Benedettina* at the Academy. There are also favours requested by Laura for her cousin and for others and Flaminio's response to these. The third part discusses correspondence between Laura and her earliest supporters, Iacopo Bartolomeo Beccari and Giovanni Bianchi. Both men were quite much older than her and acted as mentors for her development and studies in science. Bianchi had an especially important influence on Laura and their correspondence was quite regular. Bianchi also visited Laura and her parents from time to time in Bologna.

For women and men working in science, even today, it is essential to communicate with other scientists, to discover what has been accomplished and what future developments are being planned. Scientists can decide if they wish to replicate certain experiments to verify their accuracy and results, or continue on their own path and topic of interest. Progress in science consists mostly of small steps building on past achievements. Occasionally breakthroughs happen, but even these are mostly the consequence of work by many persons, including collaborating principal investigators, research assistants, students, and laboratory technicians and technologists. Discovery is rarely the work of a single individual. Communication of research is very important, to share what has been learned, with both positive and negative results, thus minimizing duplication and allowing others to build on what has been established. This enables the science enterprise to progress towards an understanding of the world we live in. Today, science is communicated through internet, email, presentations at conferences, articles published in journals, and books.

In Laura's time, the communication opportunities included presentations at the Academy, publication in its journal, disputations in homes (Salons). Letters

between philosophers was also a very important mechanism, not only to develop a network of colleagues, but to share information. Letters also frequently contained some social news or requests for favours. With her fame, Laura had become an intermediary between some people and her powerful patrons and supporters.

Between the time of Laura's Theses defenses in 1732, and her sudden death in 1778, Laura corresponded with many of the famous men in science, medicine, and philosophy, and men in high places. Since little has been preserved of the written dissertations she presented at the Academy, we can find a little bit more about her work through her correspondence and follow the development of her career, discover her interests, and what she studied. A few of the letters mention equipment sent to her, or the sender asks her to test some instrument, while others suggested some experiments that she could carry-out to verify their claims or their theory (Figs. [8.1](#), [8.2](#), [8.3](#), [8.4](#), [8.5](#), [8.6](#), [8.7](#), [8.8](#), [8.9](#), [8.10](#), [8.11](#), [8.12](#), [8.13](#), [8.14](#), [8.15](#), [8.16](#), [8.17](#)).

The letters to Laura Bassi from Beccari were compiled by Cenerelli and those written by Laura and Bianchi appear in the article by Beate Ceranski *Il carteggio tra Bianchi e Laura Bassi, 1733–1745* (The correspondence between Bianchi and Laura Bassi, 1733–1745) published in 1994. Some of the famous men who had some contact with Laura lived in Bologna, so there would not be much correspondence with them since they likely met at Academy meetings and at each other's home for disputations from time to time. A short profile of the men involved in the correspondence included in this chapter helps to understand how their interests related to Laura Bassi's own work.

In the period between her defense in 1732 and her membership in the Benedettina in 1745, several letters concern Laura's literary activities, since she was expected to concentrate on these works rather than on science. Some of the letters were from admirers of Laura's work.

Letters from Literati (Writers and Poets)

The extraordinary events of Laura's Theses defense and obtention of her degree led to a flurry of poems and sonnets written about her and sent to her. She was the focal point for a collection of verses, three of which were printed and others were in manuscript form. Additionally, there were a number of individual compositions, published on single sheets or left unpublished; this was the fruit of an unprecedented mobilisation of poets. These laudatory pieces were not just from Bologna or from the Italian Peninsula. There was an ode in a strong feminist voice composed by the German poetess Cristiane Marianne von Ziegler when she heard the news of the bestowal of a doctoral degree on a woman (Cavazza and Bertucci [2003](#), Classics Online; Ceranski [1996](#)). From another woman, there was the opening composition of a small collection of poems titled *Rime per la Conclusione filosofica* (Rhymes for the philosophical conclusion) published by Lelio dalla Volpe and sold in Bologna, although none of the poets in the book were from that



Fig. 8.1 Portrait of Laura Bassi. (Reproduced courtesy of the Biblioteca Comunale dell'Archiginnasio di Bologna.)

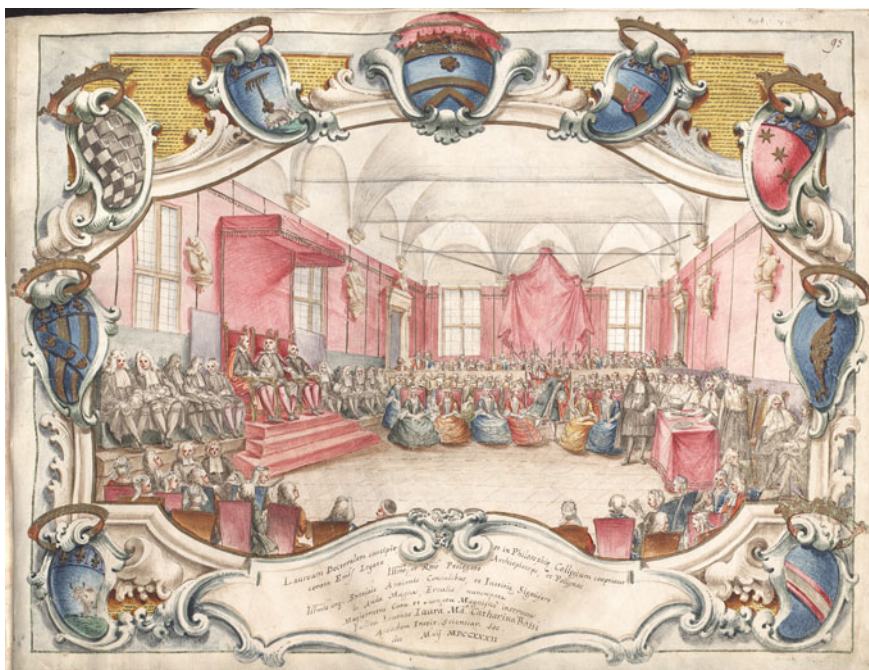


Fig. 8.2 Miniature of the room where Laura BassiGúos Thesis defense took place at Palazzo Pubblico in Bologna. (Reproduced courtesy of the Archivio di Stato, Bologna, Insignia Senato, Anziani Consoli vol 13, cc 95, 1732.)

city. There was an interesting dedication to the candidate by the priest Lorenzo Stegani, her first teacher. Another piece, *All'Insegna della Rosa, sotto le Scuole* (To the sign of the rose, under the schools) was authored by the Venetian Luisa Bergalli, the woman who had edited an important collection of poems by Italian poetesses a few years earlier. Her poem reflects female pride as seen in the last stanza: “Donne gentili, questi/Pregi c’imparte il Facitor divino;/Ch’atte siam pure a gloriose imprese [...]”. The second poem is also by a Venetian, Gaspare Gozzi, Bergalli’s husband, while the other authors come from other Italian cities. Laura was given a copy of the volume with a sumptuous cover in embroidered silk (Cavazza and Bertucci 2003, Classics Online).

Cavazza argues that the most significant of the poetic collections published in Bologna in 1732 appears to be *Rime per la famosa laureaione* (Rhymes for the famous graduation), again published by Lelio dalla Volpe. Here, the writers are thought to be from Bologna as they had direct knowledge of the *dottoressa*. Some of these poems portray Laura Bassi as a Newtonian philosopher. A foremost example of this is the sonnet by Francesco Algarotti, *Ombra del gran Britanno* (In the Shadow of the Great Briton). In *Non la Lesboa Vergin Febea* are the two first verses of a long poem by Francesco Algarotti. He refers to Sappho, the ancient Greek poetess from Lesbos. After referring to several other women in Antiquity, Algarotti begins to write

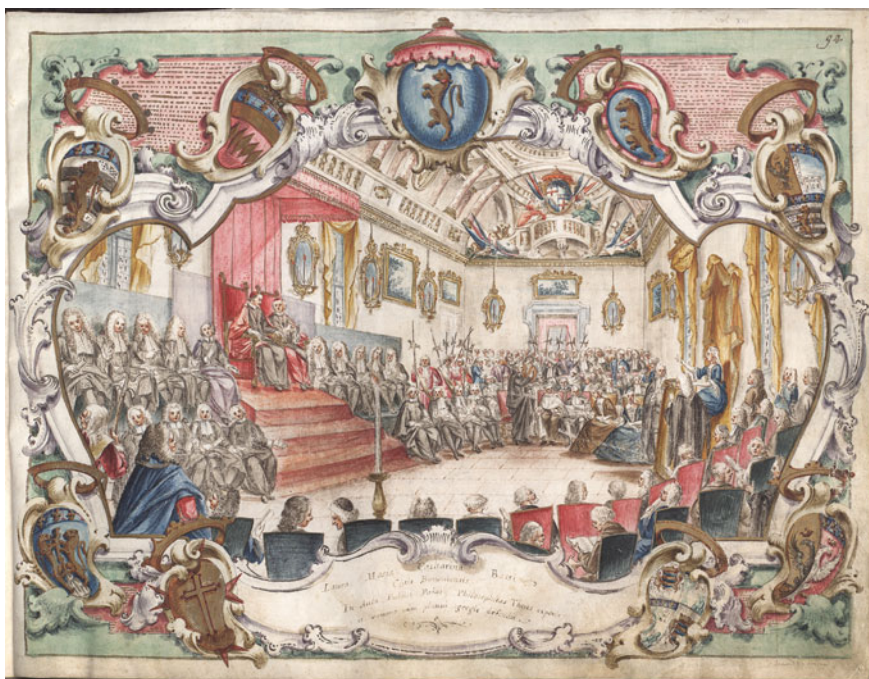


Fig. 8.3 Ceremony where Laura Bassi was awarded the degree. (Reproduced courtesy of the Archivio di Stato, Bologna, Insignia Senato, Anziani Consoli, vol 13, cc 94, 1732.)

about Laura Bassi, presenting her as a follower of Newtonianism through her ideas on cosmology, tides, light, and colour. The most famous verses from Algarotti's poem speaks about Newton's *Optics*: *O de l'aurata/Luce settemplice/i varioardenti, e misti almi color Non la Lesboa*, where he calls Laura Bassi the 'rich inexhaustible mine of the new, beyond the seas, high knowledge', a perfect expert in the Newtonian system, from the stars' orbits to the explanation of tides, to the theory of light and colours (Cavazza and Bertucci 2003, Classics Online).

One of Laura Bassi's most devoted admirers, Giampietro Zanotti, was a painter and a poet. In a long poem, he celebrated the young philosopher's diligence and pleasure in penetrating the least accessible mysteries of nature through her adventurous research, which Zanotti considered an offer of the highest honour to the ashes of the British philosopher (Newton). A poem by Giosseffo Pozzi was addressed to Laura's teacher, Gaetano Tacconi. For Pozzi, Newton was not the only great mind Laura measured herself against; he saw 'the shadow of the English philosopher holding her by the hand', but added that 'a subtle René Descartes rendered homage to Laura'. Cavazza says that the analogy between Bologna and Bassi, between their virtues and their glorious reputation, was brought out clearly in the last two stanzas of Pozzi's poem. Pozzi invites everyone to remember honouring her (Bologna's) ancient Heroines, referring to the time in Bologna when women in the Middle Ages are said to have gained a degree and taught law or



Fig. 8.4 Laura Bassi's first lecture. (Reproduced courtesy of the Archivio di Stato, Bologna, Insignia Senato, Anziani Consoli, vol 13, cc 98, 1732.)

medicine at the university. He added that Tacconi should not try to bring about the miracle achieved with Laura Bassi with other women, because it would be quite impossible to find another with equal virtues and with such an exceptional mind (Cavazza and Bertucci 2003, Classics Online).

Marta Cavazza, in the article on Laura Bassi (Cavazza and Bertucci 2003, Classics online) wrote that Ferdinando Antonio Ghedini addressed his sonnet to *Felsina* (the ancient Bologna), in whose honour Laura had carried out 'her rare and admirable achievement'; Father Achilleo Geremia Balzani ended his poem with these words of praise: "You the glory and you the treasure are/of the name of Felsina, and your own sex". Flaminio Scarselli referred to Laura Bassi as "Laura the gentle one, delight, and love of our century, indeed glory too, and honour"; and Giovanni Battista Vicini wrote: "Laura revives the honour of her sex"; Gioseffo Manfredi called Laura the 'Great Virgin, Who adorns Felsina' (Cavazza and Bertucci 2003, Classics online).

In her inventory of the papers regarding Bassi and Veratti, Busi lists 30 manuscripts and poems in praise of Laura Bassi after she obtained her degree (Busi 2001, 298–299). An eulogistic sonnet accompanied Father Domenico Fabri's letter of August 20, 1737 to Laura. But only the letter can be found today, not the sonnet (Cenerelli 1885, 66–67). The famous *Elogio* written by Fantuzzi after her death presented Laura Bassi's abilities, knowledge, and career. Several famous men



Fig. 8.5 Laura Bassi at the anatomy carnival in Teatro dell' Archiginnasio. (Reproduced courtesy of the Archivio di Stato, Bologna, Insignia Senato, Anziani Consoli, vol 13, cc105, 1734.)

wrote of their admiration for the woman philosopher and for the City that supported her ascent. Among these were Voltaire, Lalande, Burney, Johann Jacob von Volkmann and the American physician John Morgan.

Charles Burney (1726–1814), a music historian who visited Italy wrote:

In Italy, degrees are given to scientific Ladies; and at this time one of the most distinguished is la Signora Laura Bassi of Bologna... This lady is between fifty and sixty; but though learned, and a genius, not at all masculine or assuming. She seems perfectly acquainted with the merit of all the learned and scientific men in Europe, and was particularly civil to the English in encomiums on Newton, Flamsteed, Hailey, Bradley, Franklin and others. This Lady has made an uncommon progress in Electricity, has invented new machinery, made new experiments, and fairly earned the title of *Dottoressa*. (Burney 1959, 159)

Summaries of Correspondence (1732–1745)

As mentioned earlier, Laura Bassi was constrained in this period to carry-out her role as an 'exceptional woman' in the humanist tradition, and in view of her great fame, she had to produce poems and sonnets in response to frequent requests from



Fig. 8.6 Portrait of Iacopo Bartolomeo Beccari. (Reproduced courtesy of the Biblioteca Comunale dell'Archiginnasio, Bologna.)



Fig. 8.7 Portrait of Giovanni Bianchi. (Reproduced courtesy of the Biblioteca Comunale dell'Archiginnasio, Bologna.)

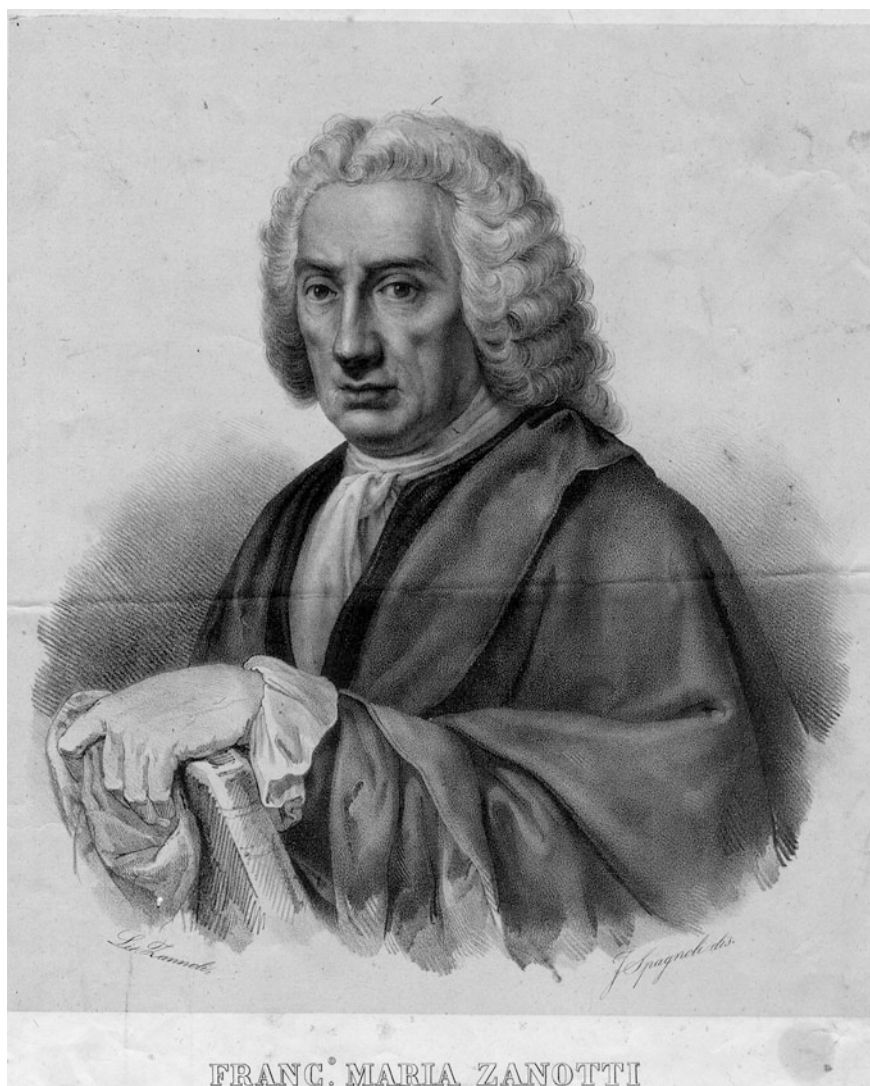


Fig. 8.8 Portrait of Francesco Maria Zanotti. (Reproduced courtesy of the Biblioteca Comunale dell'Archiginnasio, Bologna.)

the elite in Bologna. In these 13 years, she also spent some of her time on learning mathematics and physics, preparing herself for the day when she could dedicate all of her time to explore the sciences. The correspondence in this period is interesting because it shows how she continued to believe she would have a future in science and how she forged this future step by step with the help of her friends, men in high places. Laura's decision to marry Giuseppe Veratti was a step in the right direction; some of the letters written to her and by her discuss this important event.



Fig. 8.9 Portrait of Lazzaro Spallanzani. (Reproduced courtesy of the Biblioteca Comunale dell'Archiginnasio, Bologna.)

Another serious discussion concerns the fact that Tacconi, her former teacher, was upset with her; some of Laura's friends offered advice on how to effect a reconciliation of her family with Tacconi. One of these friends was Matteo Bazzani who expressed his thoughts on the problem. This was a difficult period for Laura. Tacconi had stopped being in contact with her parents after she chose not to dispute on ethics in her second set of Theses defense. Matteo Bazzani (1674–1749) was a famous philosopher, doctor, and anatomist. He held the Chair in Medicine and Anatomy in Bologna and was renowned for his elegant Latin writings. He was also one of the founders of the Academy of Sciences at the Institute and its first



Fig. 8.10 Portrait of Alessandro Volta. (Reproduced courtesy of the Biblioteca Comunale dell'Archiginnasio, Bologna.)



Fig. 8.11 Portrait of Luigi Galvani. (Reproduced courtesy of the Biblioteca Comunale dell'Archiginnasio, Bologna.)



Fig. 8.12 Leopoldo Marc Antonio Caldani. (Reproduced courtesy of the Biblioteca Comunale dell'Archiginnasio, Bologna.)

Secretary. He became its president in 1723 and was made a member of the Benedettina when it was created.

Bazzani wrote to Laura from Bologna on August 6th, 1732; they both lived in Bologna at this time. He had been one of the professors at her defense. Bazzani probably thought a letter would be appropriate as Laura and Matteo probably did not frequently have an opportunity to meet.

In his short letter, Bazzani expressed his regrets at hearing that both Laura and her parents were not successful in regaining the respect and the friendship of Doctor Gaetano Tacconi in spite of their efforts. Bazzani referred to the confrontation between Dr. Tacconi and the Bassis that had occurred in 1732. Laura's



Fig. 8.13 Portrait of Maria Gaetana Agnesi. (Reproduced courtesy of the Biblioteca Comunale dell'Archiginnasio, Bologna.)



Fig. 8.14 Portrait of Anna Morandi Manzolini. (Reproduced courtesy of the Biblioteca Comunale dell'Archiginnasio, Bologna.)

different choice of These defense topics had caused a real rift between the teacher and his former pupil. In this letter, Bazzani advised Laura and her parents to maintain the utmost silence on the regretful event and to act as if nothing happened. He promised that, on his return to Bologna, he would provide Laura with his personal opinion on the matter. He thought this was better discussed in person than in a letter. Bazzani concluded with the usual reverent salutation to Laura and her parents. (A footnote, added by Cenerelli to this letter, mentions that Matteo Bazzani played no direct role in the future reconciliation between Tacconi and Bassi).

From his home, Bazzani wrote to Laura again on December 22, 1732 and sent her back the beautiful and knowledgeable Oration she had written. He remarked that anything written by Signora Laura can be nothing less than wonderful and fully accomplished. Bazzani added that Laura would soon receive favourable news



Fig. 8.15 Portrait of Gabrielle-Émilie du Châtelet. (Wikipedia, in public domain.)

from Mr. Azzoguidi about Tacconi's opinion of her. (This seems to indicate the imminent reconciliation between Laura Bassi and Gaetano Tacconi).

In another letter sent from Bazzani on July 9, 1733, he suggested that Laura invite Doctor Tacconi to the evening where she will be giving a philosophical talk to Cardinal Acquaviva at the Zambeccari's residence. He was sorry not to be able to attend the event because of a previous engagement which forced him to leave town for a couple of days. Bazzani regretted missing the opportunity to listen to Signora Laura who, as usual, will be heard with admiration and respect.



Fig. 8.16 Portrait of Cristina Roccati. (Reproduced courtesy of the Biblioteca Comunale dell'Archiginnasio, Bologna.)



Fig. 8.17 Portrait of Maria Dalle Donne. (Reproduced courtesy of the Biblioteca Comunale dell'Archiginnasio, Bologna.)

On August 27, 1736, Matteo Bazzani thanked Laura for interceding with Mr. Flaminio Solimei on behalf of one of his farmers. Laura presented the case of the farmer in a new and positive light. The farmer had been accused of some mischief, but he was not the guilty party; he was the victim. After the case was heard, the farmer had to return to the hospital from which he was been released prematurely even though not completely cured. Bazzani concluded his letter by asking Laura to give his very polite salutation to Mr. Solimei and to Laura's mother.

There is no date on Bazzani's last letter. A footnote mentions that it was probably written in 1738, given that Bazzani talks about the possibility that Laura was

pregnant. She was married in February of that year. In the letter, Bazzani asked Laura to prepare a funerary oration, but he incites her to carefully examine his request before accepting, considering that she is now married and if not presently pregnant, she could be in the next few months. He expressed his regrets for not having thought about this before writing and hoped that she would welcome his concern for her health. He added that she did not have to reply to his brief letter.

Matteo Bazzani was an important man for Laura and her career. In addition to having been one of the examiners at her first set of Theses defense, he had strongly supported the awarding of her degree. He also had composed and read an extraordinary oration (in Latin) on that occasion which was later included in print at the end of Fantuzzi's oration of 1778 after Laura's death. Similarly to Giovanni Bianchi, Matteo Bazzani offered Laura advice and complimented her on her knowledge and on her written and oral skills.

Flaminio Scarselli (1705–1776) was a powerful man and a friend. He acted as intermediary between Laura and Pope Benedict XIV (the former Cardinal Lambertini). Scarselli, born in Bologna, was a poet, orator, and taught literature at the University of Bologna. He held public offices, principally as Secretary to the Bolognese Senate's Ambassador in Rome between 1742 and 1760. He later returned to Bologna as Principal Secretary to the Senate. Because of his long and honourable service to the State, he was eventually inducted into the nobility of Bologna (Cenerelli 1885, 228).

Letters from Flaminio Scarselli (from Cenerelli 1885, 104–125)

Many letters were exchanged between Laura Bassi and Flaminio Scarselli. The latter and the Pope proved to be the most influential forces for Laura's success in establishing a life-long career in science. They were also an important influence in eliminating several obstacles put in her way by some of the members of the Academy and by the university. In addition to requesting a major favour for herself (that is, to become a member of the Benedettina), Laura was also a conduit between men needing favours and her influential friend Flaminio Scarselli.

The earliest letter on record from Flaminio Scarselli was written from Bologna on August 21, 1733. Flaminio began his letter by congratulating Laura for her cousin's success in being admitted to the Collegio Poeti and having appropriately answered all the questions and solved all the problems. He said being happy that her health had improved. With his letter, Flaminio sent Laura a Libretto (a collection of poetry) and hoped she would enjoy reading the sonnets written by Senator Isolani just before his death and published by his dear friend Giampietro Zanotti. In the publication, Zanotti had added some poems in praise of Isolani. Scarselli's letter ended with respectful salutations to Laura and to her mother (Cenerelli 1885, 104–105).

From Rome, July 20, 1743, Scarselli transmitted questions from one of his friends, ‘a man of letters’, who had often asked about Laura’s accomplishments. Scarselli begged Laura to respond to the questions from his friend and hoped for a continued gracious friendship with Laura. He concluded with respectful and honest greetings, also from his wife, for both Laura and her husband (Cenerelli 1885, 105).

From Rome, August 10, 1743, the letter follows shortly after the previous one; Scarselli thanked Laura for having responded so clearly and modestly to all the questions from his friend. He informed Laura that he found it appropriate to mention the topics of her lessons on public schools and her interest in poetry. He responded to Laura’s letter of July 31, 1743, where she had asked Scarselli how a priest should proceed to request a leave from his residency (Melli 1960, 89). Flaminio explained that it would be sufficient for the priest to ask a formal permission from the Bishop if it was a matter of only a few days; but if the absence was longer, then it would be necessary for the priest to make his request to the Saint Congregation of the Council. (We do not know who this priest is; it could be one of her brothers or another relative). In concluding, there was a personal matter: Flaminio tells Laura that his wife had to stay in bed since June 16 as she suffered from an abundant uterine haemorrhage (Cenerelli 1885, 106–107).

Laura wrote to Flaminio on April 11, 1744 telling him that, on her return home, she found the tragedy written by him and said how much she enjoyed reading it; she suggested it would enrich the world of literature (Melli 1960, 92).

On July 18 of the same year, Laura asked Scarselli if he could intercede in favour of a friar. There were two more letters from Laura on August 5, where she expressed her wish to return favours for his great kindness to her. On September 26, Laura interceded for her own husband; he wanted to obtain the right to be the physician for a monastery of nuns. To be the official physician in a nunnery, a man had to be 40 years old, but Laura’s husband was 38. Laura wrote again on October 14 and on November 4 about this last request (Melli 1960, 93–99).

Scarselli responded from Rome on November 11, 1744 about Laura’s request for the friar. He regretted not being able to help for diplomatic and religious reasons, as he had promised never to get involved with any matter related to friars. He believed this would be the first and last time he would miss the opportunity to serve Laura and hoped she understood his delicate position. Regarding the position of physician for the Dominican nuns, Flaminio said he was pleased that Monsignor Boccadelli complied with Giuseppe’s wish and her husband was now nominated official physician of the Santa Maria Maddalena convent through a concession from the Pope (Cenerelli 1885, 107–108). Laura thanked Scarselli in her letter of November 18 and on December 9, 1744 (Melli 1960, 100–101).

The next series of letters were alluded to in the chapter discussing how Laura was added to the special group at the Bolognese Academy, the Benedettina. Laura’s letter on this topic was written on April 20, 1745. She began by stating that this letter did not make any requests about monasteries or friars, but concerned only her. Laura mentioned that he (Scarselli) would know better than her about the wonderful idea of the Pope to create his special group within the Academy of

Bologna. Laura admitted having heard that she was not one of the nominees that would become a member of this group and suggested her merit be judged by the Pope who knew her well. He had interceded for her to obtain a lectureship at the university in 1732. She hoped the Pope would agree to add a position to the 24 so that none of the men already chosen would be eliminated from the list. Laura mentioned her husband, who sent his respects; Giuseppe had been in bed with a fever and a cold since fifteen days (Melli 1960, 103–104).

Flaminio responded from Rome on April 28, 1745. In his lengthy letter, Scarselli addressed Laura's complaint about her difficulty to participate in Academy affairs and about the malicious gossip surrounding her name. In a very diplomatic way, Scarselli reassured Laura that, if necessary, he would beyond any doubt promote her excellent work and support her wish. He explained that the situation was in the hands of the Cardinal and that it should not be difficult to have her name added to the *Pensionati* (the *Benedettina* at the Institute who were to receive one hundred lira per year and be required to present a dissertation every year), in view of the fact that the Cardinal also knew her well and respected her. He ended by expressing his deepest regrets for not being able to be in Bologna to discredit the malicious gossip and speak the truth (Cenerelli 1885, 108–110). (Note: We do not know what the gossip was about, since she was married since 1738; perhaps it was on the inappropriateness of a woman requesting to be elected to the *Benedettina*, as there was some grumbling at the Institute about her request to the Pope).

Laura wrote to Flaminio on May 12, 1745 informing him she was expecting a response soon from the Cardinal Legate about her request to be added to the *Benedettina*. She wondered if he thought it would be appropriate to also resuscitate the matter of her public lectures, adding that Gabriello Manfredi had already spoken to the *Assunti di Studio* (administrators at the university) and to the Pope, and there did not seem to be much difficulty about being allowed to teach. However, she informed him that the school was now closed following the Spanish Troups' presence in Bologna. She informed Scarselli that Cardinal Alberoni has been ill until the end of his mandate as Legate (Melli 1960, 105).

In her letter of June 5, 1745, Laura expressed her optimism about the success of her request and assured Flaminio that she will forever be grateful for his help in interceding with the Pope. On June 19, Laura wrote to Flaminio to say that she was sure the matter would be successful following his intercession with the Pope.

Another letter from Laura written on October 16 mentioned that her cousin Don Carlo had desired for many years to obtain a canonry at the church of Santa Maria Maggiore. She asked Flaminio what advice she should give her cousin (Melli 1960, 106–111).

October 23, 1745: (This letter was said to be from Bologna, but it was most likely written from Rome, like the others). Scarselli wrote that he was always extremely pleased to obey Laura and, when he had the power of doing something for her, he was happy to serve her. Regarding the appeal for her cousin Don Carlo, Scarselli suggested that he should wait for a vacancy or else perhaps he should ask for assistance from Lady Imelda Lambertini, the niece of Pope Benedict XIV. In

this letter, Scarselli suggested that Laura print some of her dissertations and dedicate the work to His Holiness the Pope, even if the same dissertation had appeared in the Proceedings of the Academy. Scarselli provided the example of Mr. Molinelli who recently printed his works on aneurisms and dedicated the work to the Pope who was extremely impressed and pleased; the same paper had also been printed in the Proceedings of the Academy. If she were to present the Pope with such a book, with a dedication, then it would be simple for her to make her request and there would be no need for further assistance (Cenerelli 1885, 110–111).

Laura wrote to Flaminio on October 30, 1745, saying she did not want to offer an imperfect work to the Pope and asked advice on what she should send (Melli 1960, 112–113). Flaminio responded from Rome on November 6. As to which dissertation she should send to the Pope, he suggested that Laura make the choice herself. He reminded her that sooner or later she would find out if His Holiness was appreciative of the dedication and the work. He also advised Laura that her cousin (Don Carlo) should not insist any more about his request at the present time (Cenerelli 1885, 111–112).

There were two more letters from Laura at the end of this eventful year of 1745. She wrote on November 13 and on November 27. The former was again about her cousin Don Carlo, where she agreed with Flaminio's advice that her cousin should drop his request at this time. The second letter regarded a meeting of the Benedettina at the Academy on an evening when neither she nor her husband could attend, and therefore were not able to vote or to intervene in the discussion. At that meeting, the members of the special group (Benedettina) decided to continue to keep Laura apart, in spite of the fact that the Pope had agreed to add her to the 24 members. Laura told Scarselli she preferred to appeal directly to the Pope about this or to keep the whole thing silent. She added that if the Benedettina members recognized her, they should also provide her with the right to vote and all other privileges that went with the title. She did not understand how the Academy members could vote to exclude her, after an intercession from the creator of this group, especially since she had not displaced anyone but was merely added to the chosen members! She added that these members were preventing her from the most beautiful opportunity to participate in scientific activities. She suggested that he write to the president of the Institute (Dr. Galeazzi) to express both of their sentiments (Flaminio's and Laura's) on the question and to ask for a response (Melli 1960, 114–115).

A last letter that year was written by Laura, on December 11, expressing her gratefulness for Flaminio's prompt letter to Dr. Galeazzi who now promised, at the first opportunity, to clear any doubts in the mind of the academicians about Laura Bassi's participation. Laura hoped for a successful conclusion to this matter and mentioned that, in the second vote for her election to the group, she would need sixteen votes (2/3) for the motion to pass. She also mentioned that Monsignor Leprotti advised her not to appeal to the Pope at this time, a point with which she agreed. Laura added she just wished to keep him (Scarselli) informed of events and assured him she knew her cause was in good hands (Melli 1960, 117).

From the correspondence between Flaminio Scarselli and Laura Bassi, we can see that she informed him about the difficulties she was facing at the Academy, and about her activities. As mentioned in a previous chapter, Laura did not hesitate to contact the Pope through Flaminio Scarselli when the Benedettina was created at the Academy of Sciences of Bologna. As we know, this exchange of letters between Laura and Flaminio was quite successful in assuring her a proper place within the Benedettina at the Academy and stifled much of the opposition to her active participation in academic affairs. Laura's strategy was to ask for support from her powerful patrons and friends when she needed it. Her political acumen and the respect she had gained from powerful men were critical factors in the establishment of her fruitful and long career in science.

Letters from Famous Men in Science and Medicine in this Early Period (1732–1745)

In this section, we examine the correspondence from Giovanni Bianchi, a physician in Rimini who provided advice and encouraged Laura during the years after her defense until 1745. The chapter ends with a letter from the Secretary of the Academy, Francesco Maria Zanotti.

Giovanni Bianchi (1693–1775) and Laura Bassi corresponded for many years with numerous letters. They also met during his occasional visits to her parents' home in Bologna. Bianchi was born in Rimini, the son of a pharmacist (Gerolamo). He studied medicine and philosophy between 1717 and 1719, after which he practiced medicine in Rimini. Later he was appointed to a Chair in Anatomy at the University of Siena by the Grand Duke of Tuscany, between 1741 and 1744. He eventually left because of conflicts with colleagues over his philosophy and ideas. Upon his return to Rimini in 1745, he re-started the Academy of the Lincei, originally created in Rome by Federico Cesi in 1603. The Academy had been dormant since 1630. Its revival in Rimini was quite successful until 1765. Bianchi became famous all over the Italian Peninsula after the 1739 publication in Venice of his book titled *De Conchis minus notis liber* (On shells). From 1745, he worked on science topics and on botany, zoology, hydraulics, but his principal interest remained on human anatomy. He continued to practice medicine throughout his career. In 1751, he published *La Storia Medica* (History of Medicine). It seems others had also published on this topic prior to his publication. He is known to have taken the pseudonym of Jano Planco for the autobiography he published in 1742.

Seventeen letters were included in Beate Ceranski's article titled *Il Carteggio tra Giovanni Bianchi e Laura Bassi, 1733–1745* (Ceranski 1994, 207–231). They appear in the original language (Italian). Eight letters were from Bianchi to Bassi and nine were from her to him. In the foreword to the letters, Ceranski mentioned that most of the letters were preserved in good condition, although a few had some

water damage with a few parts difficult to read. But overall, they offer a good example of the discussions that occurred between Giovanni Bianchi to Laura Bassi (Ceranski 1994).

The letters were written in a period of 13 years while Laura was trying to establish herself as a respected scientist and during a time in which she faced many obstacles because of her sex. During these years of preparation of her future career, it was also an important time for her personal life; Laura had to decide between getting married or remaining single. Doctor Bianchi provided counsel and advice to Laura, making suggestions on her studies and sharing with her some of his own problems. A warm friendship and mutual respect developed between them over the years. A summary of the content of the letters is provided below. The letters from Laura concerned the progress of her scientific studies, her wedding, and choice of husband. Giovanni mentioned his research work and sent Laura copies of some of his publications. In spite of the fact that he was a physician, Bianchi also had a deep knowledge of natural sciences and he was an antiquarian.

Before looking at the letters we should remember that, prior to Bianchi getting to know Laura Bassi, he thought too much fuss was being made about this young woman. But his attitude changed dramatically after meeting her and his respect for her talent and knowledge grew substantially over the years. The correspondence began ten months after her defense of April 1732. At this time, he started to pay attention to her studies and offered advice. He encouraged Laura to abandon her studies of the Classics and suggested she concentrate her efforts on physics, more specifically on the philosophy of Descartes and of Newton. As mentioned previously, Laura began to take lessons in advanced mathematics from Gabriello Manfredi after her defense and she became familiar with calculus and the work on optics by Newton. Laura also began to do some of Newton's experiments on optics to understand them better, and other works which continued to develop her reputation and credibility. Some of the letters mention that she was invited to dispute with academicians and other elite men of Bologna. Thus her activities in these 13 years paved the way to her eventual obtention of the membership in the *Benedettina*.

Bianchi not only advised her on scientific matters, but also on linguistic ones, encouraging her to learn the English language. An interesting aspect of the correspondence between Laura Bassi and Giovanni Bianchi is that he was asking her from time to time to transmit his greetings to some of the members of the academy, and at other times, to share some of his publications with them, providing a channel for her to make connections with her Bolognese colleagues. In his way, Bianchi was also showing to the academicians that Laura was a young colleague with great potential for future work in the field of her choice. This must have helped Laura to be integrated into the scientific community of Bologna. By 1744, Laura was also beginning to be integrated into Bolognese society; she reported to Bianchi that she now had a conversation with Marchesa Davia, who had refused to see her in 1733 (Ceranski 1994, 207–212).

Bianchi's first letter to Laura was written from Rimini on February 10, 1733. He started to say he would always remember her valour and expressed how much

esteem he had for her. The entire letter compliments Laura on her accomplishments in science. Since it was written several months after her first and second defenses, and after her first lectures in December, Bianchi had become quite familiar with Laura's great knowledge and oral and written skills. He asked Laura to transmit his regards to Doctor Paolo Battista Balbi, physician and philosopher and the holder of the Chair in physics at the Institute. He also sent salutations to a Mr. Tozzi.

Laura responded a few days later, on February 14, expressing her gratitude for the compliments and the honour which Bianchi proffered on her in his letter. Laura said being pleased that he arrived safely back in the country and informed him she had delivered his regards to Dr. Balbi and Mr. Tozzi. Laura mentioned a new collection of poetry that was written in her honour and that a portrait of her had been painted. She added that Dr. Balbi promised to deliver the collection of poetry to Andrea Battaglini (1704–1735), a historian and philosopher in Rimini.

On June 7, 1733, Bianchi wrote a very long letter to Laura, the largest part discussing a book by Giovanni Crivelli on elements of physics. Bianchi began by mentioning that her fame was not only in Italy, but all over Europe. He recalled fondly his visits to Bologna during the past winter, when he had stayed in her parents' home several times and holding discussions with her and other philosophers. He reminded her of the evening when they talked about Crivelli's book published at the author's cost by a press in Venice, which contained a compendium of the doctrines of the most talented philosophers, past and present. Bianchi said he found some errors in some of the facts and so he thought the book would not be a good one for young students who may not recognize the errors. Bianchi made detailed notes of the errors in the text and assured Laura that this was not to censure the propositions in the book, but rather to ensure the facts were correct. Bianchi admitted reading the book in much haste. He referred to page 24, line 15, in Book II and questioned the interpretation of the author on organic movements linked to passion; he wrote a long critic of Crivelli's text and provided his own explanation for the phenomenon. The letter mentioned other pages and sections of Crivelli's book and suggested the author should reprint his book with corrections.

July 4, 1733, Bianchi informed Laura of his arrival home in Rimini. He referred to the writing style used in his last letter as being vivid (*vivezzia mia*). As usual, he sent compliments and asked Laura to delete the last few lines of his previous letter which could be offensive to some; he had wanted to delete the lines himself, but he forgot to do so. He conveyed his respects to her mother, to Dr. Balbi, and to Don Giacomo. (Note: perhaps the two lines in question refer to Crivati in unfavourable terms and perhaps are the following: "dirò come disse a Dante nell'inferno Francesca da Ravenna quell'illustre Nuora di Malatesta da Verrucchio Primo nostro Signore").

July 11, 1733, Laura said to Giovanni that she was pleased he had again arrived home safely. She would dare give him a gentle warning, that indeed she cannot be grateful enough for his most distinguished favours and affirmed never being bored by his kindness, as he had suggested in his letter. Laura agreed that it would be better to delete the last two lines of his past letter in case she was to show it to

someone else. She mentioned not wishing to be mixed up with literary dissent. (This refers to the criticism of Crivello's book. She was in an early stage of her career and did not wish to make enemies). She offered greetings from her parents, Dr. Balbi, and Don Giacomo. (We do not know if the letter reprinted by Ceranski contained the last two lines or whether they had been scratched out by Laura).

Laura wrote again to Bianchi on June 28, 1737. (This letter was damaged, but only a few words are missing). Laura felt that, having expressed her interest in learning English during Bianchi's visit, she had placed new obligations on Bianchi, since he offered to help her. She admitted that this added to the debt she owed him. She thanked him profusely for the favours and assured him she would obey his commands. The rest of the letter concerned her tardiness in returning a book; several words are missing in this part.

On July 24, 1737, Laura thanked Bianchi for having hand-written the English grammar book, considering how busy he was, visiting his patients and taking care of them. Laura mentioned that, while in her villa in the countryside, if she found some spare time after finishing her study of algebra, she would immediately start using the beautiful English grammar book. Laura made a reference to Dr. Balbi and to an issue about a prohibited topic, but suggested this would be resolved one of these days. (We do not know what this refers to).

On April 19, 1738, Giovanni complained that it had been a long time since he received a letter from Laura. Her last letter was in July 1737. So he dared break the silence and rejoiced in the happy news of the wedding celebrated with Dr. Veratti. He assured her his note was not as a duty, but to say how pleased he was. He reminded her that during his last visit to her home, he had predicted this happy event. He wished both Laura and Giuseppe a long and happy life together, with a prosperous family (many children) who would pass on to future generations the memory of such a worthy person (Bassi), whose fame and value will last forever.

In this letter was a sentence which is often quoted:

Da ciò che io dico ognun vede che io non sono di que' rigidi uomini che sinistra mente le cose interpretando potrebbe quasi questo matrimonio in Lei condannare, come per un segno di remissione allo studio, perciocché io più tosto credo sempre che questa soave associazione servale d'uno allegiam:¹⁰ per vieppiù lietamente avvantarzi nel corso incominciato, e ciò maggiormente, poichè veggo che nell'accoppiarsi non solo ha scelta persona dotta e valente, ma anche tempo opportuno, quale è la Primavera madre degli onesti piaceri, e stagione a Venere dedicata, che Lucrezio Caro grande Antesignano della Novella Filosofia a Lei e a tutti I saggi cotanto gradita, per Protettrice di se, e di questa così dicendo invoca.

My translation of the Italian text:

From what I say, everyone can see that I am not one of these rigid men who would condemn you for this marriage and assume you would abandon your studies, for I always believe you will follow joyfully what you have begun, and what more, since I see not only that you have chosen a learned and talented person, but also the proper time for this.

This statement was accompanied by a poem by Lucrezio, *De Rerum Natura libri sex*, Book I, verses 6–14, which Bianchi sent for the occasion of Laura's

wedding. Bianchi suggested that, when she had time to write back, she should let him know how she was doing with the English language, using the dictionary and grammar book he had provided. He mentioned being currently involved in a translation of an article by Newton on coins; Newton was Master of the Mint at the time; this work gave Bianchi much pleasure. Giovanni also spoke about the work on *aurora borealis* by three men: Eustachio Zanotti (1709–1782) from Bologna, Giovanni Poleni (1683–1761) from Padua, and Diego Revillas (Abott and Professor of mathematics in Rome). All three works explained the phenomenon from an astronomical point of view, but did not explain the reason for the phenomenon. This is why Bianchi felt he had to add his own observations and the piece he sent summarized the two most famous opinions of the time on this subject. (Note: Revillas' article was published by the Royal Society in London in 1740).

On April 26, 1738, Laura referred to the congratulations in Bianchi's last letter and said she did remember the prediction he had made on her future marriage when he saw the ring sent to her by the Elector of Bavaria. She admitted having thought very much about whether to get married or not, and that she had been quite uncertain about which decision to make. She admitted having initially been against marrying. But her domestic circumstances led her to change her mind (likely referring to the gossip about her meeting men). She chose a person who would not condemn her studies, a man who walked the same intellectual path as herself. The marriage would provide more freedom and make it easier for her to do her work. Concerning the question about learning English, she admitted not having had the time yet to begin this study, as she was still involved in learning algebra. She hoped to begin the study of English during her next vacation, in addition to reproducing the experiments of Newton on light and colour that she had started last year and which she had not had time to complete. She also thanked Bianchi for the dissertations he sent her on *aurora borealis*. She mentioned reading and rereading these with great pleasure and asked if she could share his work with friends and colleagues. She also sent greetings from her husband.

On May 3, 1738, Bianchi agreed Laura could share the dissertations on the *aurora borealis* with others. He did not have the time to share this article with others, as he had done with her. He understood from her previous letter that she was going to learn English and execute Newton's experiments on light and colour during her upcoming vacation. As for the language, he was sure she could learn the grammar quite easily, since the theory of the grammar was very simple; but the pronunciation needed some practice through speaking. Bianchi suggested that repeating the experiments of Newton would be superfluous, as the results were well-known to her; he added they no longer required to be done in darkness, with the constant assistance of her husband. Again he sent his greetings to her consort, Giuseppe Veratti.

On May 24, 1738, Laura mentioned that she passed her favourite piece by Bianchi on *aurora borealis* to Dr. Monti, and when he would return it, she would pass it on to Dr. Balbi and to other common friends. She explained the lateness in responding to his kind letter was due to a cold with a little fever, which she said many in Bologna had because of the frequent changes in the weather. Now that she

was better, she planned to continue the Newtonian experiments to better understand the wonderful discoveries of this famous philosopher, since she could not complete the most important ones last year. In an entire paragraph, Laura tried to dissuade Bianchi from thinking there were hidden reasons in her wish to reproduce Newton's experiment in the dark. She explained that it would have been difficult to have hidden reasons considering that the man in question (her husband) was hardly ever with her, and when he was, he was accompanied by others.

On June 3, 1738, Bianchi said he was pleased that Laura shared his article on aurora borealis with Dr Monti and other friends and hoped that her health returned after the cold she suffered. He advised her to take care of her health and avoid strenuous exercise. Bianchi explained that he was joking about her possible intentions behind doing experiments in the dark with her husband. He expressed the hope that she would take his words lightly, and not see any maliciousness or a second meaning in his message, as her response had suggested.

A year later, on June 27, 1739, Bianchi sent a short diplomatic letter asking Laura if she had received the essay he wrote about fluxes and refluxes of the sea. He had given the essay to Dr. Monti who was supposed to pass it on to her.

A few days later, on July 1, Laura mentioned that, since Giovanni liked sincerity, she would make an open confession to him about her foolishness. She complained about the useless ceremonies she had to attend. She reiterated how much she owed him for his kindness. She confirmed that his essay was given to her by Dr. Monti and thanked Bianchi again for letting her see it. She expressed her regrets for not having immediately commented on the essay, saying she postponed writing to Bianchi to thank him until she had finished reading it. She said having found the essay accurate and erudite.

On October 28, 1744, Laura mentioned to Bianchi that one evening, the Marchesa Davia favoured her (invited her); she added that the two of them had a hard time understanding the bizarre story of a woman who wanted to live in hardship and die violently because of her 'unusual love'. Laura thought this was an opposite emotion to what women normally felt. (This likely refers to a woman who was a lesbian; the footnote says that this woman lived for eight years dressed as a man). Laura referred to the woman as an Amazon who should have used her constant courage in some other way. The woman gained fame by becoming the cadaver studied by Bianchi. Laura mentioned having had much pleasure reading Giovanni Bianchi's study of the body of the woman mentioned above.

On October 23, 1745, Bianchi told Laura that his epistle (a letter) was finally published, defending him against the anonymous Bolognese slanderer. He quickly sent her a copy. It took almost a month for the letter to be published; he finally received it only three or four days before writing this letter to Laura.

A few days later, on October 27, Laura assured Bianchi that she had read and reread the response against the slander and congratulated him on the pure Latin language he had used in his piece, which she said was not surprising coming from a most learned pen. She mentioned being honoured by the fact that Bianchi had mentioned her in his piece. She was compared to the great Marchesa Davia, and

openly recognised as a friend. She was terribly sorry that such a slanderer existed and that he came from her city of Bologna.

This voluminous correspondence between Laura and the famous philosopher, physician, and scientist spanned 13 years. He was 40 years old when it began and Laura was 22. This was a critical formative period for Laura, where she had a degree and a salary, but no real academic tasks to perform like her male colleagues. She was also prevented from teaching regular classes, and obstructed from participating as an active scientist in Academy meetings. However, she cleverly used the years between 1732 and 1745 to deepen her knowledge of mathematics, of Newtonian theories and experiments in light and colour, and to strategize politically through her powerful friends, Flaminio Scarselli and the Pope Benedict XIV, to eliminate obstacles to a lifelong and fruitful career in science. It is certain that she was guided well by Giovanni Bianchi. His advice was sound and helpful, especially regarding the importance of learning English if she wanted to read the excellent *Philosophical Transactions* from the Royal Society instead of waiting years for their Italian translation. A serious scientist like her wanted to remain aware of what others published.

In this period, there was also a note from the famous French writer and philosopher Voltaire. He wrote to Laura Bassi in 1744 to congratulate her on her appointment to the Academy of Science of Bologna. He wrote: “There is no Bassi in London, and I would be much happier to be added to your Academy of Bologna than to that of the English, even though it has produced a Newton” (Findlen 1993, 441–442). This was indeed a great compliment!

The letter from the Secretary of the Academy, Francesco Maria Zanotti (1692–1777) is included here in view of Zanotti’s important role in the Bolognese circle of scientists. He was the son of Giampietro Zanotti and a pupil of Eustachio Manfredi. In 1718, he became a professor of philosophy at the University of Bologna and a member of the Academy of Sciences of Bologna. In 1723, he was appointed as secretary to Count Luigi Ferdinando Marsigli, who had studied mathematics, anatomy, and natural history with the best teachers in Bologna. In 1741, Francesco Maria Zanotti became a Fellow of the Royal Society in London and in 1766, became the president of Institute of Science in Bologna (Cavazza 2002, 16).

Zanotti wrote to Laura from his home in Bologna on November 27, 1745, referring to himself as a humble servant of the Lady Laura. He sent her seven manuscripts on physics for her to review and hoped she would have the patience to scroll through these writings and possibly suggest the elimination of material that was not necessary, not only to make it shorter, but to make the text more accurate. The author submitted himself entirely to the ingenuity and knowledge of the Signora Laura who, he said, was custodian and arbiter of all his judgments. He mentioned she should not be afraid to require changes or amendments, as the writer knew the review of his work was in good hands (Cenerelli 1885, 164).

The process of peer review is still a main approach to publications in journals or in conference proceedings today. The fact that Laura was asked to review scientific

works means that she was reputed to be a good scientist herself and a fair judge of scientific works, at least by men like Zanotti, Bianchi, and Beccari.

Gian Lodovico Bianconi (1717–1781), a philosopher, physician, and distinguished writer was known throughout Europe. In 1744, he was appointed physician at the Court of Prince Joseph, Landgrave of Darmstadt. In 1750, he became the physician of King Ferdinand Augustus III, Elector of Saxony, and in 1764, he was appointed as resident physician for Pope Pius VI.

Bianconi wrote to Giuseppe Veratti from the Palace of Hindenlang, on August 24th, 1744. This is a very long letter in which Bianconi begins by thanking his ‘dearest and most honoured friend’ for having visited a sick woman in the Bentivoglio household; this woman had been in the hands of an incompetent doctor. Bianconi wrote: “may God save us from such diseases and such doctors.” He then asked Veratti to send him Beccari’s dissertation or, if he could not, then maybe Mr. Rizzardi could. He complimented Beccari’s work. Bianconi was a physician at the court of Joseph Ignaz Philipp von Hessen-Darmstadt, who was Prince-Bishop of Augsburg from 1744. He explained that he was following the Prince who was now on holiday in Dillingen (Germany) and would also travel to Füssen which was on the border with the Austrian Empire. Bianconi gave a detailed description of the Prince’s hunt for deer and chamois; he added that, when not hunting or serving the Prince, he had a lot of time at his disposal to further his studies. Bianconi thanked Veratti for sending news about Bologna, and said he was saddened by the death of Donduzzi, a much loved politician of the time. Also Bianconi’s protector, Canon Bassi, sent his regards and affection.

Accompanying his letter to Veratti, Bianconi sent a letter for one of his sisters in the convent of the Angels, and he asked Veratti to make sure the letter was given by the physician, Veratti’s brother, directly into the hands of Sister Angela Agostina without the knowledge of the Mother Superior. Bianconi sent warm regards to Signora Laura and to all the members of the Academy. He mentioned the rumour about the death of the King of France, although this news had not yet been confirmed. (A footnote added that, during the Austrian war of secession, it was erroneously announced that Louis XV had died, when in fact he died in 1774). At the end of Bianconi’s letter, there was a post scriptum written by Canon Giambattista Bassi, Veratti’s cousin. Canon Bassi wrote with a humoristic tone and asked Giuseppe if he still cared for his far away friend, now that he was distracted by the love of his wife and children. He said being well and in the pleasant company of Bianconi who was continuing his studies in medicine and mathematics and was well liked by the Prince. Canon Bassi hoped to receive some news about Giuseppe and his family and sent his regards to the Academy and to all their common friends. He also sent especially warm greetings (and kisses) to Signora Laura and the children (Cenerelli 1885, 196–200).

From Dillingen, November 26th, 1744, Bianconi was asked by Canon Bassi to write on his behalf, as he was too busy at the moment; this was to inquire about a parcel which seemed to have been lost, containing a portrait of Signora Laura. Bianconi explained that a certain Gian Giacomo Haid, a Lutheran, had started to print a work about the most important scholars of the time and had included a

portrait of Laura Bassi. He wished to have as much information as possible about her, such as date of birth, her teachers, her studies, her publications and dissertations, her research for the doctorate, her acceptance into the Academy, visits and letters of praise, etc.,.... Bianconi explained that he preferred to make his request to Veratti rather than to Laura herself, because she might be too humble to agree to participate in such a project. He added some news about Germany which was in a state of war. He wrote about a publication from Lipsia on the power of electricity written by Cristian Augusto Hausen. He concluded his letter in a humoristic vein, scolding his friend Veratti for having gotten his wife pregnant once again. He went as far as saying that if castration could be done without pain, he himself would go and perform the operation on Veratti. (Laura had her second boy *Ciro* in 1744 and was soon pregnant again with a girl, *Caterina*, who was born in 1745). In the post scriptum Bianconi excused himself for the poor quality of his letter, due to the large amount of work he had at present, and hoped to receive news and gossip in the next letter, to satisfy the curiosity of Canon Bassi and his own (Cenerelli 1885, 200–203).

The Academy Secretary, Francesco Maria Zanotti, wrote a letter with no date, thanking Veratti for his observations, and stated that he would write a report to be added to their Literary History. He begged Veratti to urgently write a dissertation which would be added to the works of the Academy. He also asked Veratti to comment on Zanotti's own report, and to suggest corrections and changes. He sent regards to the most Learned and Illustrious Signora Laura (Cenerelli 1885, 219–220).

From Russo, September 5th, 1744, Zanotti said having received Veratti's dissertation (likely the one mentioned above) and thanked him. He admitted not being able to work on it right away, because he was finishing another part of the work. Again he sent regards to Signora Laura (Cenerelli 1885, 220–221).

The last letter in this chapter is a short note from Laura Bassi to the infamous Giovanni Giacomo Casanova, written from her home to an address for Casanova in Bologna. Casanova travelled extensively, especially after he escaped from his prison cell in the Doge Palace in Venice. But it seems he was in Bologna when Laura wrote the note. It is interesting that she would have known him. He was an adventurer, a writer, and had many affairs with women. He associated with cardinals, popes, royalty, and with philosophers such as Goethe and Voltaire. Laura wrote:

Except for today, in which I have to go out, you are free to visit (me) with Mr. and Mrs. Curlandesi at any time in the afternoon or the evening, since I am busy most of the morning with literary activities. (Melli 1960, 174)

The next chapter presents the correspondence between famous scientists and Laura in the years between 1746 and 1778, a period which covers her intense work in science. Some letters are also between some of these men and Laura's husband. The summary of the content of the letters is more or less in chronological order. This is important, especially during the intense debates on electricity.

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Chapter 9

Correspondence with Men in Science and Medicine (1746–1778)

This chapter presents summaries of correspondence between men in science and medicine and the Bassi-Veratti couple. Although these letters are only a part of the entire correspondence compiled by Cenerelli (letters to Laura and to Giuseppe) and by Melli (letters from Laura), they complement well the description of the work in science accomplished by Laura and by Giuseppe in [Chap. 7](#). Some of the men asked Laura for favours; frequently this was to meet a foreign visitor interested in her work and act as a conduit for the visitors to meet other men from the Institute in Bologna. Due to her fame in the Italian Peninsula and abroad, Laura was a focal point for visitors to Italy and an intermediary between them and some of the members of the Academy. The correspondence presented here is from Giambattista Bianchi, Abbé Nollet, Francesco Algarotti, Alessandro Volta, Leopoldo Caldani, Felice Fontana, Lazzaro Spallanzani, Gian Lodovico Bianconi, and Francesco Maria Zanotti. The letters are presented in as much a chronological order as possible.

The letter from Giambattista Bianchi (1681–1761) to Giuseppe Veratti from Turin on July 12th 1749 was discussed briefly in [Chap. 7](#). Bianchi was experimenting with electricity, using it as a means of purgation. In addition to warning Giuseppe that Abbé Nollet and the friar who accompanied him insisted on declaring all these experiments a fraud and an imposture, Bianchi added that this denial of the veracity of their claim was likely due to Nollet's personality as a true French man. (This may be due to the competition and enmity between France and Italy at that time.) He asked Veratti to pass on to Pivati the package containing copies of his book *La storia del mostro* (Story of the Monster) printed in Turin; he included a copy for Mr. Pivati and one for Mr. Pasquali (Cenerelli [1885](#), 193–195).

Francesco Maria Zanotti wrote to Giuseppe Veratti from Rome on November 22, 1749, informing him that he had received a letter from Abbé Nollet. Although the letter was addressed to Zanotti, he believed it should be shared with Veratti and with all the members of the Academy to whom Nollet sent his regards. This included Bazzani, Beccari, Galeazzi, Pozzi, Menghini, Laghi, Matteucci, Bonzi, Monti, Manfredi, Bianconi, and above all Signora Laura, the most worthy of all. He asked Veratti to tell everyone that Nostro Signore (the Pope) was extremely satisfied and happy with the Bolognese Academy (Cenerelli [1885](#), 221). (The letter

from Nollet indicated he wanted to visit Bologna to verify the results published by Pivati and Veratti on medicated vases.)

Francesco Algarotti wrote to Giuseppe Veratti from Berlin on July 3, 1751 to congratulate him, after reading with extreme interest his knowledgeable book on electricity. Algarotti informed Giuseppe that Abbé Nollet refuted the results obtained on electricity applied to medicine, especially in the case of purgation. Algarotti himself did some of the experiments, the first one with five children between the age of 14 and 15 and a second series with two children aged 10 and 11. In the first set of experiments, Algarotti obtained results only with one of the boys; in the second set, where the electricity was rendered more efficacious, both boys were purged. Algarotti added that the wonders of electricity were now being demonstrated in Germany, so they were not “locked up in Italy”, to quote Abbé Nollet. In conclusion, he praised Veratti for his discoveries which so enriched the field of medicine and asked to be kept informed of any new development. He sent his regards to Signora Laura and added a post scriptum in which he quoted Abbé Nollet’s criticism and doubts which included the Turin experiments of Giambattista Bianchi, in case Veratti had not yet seen Nollet’s book on this matter (Cenerelli 1885, 191–192).

Giambattista Bianchi sent another letter to Giuseppe Veratti on September 19, 1751, excusing himself for the delay in answering his letter, saying this was due to problems with his hands and feet. He confirmed that the experiments in Berlin were of great interest to him and he wished to be informed if a dissertation was to be published on this topic. Giambattista added that the French version of Veratti’s book on electricity was received with approval and praise across the mountains and even in Paris. He assumed Abbé Nollet had silenced his doubts. Giambattista himself had used electricity to cure a man who had almost constant pain in his limbs (Cenerelli 1885, 195–196).

The man who threw doubts on the Italian experiments was the French Abbé Jean-Antoine Nollet (1700–1770). Nollet wrote several letters to Laura Bassi in this period. His five letters began in 1750, the fourth was dated 1767, and the last one had no date. Unfortunately, Melli’s compilation of letters from Laura Bassi to the famous men does not include any of her letters to Nollet.

In a letter written from Paris on November 13, 1750, Nollet thanked Laura for all the attention she showed him during his visit to Bologna the previous year. He informed her of the imminent visit of the meritorious and distinguished philosopher from Aberdeen (Mr. Fordice) who would be visiting Italy and asked if she could put him in contact with her husband and with her other colleagues in the City, just as she had done so well for him when he visited Bologna. He concluded his letter by saying how grateful he was and that he would search all manners of expressing his gratitude to her. He reiterated the profound respect with which he regarded her (Cenerelli 1885, 95–96).

From Paris, December 10, 1751, Nollet requested once more that Laura put his three friends (Mr. Randon, de Boisset, and Schveling) in contact with her husband, since they wished to see what was to be admired in Italy, visit the Institute of Sciences, and discover the general state of science in Bologna (Cenerelli 1885, 96).

On March 30, 1753, Nollet wrote that he regretted the delay in responding to Laura's two letters. He explained that the two prisms, which were to be sent to her by Mr. Hortega when he returned to Barcelona, were currently used by him because his staff needed them. Mr. Hortega's return to Barcelona was delayed by his travels in England, but he did acquire two prisms in that country for her. Nollet was sending them with his letter. He added a magnifying glass that focusses rays that had been refracted. He also included copies of his book *Letters on Electricity* printed five or six months before, and asked if one copy could be given to Francesco Maria Zanotti, Secretary of the Institute, and another to the Library of the Institute. She could keep one copy for herself. Nollet mentioned that his book described all that he knew at the time (1760) on the subject of electricity. He ended the letter by thanking Laura and her husband for all the kindness showed Mr. Randon and Mr. Schveling during their visit to Bologna and promised he would offer the same hospitality to any of the couple's friends and colleagues visiting Paris in the future (Cenerelli 1885, 97–98).

From Paris on April 7, 1762, Nollet mentioned to Laura that he was very pleased she remembered him regarding a visit of some persons she knew who were travelling to France. He asked if she could connect Mr. Dubreuil coming from France to Bologna with Iacopo Beccari and Francisco Maria Zanotti, affirming that the man was well educated and travelling to Italy with one of the best professors from the University of Paris. Nollet mentioned that it was quite difficult to send letters to and from Bologna, so he asked her to give Mr. Dubreuil a short note on how she was faring, as well as some news from the men he had the pleasure of meeting when he was in Bologna. Nollet hoped he could lighten his workload by reducing his classes and by appointing someone to his Chair so that he could have some leisure time and also more time to correspond with friends and colleagues (Cenerelli 1885, 98–99).

From Paris in 1767, Nollet sent Laura, through a colleague travelling to Italy (K.P. Frisi), a few 'bagatelles' (trifles) to amuse herself and that she could show to amateurs of physics in her 'Museum' (her home laboratory). In another letter without a date, Nollet described in minute detail some electrical experiments that Laura could carry-out to create beautiful light patterns.

In addition to his contact with the Bassi-Veratti couple, Nollet disputed on the topic of electricity with Benjamin Franklin from Pennsylvania in America. The letters to Laura from Jean-Antoine Nollet, a famous man in science, were always full of respect for the scientist and physicist of great talent that she was. In today's terminology, he was networking with her and with men in science in Bologna through her. He discussed science topics, especially electricity, and introduced other philosophers to her and to her network of colleagues in Bologna. She was a great contact person for Nollet and his friends, as she knew everyone involved in science at the Institute of Bologna.

As mentioned previously, during this period of heated debate about electricity, two famous men, Antonio Caldani, and Felice Fontana, performed several experiments on electricity at the Bassi-Veratti home in the upper years of the 1750s. They were collecting evidence in support of Haller's theory. One letter

from Felice Fontana to Laura and five letters to Giuseppe were included by Cenerelli in his *Lettere Inedite*. Caldani, for his part, kept in touch with Laura for a period of ten years, from 1768 until her death in 1778. Caldani also wrote a few letters to Giuseppe during that time.

Felice Fontana (1720–1805) was born at Pomerole, near Rovereto in the Austrian South Tyrol, a territory which was returned to Italy in 1918. He was educated in Verona, Parma, Padua, and Bologna and was appointed early in his career to a Chair of Philosophy in Pisa. At the same time, he was put in charge of the Museum of Physics and Natural History in Florence, which contained instruments used by Galileo, Torricelli, and Viviani. He personally added many other specimens from France and England acquired during his travels to these countries. He created anatomical specimens in coloured wax and was a pioneer in studying snake venoms. He also studied the effect of opium and of laudanum on nerves and on organs like the heart. He was also known as a ‘standard-bearer’ on the Hallerian theory. His contributions to science are numerous and he is considered as one of the most versatile biologists of his period (Garrison 1935, 118–119).

Fontana Felice wrote to Giuseppe Veratti from Pisa on March 25, 1759. He apologised for not having written for a long time; he could not write anything for 40 days and hoped Veratti would forgive him. Fontana thanked Veratti for the wonderful letters written by the philosopher Beccaria. Frisio, Fromond, Guadagni, and Perelli sent greetings and compliments. He was not surprised by the fact that Caldani kept making enemies. He added that Caldani was a very strange and peculiar man. Fontana wrote about some experiments with electricity done by Dr. Guadagni and informed him about an interesting pneumatic machine from England that Dr. Perelli has shown him. In the post scriptum, he added that Mr. Melchiorin sent greetings. Fontana asked Veratti to give Bassi a letter and added he would also send her his new study on the pupil and iris, on their movement and other parts of the eye. Most of his work was innovative and went against what has already been said on the topic.

Fontana had established the new wax museum in Florence in 1771. He wrote to Veratti from that city on October 9th, 1765. Fontana, who had recently visited Veratti in Bologna, thanked him for his kind hospitality. Fontana admitted he would like to have the opinion of the illustrious Academy of Bologna on his study of the iris; if there was a favourable judgement on it, he hoped that his work would be known for its importance and novelty. He would also like to know from Veratti if he should write a letter to the Academy or to the Secretary (Zanotti) and how he should go about sending copies of his work (Cenerelli 1885, 213).

In his letter to Laura dated August 22, 1769, Felice Fontana said he was sending a package marked L.B.; he asked if she would have the goodness to pick it up at the customs; the package was to be delivered by a coachman from Florence. It contained an electric machine with a plate from the new design by Mr. Ingenhousz in England. To prevent the machine from breaking, he filled gaps in the box with seaweed and recommended that Laura clean it completely, especially the crystal when she was ready to use it. Little by little, she would find the use of the parts and

how to tackle some small defects which were accidental but which could prevent the machine's proper operation. Fontana apologized for not having sent it earlier. He told Laura that she would now know the great difficulty in making machines in physics that work properly. He added she would find a lens in the box in good working order which would allow her to see very tiny objects. Fontana informed Laura that he wrote to the Marquis Calderara in Milan to let him know the machine was to pass through her hands, in Bologna, and that she would forward it to Milan afterwards, packaged in the same way that he had done for her, or it could end up in a thousand pieces. He ended the letter by assuring her that the expense for the shipping would be paid either by him or by the Marquis Calderara.

Again from Florence, on July 20, 1771, Fontana informed Veratti about a new instrument for navigation designed by Mr. Lorenzi, whom he advised to send it to London's Admiralty to be assessed for a prize. He also mentioned a new machine to divide the instruments of astronomy designed by the Duke of Chaulnes who was working on this in Florence instead of Paris, because it was less expensive. Fontana said he would send his latest notes on the physics of animals to Veratti (Cenerelli 1885, 214).

Fontana wrote to Giuseppe from Bologna on June 19, 1776, saying he was very briefly in the city, but had to leave early in the morning, so he was not able to meet with him. He said that when he was in Pavia, Father Barletti gave him an iron weathervane that had been hit by lightning and now had holes in opposite directions. This object was to be given to Dr. Canterzani. Father Barletti planned to explain the phenomenon in a dissertation to be published shortly (Cenerelli 1885, 214–215).

Leopoldo Marco Antonio Caldani (1725–1813) was born in Bologna; he studied medicine and received his degree in 1750, becoming a professor of practical medicine in Bologna in 1755. It is said that he left his position in Bologna on account of enemies and conflicts. He became a professor of anatomy and theoretical medicine in Padua from 1771 until his retirement in 1805. He championed Haller's theory of irritability and experimented on the spinal cord. Caldani introduced the use of electricity in the study of the physiology of nerves. His main contribution was an anatomical atlas which he developed with his nephew Floriano.

The first letter Caldani wrote to Laura Bassi came from Venice, August 6, 1768. Caldani mentioned that two of her letters sent to his address in Padua seemed to have been lost. He was in Venice at that time working on a commission ordered by their Excellencies and by Parma regarding the establishment of a university associated with that regal court. He was also preparing a publication to be called *Cogitata Physiologica* (Ponderings on Physiology) containing a simple explanation on physical phenomena of the body and recommending exercises that should be done by students in schools. But this work was delayed because he had to do some inoculations in Padua. He informed Laura that Haller did not write anything to him about sensitivity or other things, because he was very busy at the moment reprinting his magnificent book titled *Enumeratio Stirpium Helveticarum* (Listing of Swiss plants). Caldani said the third tome of the *Opuscula minora* had been

published and would be the last of Haller's Miscellanea. Caldani said his own copy of the book was in Turin. (Cenerelli added a note that this information was an error, as the first printing of the book by Haller was in Göttingen in 1742 titled *Enumeratio methodica Stirpium Helvetiae indigenarum*.) The book was reprinted in Bern in 1768 titled *Historia Stirpium indigenarum Helvetiae* (Cenerelli 1885, 56–57).

In the letter above, Caldani referred to two letters from Laura Bassi that seemed to have been lost. Melli, in his compilation of Laura Bassi's letters, found one that Laura had written to Leopoldo Caldani on July 29, 1766, and a second one written by her on August 2, 1768, just before Caldani wrote his letter on August 6, in the same year (1768). It is not certain if these are the two letters he was referring to since his letter does not respond to the requests that Laura had made in her two letters.

In the earlier letter (July) sent to Caldani in Venice, Laura expressed the wish to obtain all the information on hydraulics written by Mr. Marchese Poleni that could be found in a book store in Venice. She heard they had these books in stock, so perhaps they could be acquired through a contract. Laura also said that she and Giuseppe were expecting from him some literary news (new publications by Caldani) (Melli 1960, 164).

In Laura's second letter dated August 2, 1768, she told Caldani that young Dr. Carnielli, previously supervised by him, started to attend her physics classes for about two and a half months, then he did not show-up on any day; finally he did not attend at all for an entire month. She added that he may mean well, but he did not seem much committed to his studies. Laura added that she and her husband endeavoured to take into account the student's habits, but this one seemed somewhat debauched and they never saw him with a book in hand; he also frequented a Coffee House in whatever spare time he had. The student had arrived full of good will and was committed initially, but in a few months he changed completely. Laura prayed Caldani to make discrete use of this note to make sure that the right information they were looking for was found. She added being sure Mr. Carnielli was often gaming at the Coffee House.

Laura closed by mentioning she had done some investigations on his (Caldani) latest anatomical observations about the 'sensitivity' work and wondered if there was more information reported by Haller on this (Melli 1960, 168–169). Caldani, in his letter to Laura on August 6, 1768 did not mention Carnielli, as this was supposed to be a discrete point in Laura's letter. But he did respond to her question about Haller's work.

Caldani sent Laura another letter with no date, but Cenerelli believed it could have been written in 1774. Caldani mentioned that while in Venice, he was urgently called to see a young woman who was about to die, but she was expecting a miracle from him. In fact, she died 26 hours after his arrival at her side. Caldani mentioned it was common for professors of medicine in Padua to be called at the bedside of extreme patient cases. He added that Mr. Negri was to visit him and while he waited for his return, he hoped that Mr. Negri would profit well from the useful lessons she provided. Caldani mentioned that Mr. Negri was struggling to

communicate the simplest ideas, and that whatever he said turned into a tedious and boring story which would need to be corrected or rearranged; but this was not the duty of someone who taught science and the arts. Caldani informed Laura that his own studies had slowed down to nothing because of the heavy duties of the two Chairs he held. One Chair was on anatomy and he was trying to render it as useful as possible, changing the lessons little by little so as not to offend his predecessor, whose fame in Europe was due to his work, not to his lessons. (Later Caldani said his predecessor was able to teach his subject in only thirty lessons.) Caldani was referring to the famous Giambattista Morgagni, professor of anatomy at the University of Padua, who died on November 5, 1771. Caldani replaced Morgagni in that position. He enumerated all the tasks he had to attend to at the University: he had to give the same number of lessons as always, both public and private; administer public exams which began on the sixth; deal with doctorates and licenses in surgery; and several other matters that needed his attention due to his two chair positions. To this list, he added domestic affairs which always had to be done, and writing letters to literary friends. Caldani mentioned two of his publications, one written in the last two years, *Institutiones Pathologicae*, published in Padua in 1772, and another published 16 months before on Physiology. The first one was being reprinted in the coming month, so he was busy cleaning it up a little. Caldani mentioned he was preparing an article on medical matters and on anatomy, but his numerous tasks prevented him to finish writing it. Caldani said that, before last Christmas, and with the greatest difficulty, he managed to send an author's note on ureters to the Academy in London. He closed by informing Laura that he was not able to get back home to Padua, but if she wanted to visit him in Venice, he would be honoured by her visit. He begged her to deliver his distinguished salutations to her husband (Cenerelli 1885, 58–59).

The next letter was written from Padua to Laura on October 25, 1776. Leopoldo said that, although Mr. Gzerzichiewich was not yet back in Padua, he (Caldani) wanted to thank Laura for the kind favour she did for this man. He asked if she had written to him (Gzerzichiewich) to ask about his contribution to the *Encyclopedia Italiana*. Many had been asking him about this, but to all he responded being incredibly busy with his course for eight months of the year, with little time for other things. If he could finish the article that has been sitting on his table for eight years, it would benefit both his name and his purse. Then, he would not take any other commitment prior to having obtained a copy of the Encyclopedia of Yverdun to which have been added many authors of similar calibre, including Bernoulli, Haller, Tissot, Hirtzel, and Gesneri. Caldini mentioned he saw a small publication going around that had his name on it as author, promising that articles would soon appear on anatomy, physiology, and pathology. This information was sent to him by friends from Pavia, Milan, Florence, Rome, and Naples; and they asked under what condition this was done so they could follow his example. Caldani insisted he had not seen this announcement and he was very surprised. All this was done without his consent and he would not have agreed to write the note for the Encyclopedia for less than two Venetian Zecchini (local money) per page. He knew that other authors were made to pay two golden Louis per page, in addition

to gifts of specimens. Caldani said he found this out from authors of the medical articles.

Later in his letter, Caldani thanked God that the physics room at the Institute was being used only by persons who deserved to be there. He deplored the fact that some of the instruments were broken by persons who did not know how to use them. He congratulated Laura on being awarded the Chair in physics at the Institute. (Laura Bassi was appointed to this Chair on May 10, 1776, replacing Paolo Balbi who had recently died.) Caldani hoped to have answered all her questions and added he was still extremely busy as she well knew. Perhaps she did not know that he often had to toil for others, examining books or manuscripts and that it sometimes upset him to examine works by visionary writers or speakers. Caldani told Laura she would not believe that in the past few days, he had reviewed a most voluminous manuscript on characteristics of putrid fevers affecting the wrist joints. He added in Latin: *Quantum est in rebus inane!* (*How much futility there is in the world*). He closed his letter by saying that if the Italian Encyclopedia was ever completed, and if she contributed articles in Physics or Mathematics for it, he wished that she would be well paid for them. He wrote: We have come to an age where we need not toil for the ‘water of the eyes of others’; he added “Age, however, begins to weigh on my back excessively” (Cenerelli 1885, 60–61).

The fourth letter has the date as the 11th, but no month was mentioned. It could have been January, 1778, as the letter referred to the sad news of two recent deaths: Francesco Maria Zanotti (on Christmas day 1777), and his friend, the great Haller, who passed away in Bern on December 12, 1777. The letter was sent to Laura very shortly before her own death in February 1778. Caldani said he had lost a rare and excellent friend (Haller) and was very saddened by this news. In his letter, he thanked Laura for her kind hospitality of Dr. Varé who had visited the Bassi-Veratti home recently. According to Caldani, Dr. Varé lacked talent, but he was a hard worker.

Caldani said he was teaching early in the morning until noon at his home, and then at the university at 10 pm, with some discussions also occurring in the evenings. To this he added his clinical duties as a physician, writing letters, and other things which left him little time to review his Physiology manuscript before the reprinting. He promised to send her a copy when it was available. He added that he would need comfort and a long life to accomplish all that was in his mind (Cenerelli 1885, 62).

These letters show that Caldani and Bassi were colleagues and friends. In spite of being very busy, Caldani took time to write long letters to Laura over a ten year period. He and the Bassi-Veratti couple had supported the Haller theory, so they had much in common on their views of electricity and human physiology. Both Caldani and Nollet complained about the heavy workload resulting from teaching, reviewing other people’s work, and writing their articles and books. This was certainly a familiar topic for Laura, as she too had heavy teaching responsibilities with her experimental physics classes, the lectures she was asked to do at the University from time to time, her research and writing, and reviewing manuscripts

by other colleagues. Teaching responsibilities made it more challenging for all of these professors to spend time on research, writing, and to have some leisure time for corresponding with friends and colleagues. This is still true for academics today.

A famous man, still well known today, Alessandro Volta, wrote two letters to Laura. Volta (1745–1827) was born in Como and became a professor of physics at the Royal School in his home town in 1774. In 1775, he improved and popularized the electrophorus, a device that produced a static electric charge. The machine operated on the same principle as one described in 1762 by a Swedish professor, Johan Wilcke, but Volta is often credited with this invention because his promotion of it was extensive. Johan Wilcke published his work on electricity in 1757 titled *De electricitatibus contrariis* and he invented a first version of the electrostatic generator in 1762. Volta's invention of the electrophorus was in 1775. Between 1776 and 1778, he studied the chemistry of gases. After reading a paper by Franklin on 'flammable air', he discovered the existence of methane. One of his main contributions was his study of what is now called electrical capacitance, and demonstrating that voltage (V) and charge (Q) were proportional to each other. The unit of electrical potential is now called a volt. In 1779, Volta became a professor of experimental physics at the University of Pavia, occupying this chair for 25 years. Like Galvani, Volta experimented with electricity and frogs. He connected two different metals to a frog's leg and to each other. He noted that the leg acted both as a conductor of electricity (an electrolyte) and a detector of electricity. In 1800, Volta invented the voltaic pile, an early type of battery that produced a steady electric current. He used zinc and silver as dissimilar metals to produce electricity. Volta retired in 1817 and died on March 5, 1827 in Camnago Volta, a place named after him. Napoleon had made him a Count in 1801 (Wikipedia_Volta 2013).

Volta was 26 years old when he wrote his first letter to Laura from Como on July 15, 1771, in which he noted that it was well known by all that Laura Bassi was a most virtuous lady, that she was valued as a philosopher of science, and that she was eminent in all aspects of physics. He admitted that he would not have written to such a famous person her about his work, if it was not for Mr. Abate Spallanzani's suggestion. The latter, to whom Volta dedicated his dissertation, said that Laura Bassi was very interested in electricity. Therefore Volta said he would be most honoured to receive her opinion on his dissertation. He was sending it to her so she could judge it simply and honestly, and should not feel under any obligation of courtesy (Cenerelli 1885, 157–158).

Again from Como, on June 15, 1777, Volta wrote that a Doctor Campi mentioned she had not received his two letters sent with his articles on native inflammable air in marshes, so he was now going to send her his complete set of seven letters on this topic via a youth who was moving to Bologna; he hoped the entire volume was faithfully remitted to her. He again expressed the wish to receive her opinion on the work. Alessandro said he was doing new experiments that were both interesting and curious, with pistols and on the different types of air found in marshes. He mentioned that he was designing new instruments which

were described in the volume of letters he was sending her. The experiments on inflammable air in marches were intended for creating a lantern; he hoped she was pleased to receive the description as this was a topic of interest to her. He also asked if she could send him further information about the *ambulonei incendiarii* (fires forming over marshes). Again he expressed much respect for Laura's great knowledge and abilities.

Volta sent her a description of some of the machines he had invented and expressed his intention to dedicate the description of an instrument, once perfected, to Laura; he called her 'bell'ornamento delle naturali Scienze, e lume e Gloria del Sesso nella nostra Italia.' (Beautiful ornament of natural Sciences, and light and Glory of your Sex in our Italy.) Volta asked Laura for the permission to do this dedication; he expected to finish the work very soon.

Laura had begun to be interested in the topic of flammable air and 'ardent terrain' in 1770, before she received Alessandro's letter. She also had presented work on fire and liquids at the Academy of Bologna in 1775 and on fire and air in 1776 (Cenerelli 1885, 158–159).

Another famous man in science was Laura's cousin, Lazzaro Spallanzani (1729–1799). Born in Modena, he became a physiologist who made important scientific contributions to the study of the reproduction of animal parts and the study of body functions. Educated in the classics and philosophy, he went to Bologna to study law, but his interest in science was sparked by his cousin, Laura Bassi. In 1754, Spallanzani became a professor of logic, metaphysics, and Greek at Reggio College, and in 1760, he was appointed as professor of physics at the University of Modena. He studied a large variety of life forms including planarians, snails, and amphibians. He even transplanted the head of a snail on the body of another. In 1773, he investigated the flow of blood through the lungs. He also studied other organs and provided evidence that digestive juices have chemicals that are suited to specific foods. Lazzaro became a Fellow of many scientific societies in Europe and he accepted a chair at the University of Pavia in 1769, remaining there until his death in 1799. Some of his last works were on the electric charge of the torpedo fish and on the sense organs in bats (Wikipedia_Spallanzani 2013).

There was a major debate following the publication of Spallanzani's book *Prodromo di un'opera sopra la riproduzione in animali* (on the reproduction in animals). Spallanzani maintained that certain animals (salamanders, earthworms, and snails) could grow back parts of their body after these parts were cut off. He asserted that snails could grow back a head if the original one was cut off. Spallanzani assumed that when he cut off the head, he had also removed the brain or the ganglia. The opponents of his theory believed that some of the ganglia remained after the cut and that the snail only grew back a part of its head; they were actually correct in their objection. Spallanzani wrote several long letters to Laura, hoping she would agree to replicate some of his studies on regeneration, to add substance to his claims and gather more evidence for his theory.

The first letter found from Laura to her cousin Lazzaro was written on September 29, 1765, where she informed him that she had received his two dissertations, one

on microscopic observations concerning the system of generations by Needham and Buffon, and the other titled *De lapidibus ad aqua resilientibus* (on stones from receding water), published in 1765. The rest of the letter concerns family matters (Melli 1960, 162).

On April 9, 1768, Laura informed Lazzaro that she received his work *Prodromo d'un opera da imprimersi sopra la riproduzione animale* published in Modena (1768) and that after lunch last Thursday at the Academy meeting just before Easter, she presented a copy to the President which was read with much pleasure. She informed him that the Secretary of the Institute had also been given a copy for which he sent his gracious thanks and promised to write to Spallanzani personally. Laura added that the President also sent his thanks in the name of the entire Academy. She and her husband added their congratulations for such fine and interesting observations (Melli 1960, 165).

On April 30, 1768, Laura said she was unfortunately not at home when Lazzaro's friend, Dr. Montanari, came for a visit. She would have liked to speak with him of the interesting things he (Lazzaro) was doing. She asked what was happening with his experiments on luminous insects and others. Laura asked if, apart from the snail, any other animal species could reproduce a brain, a heart, or a spine. She also asked whether dipping the part of the body with a cut in certain strong liquids like vitriolic oil or other substances would make a difference. She asked if applying electricity to the part would be beneficial, since it did promote growth in plants (Melli 1960, 166–167).

This last suggestion raised by Laura more than two hundred years ago is most interesting because today, electrical stimulation is used for bone healing, wound healing, and to reduce pain and inflammation in muscles and joints. In this letter, Laura makes interesting scientific suggestions to her cousin to see if they could improve his experimental results.

From Bologna, Laura wrote on January 9, 1769, to inform Lazzaro that she received the dissertation by Bonnet with great pleasure, first because it confirmed his (Lazzaro) true friendship with her, and second because the work was important material of interest to all physiologists and anatomists of their time. She added that his own dissertation should definitely be welcomed by Bonnet (Melli 1960, 170–171).

Lazzaro wrote to Laura from Modena on April 7, 1769 thanking her for agreeing to repeat the experiments with the salamanders and snails, saying he was quite sure of the excellent quality of her observations, considering her great fame inside and outside of the Italian Peninsula. He provided detailed instructions on the maintenance of salamanders, recommending to keep them in a warm but shaded area. He suggested it could take 15 days or a bit less for the reproduction of the body part, mentioning that reproduction was linked to a warm temperature. If the experiment was done in April, it would take much longer for the reproduction to occur. He explained that these creatures were lazy and innocuous. Lazzaro continued his long letter with explanations on how to cut their head and how to observe its re-growth. He recommended using 150 snails, which should be enough to observe the variety in the phenomenon of the reproduction of the head. In

closing, he mentioned expecting the visit of Father Fedele soon and he thanked Laura for the favour she bestowed on him (Cenerelli 1885, 125–127).

In his letter of April 24, 1769 from Modena, Lazzaro mentioned he was sending Laura a small basket of snails via Mr. Marchese Montecuccoli, as snails seemed more conducive to the regeneration process. He mentioned his previous long letter and his hope for a reply from Laura. A few days later, on April 30, Lazzaro sent Laura another very long letter in which he explained in great detail how to measure the part that was ablated and the part that was re-grown. He included an excerpt of a publication of the Paris Académie des sciences (1768) that discussed the regrowth of body parts of snails, reporting experiments done by Antoine Lavoisier. Lavoisier's text explained how difficult it was to judge exactly where the head part ended, making the decision of where to cut a difficult one. There was a brief description of a thin skin forming over the cut after a day or so, but Lazzaro said it would take one month to see the first effects of the regeneration. He added it would take at least three months or more to see a new head of similar size as the original one. The new head would have a transparent skin and the horns would be shorter and fatter. Lavoisier also claimed that the tail could regenerate itself. The article by Lavoisier referred to some research done by Du Verney who had died some time ago; Lavoisier announced that the Académie des sciences in Paris would now publish Du Verney's work on the snail anatomy. Lazzaro suggested there were two problems with the Lavoisier experiments: (1) his doubts about the amount of head that was cut-off indicated that he did not examine the part that was removed to properly assess the depth of the cut; (2) he used a small number of specimens and so would not have been able to observe a variety in the results. Lazzaro wrote that he could undertake a new set of experiments on the regeneration of the tail of the snail as done by Lavoisier in France. He also mentioned the book by Lyonnet on this topic, published in France. There was a sharp comment on the fact that the members of the French Academy probably were not aware of other books on the topic because they were written in Latin, and the "French are not really good friends of Latin" he added. Lazzaro ended his letter by providing again detailed instructions on how and where to keep the salamander and snail specimens and hoped to hear soon from Laura about the results of her experiments on both types of animals (Cenerelli 1885, 132–133). Some parts of Lazzaro Spallanzani's letters (and those from Nollet) were in French, which suggests that Laura Bassi also understood this language, in addition to Italian and Latin.

On May 8, 1769, Lazzaro mentioned that Father Fedele was given his full freedom and returned to Scandiano. Lazzaro requested that Laura send him as soon as possible some lenses that he needed for his microscope, as several of his lenses had degraded. He mentioned the booklet by Lyonnet, saying it was a rare publication. He did not know whether she already had a copy, but he was not going to risk sending it. He closed by hoping again to receive some news of the experiments she was doing for him (Cenerelli 1885, 134–135).

In his letter of May 19, 1769, Lazzaro encouraged Laura to mutilate all the snails he had sent her, not only because some of them perish, but also because it would enable her to visualize the diversity of the phenomenon. He mentioned that

a friend of his had already seen some change after barely one month in his own set of experiments. Lazzaro informed Laura that in July, he would bring her the booklet by Lyonnet and would examine the progress of the regeneration. He suggested that, when a small head began to show, she could feed them some wet bread, lettuce, pieces of apple or pears or some other fruit (Cenerelli 1885, 135–136).

On June 30, 1769, Lazzaro informed Laura that on July 10, he would be visiting her with Mr. Marchese Lucchesini and bring in person the Lyonnet publication. He also requested a favour: that she read a preface he wrote to a work by Bonnet (an article called: *Contemplation de la Nature*). He hoped the regeneration experiment was going well and was very much looking forward to seeing the results (Cenerelli 1885, 136–137).

From Pavia, March 19, 1770, Lazzaro referred to Laura's and Giuseppe's past illness, saying he was very glad they had both regained their health. He wished whole heartedly that her health was now stable and good and mentioned the unfortunate death of her brother-in-law. He informed Laura that Mr. Bonnet wished to correspond with her. There was a new article by Bonnet, a copy of which was sent to F. M. Zanotti at the Academy; he encouraged Laura to read it. He cited a part of a letter by Bonnet who mentioned how his dear wife had been sick in bed for the last twelve years and that there may be a better life after death for them both. He explained that Bonnet and his wife shared some readings and discussed botanical experiments they both participated in; and Bonnet admitted his wife had better results than him at times. (This shows again collaboration in science by a husband and wife.) Lazzaro closed by discussing the electrical machine that Marquis Calderara had received in Milan. (We know Laura had received the machine sent by Felice Fontana from Florence and she had tested it in Bologna, when it stopped there on its way to Milan) (Cenerelli 1885, 137–139).

From Pavia, April 6, 1770, Spallanzani heard from his brother that Laura desired to obtain a powder to polish metal. He remembered where it could be acquired and asked his brother to obtain it for her. In this letter, Lazzaro again asked for a favour, that she send back the Lyonnet publication if had she read it, through a person travelling from Bologna to Milan, as several people they know make this journey regularly (Cenerelli 1885, 139–140).

Laura wrote on May 19, 1771 and complained about a fluxion in the eyes which delayed her response. She mentioned the machine sent by Father Fedele and the microscope she received from England. Laura thanked him for the other tome he published. She referred to Bonnet as an incomparable man who did the world much good with his work and views. She hoped Lazzaro would come for a visit during his next vacation, as they had expected him last year, but he could not come then (Melli 1960, 172–173).

From Scandiano, October 26, 1772, Lazzaro announced that M. de Saussure, Professor of Philosophy in Geneva and a nephew of Bonnet would be visiting him, and then he (Saussure) expected to spend 15 days in Bologna. Lazzaro humbly asked if Laura and her husband could receive Mr. de Saussure in their home and treat him with a special attention. Lazzaro said one favour attracts another; he

mentioned knowing a young and competent mason who had some knowledge of architecture, Giuseppe Rosa, and thought Laura may introduce him to a distinguished architect who would take him in his workshop. He closed by mentioning a brief vacation he took, a working philosophical trip ordered by the Court of Vienna to the mountains around Milan, and hoped to visit her in the near future. He informed her he would remain in Scandiano until the 12th of November (Cenerelli 1885, 140–141).

Three days later, Laura responded to Lazzaro on October 29, 1772, her sixty-first birthday. She assured him that she would be very pleased to receive Mr. de Saussure and to do whatever she could to make his stay a pleasant one. Laura announced the wedding of her second son (Ciro, born in 1744) to Maria Anna Margherita Cappi, a Milanese; the mass was said by her third son Giacomo, who was born in 1749. These were all her news from home. She would now expedite the book (Lyonnet) to Milan (Melli 1960, 175).

From Pavia, December 21, 1775, Lazzaro mentioned a professor, Dr. Carminati di Lodi, who was to attend a course in anatomy and then go back to Pavia to continue his practice of medicine. He reiterated the admiration they all had for her and that Dr. Carminati would like to attend some of her public lectures. Lazzaro asked if Dr. Carminati could be introduced to her distinguished husband. Lazzaro asked about her health and mentioned that his was perfect. He announced having almost finished his article for a publication expected in January 1776 titled *Opuscoli di Fisica animale e vegetabile* (Article on the physics of animals and vegetables) and added he would send her a copy (Cenerelli 1885, 141–142).

From Pavia, February 11, 1776, Lazzaro said he was sending Laura his latest book, just printed by Mr. Abboretti, Director of the Society of typography (printers). He mentioned having disagreed with her husband on an experiment with frogs, but flattered himself that she will forgive him this philosophical freedom.

At the end of September 1776, Lazzaro cited the old proverb: ‘man proposes and God disposes’, as he had planned to visit her for a few days at the end of September, but 15 days of torrential rain and lack of time forced him to cancel his plan. Lazzaro mentioned an article on electricity written by Padre Barletti; he had two copies sent to her and was humbly asking if she could confirm whether she had received the parcel (Cenerelli 1885, 142–143).

Laura’s letter of December 10, 1776 was sent from her Villa di Barbiano in the countryside to Lazzaro in Scandiano. In this letter, Laura mentioned having received the specimens from Dr. Barletti, a professor of physics in Pavia, and sent them on to Mr. Canterzani. She hoped that the next time Lazzaro was in Pavia, he could send her compliments to them. She complained that the bad weather spoiled their pleasure of being at the villa (Melli 1960, 176).

The last letter from Laura to Lazzaro in Melli’s inventory of letters was written on April 22, 1777, referring to Lazzaro’s letter of February 10. She mentioned that a museum planned to sell a collection belonging to an amateur of natural things, but most of it consisted of animal products, medals, shells, curiosities of all kinds, mechanical machines. The heirs wanted to sell the whole collection together for

five thousand scudi. Laura offered to send Lazzaro the catalogue if he was interested (Melli 1960, 177).

In the early part of the correspondence, there were favours asked, mainly one-sided, from Lazzaro to Laura, his older cousin. Laura acted as a mentor in the early part of Lazzaro's career, and later, as a collaborator for the snail and salamander experiments. Later on, when Lazzaro's reputation in science was established internationally, he sent Laura several publications on important contemporary work as well as his own, informing her of progress in his field. Laura had, as he himself admitted, much influence on his choice of a career in science. He respected greatly her scientific abilities and entrusted her with experimental verification of one of his important theory, on the regeneration of body parts of salamanders and snails. It is interesting to note that in the twentieth and twenty-first centuries, the regeneration of animal parts is still a basis for the study of the regeneration of human body parts and a current hot topic in biomedical engineering.

Leopoldo Caldani, who had written to Laura over a period of ten years, also wrote a few letters to Giuseppe Veratti. The first letter included by Cenerelli has no date, but from the information contained in the letter, it was written from Padua. Caldani explained that he was asked to help a Mr. Stae, a physician, so he recommended him to Veratti. He added that Mr. Stae would bring some sugar and a book written by Morgagni which Caldani had found and bought for Veratti. However, Caldani admitted he was unable to find Mr. Stae at the moment, so he may have to use a courier instead to deliver the package. He highly recommended Mr. Stae and hoped he would show up to deliver the parcel in person. In the meantime, Caldani carefully detailed the expense and sent the receipts for the books to Veratti. Caldani wrote that he was studying the ear and had almost finished his booklet on the topic; he added that he may have to go to Bologna to work on cadavers. He said he loved Bologna, but the city had not been kind to him; he mentioned some of the senators and professors. Caldani informed Veratti of the death of Marquis Poleni, who left three empty university Chairs: one in mathematics, another in experimental physics, and the third on navigation. Caldani was of the opinion that the first two should be given to Veratti and to Signora Laura Bassi (Cenerelli 1885, 204–206).

Again from Padua, September 19th, 1777, Caldani wrote a brief letter to Veratti, mentioning that he received the surprising news that Monsignor Jenin appeared to be an impostor instead of a knowledgeable eye physician. Caldani said he would like to visit Veratti and his highly respected wife, but unfortunately his duties as physician and clinician did not allow him any free time. He added that he did not plan to live in this way forever and hoped that sooner or later he would be able to follow his own wishes (Cenerelli 1885, 206–207).

After Laura's death, Bianconi sent a letter from Rome on March 14th, 1778, offering his condolences to Veratti on the terrible loss of his beloved wife. Bianconi was in charge of collecting information for an article in praise of Signora Laura and her scientific accomplishments. Bianconi went on to say that he was well and a grandfather of two, thanks to the Countess Ansidei, his daughter. His wife also sent her condolences (Cenerelli 1885, 203–204).

From Padua in 1783, on the 31st, but no month is mentioned, Caldani had not written in a long time and felt almost embarrassed. He wrote that Veratti's beloved wife Laura must be in Heaven. He wished Veratti would visit Padua, but unfortunately wishes seldom come true, "so is life" he added. Moving on from such sad thoughts, Caldani recommended to Veratti a young physician, very knowledgeable and well-travelled, who had visited the universities of Berlin, Haile, Vienna, and Padua, and was now hoping to visit universities in Bologna, Tuscany, Piedmont, France, etc. The physician Manicati Safrani, from Hermanstadt, capital of Transilvania, would bring Veratti the letter. Caldani also recommended Cavalier Marquis Antonio Orologio, who would like to become a member of the Academy (Cenerelli 1885, 207–208).

What is common in the letters from famous men in science and medicine discussed in this chapter is the great respect they all show Laura Bassi, not only in words expressed in each letter, but in the discussion of serious science topics, several of which were important debates of the day.

Nothing is known of Laura's results on the regeneration problem she repeated for Spallanzani. This is in spite of the fact that Spallanzani had informed Bonnet on August 26, 1769 of his intention to obtain Laura Bassi's results, as well as those of other scientists recruited for this project. In 1783, Spallanzani published the results obtained by several scientists on the regeneration of the snails' head in the form of *petits memoires*, but he did not include Laura Bassi's name or results. It may have been an oversight on the part of her cousin who claimed in 1783 to her husband that she had been his "dearest teacher and (he) would remember her as long as he lived". Perhaps Lazzaro thought her results were no longer relevant five years after her death (Logan 1991, 44–45). The reason could also be that Lazzaro did not agree with her results. If Laura had different results from his, he may not have wanted to include them. Or else, he did not think it was important to mention her collaboration, as women were often ignored in men's publications. However, since we know today that Spallanzani was wrong in his theory and conclusions regarding this problem, it may be that Laura did not want to be cited in his publication and she may have said so. It seems that the facts about this issue are not clear.

Laura Bassi's correspondence shows a dramatic change in the years that followed 1745. Before becoming a Benedettina, she corresponded mostly with people in the literary world and with Flaminio Scarselli in her use of patronage to obtain the critical academic appointment she was seeking. From 1745, Laura's letters were mostly written to men in science and medicine. The correspondence from famous men like Beccari, Caldani, Fontana, Nollet, Spallanzani, Volta, and Zanotti to Laura Bassi was an exchange of information on instruments, experiments, methods and publications. Men frequently asked for her opinion on their articles and manuscripts. Sometimes they asked to see some of her work. The letters from Laura to Giovanni Bianchi are also very informative of the path she followed in her intellectual development. It clearly shows how she embraced the new way to do science, believing that experiments were a fundamental approach to establish a

scientific principle, a theory, or a law. She was also clearly adopting newtonianism versus the older approaches of philosophers like Aristotle and Galen.

The next chapter presents examples of women in science who lived in Laura Bassi's epoch.

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Chapter 10

Famous Women in Science in Laura Bassi's Epoch

This chapter presents five women who were considered highly knowledgeable in science and/or mathematics. Like Laura Bassi, four of them were called prodigies and they achieved international fame during their life: Elena Lucrezia Cornaro Piscopia from Venice (1646–1684), Gaetana Maria Agnesi from Milan (1718–1799), Cristina Roccati from Rovigo (1732–1797), and Gabrielle-Émilie Le Tonnelier de Breteuil, Marquise du Châtelet from Paris (1706–1749). The fifth woman, Anna Morandi Manzolini, was born in Bologna (1714–1774). Her background is more obscure than the other four women's; however, Anna developed an international reputation as an anatomist. She taught classes for the University of Bologna at the same time as Laura Bassi, so they must have been aware of each other. But there is no evidence about any meeting or correspondence between them. It is interesting to contrast the different career of these five women working in science and/or mathematics.

The women were chosen because of the several common points they had with Laura Bassi. Except for Anna, these women learned easily the difficult subjects usually reserved for men, especially Latin, Greek, science, and mathematics. They were able to dispute with the best philosophers and men in science and medicine of the day. Laura, Elena, Cristina, and Maria Gaetana had been 'created' by their family, and provided with an excellent education in the arts, languages, natural philosophy (science), and mathematics. They were required to perform for the elite in their society and had even been on display for international visitors to their city. Elena was from the nobility in Venice; Maria Gaetana was from a very rich family of merchants in Milan; her family was eventually added to the nobility of that city; Cristina was from an elite family in Rovigo; Gabrielle-Émilie was born into a noble family in France. Laura Bassi was born into a professional family but of modest means; Anna Morandi's background is rather obscure and it seems that her family was poor. As we saw in [Chaps. 2 and 3](#), it was not unheard of in the Italian Peninsula for noble or rich families to educate their daughters. The surprising fact was that Laura Bassi, who was born into an ordinary 'middle class' family, was encouraged to follow the same path as noble women and women from an elite class to become an 'extraordinary woman'.

We examine the education, contributions, and recognition these women received during their lifetime. Maria Gaetana Agnesi was appointed as a member of the Academy in Bologna, like Laura Bassi. Pope Benedict XIV also supported an appointment for Agnesi as Lecturer at the University of Bologna, as he had done for Laura Bassi earlier. Elena Piscopia was elected as a member of the Academy of the Ricovrati in Padua and even became its president at one point. In spite of opportunities presented to them, some of these women opted not to pursue a career in these fields.

Although Elena Lucrezia Cornaro Piscopia (1646–1684) lived in the seventeenth century, her story is highly relevant to what happened in Bologna in the eighteenth. Elena was the first woman in the world to be awarded a doctoral degree by a university. Elena defended her Theses on April 25, 1678 at the University of Padua and received a doctoral degree on May 5, 1678, fifty-four years before the second woman, Laura Bassi, was awarded her degree in 1732 at the University of Bologna.

Elena was the fifth child of Zanetta Boni, a healthy, exuberant woman from a lower-class family; Zanetta was the mistress of Elena's father, Gianbattista Cornaro Piscopia, since 1634. Zanetta had a child in 1635 (Francesco), and four more between 1635 and 1646. Elena's father was a nobleman and rich landowner who held senior positions in the Venetian Republic. He was a lover of culture, and love of learning had been in his family for many generations. After a 20 year affair with Zanetta, she was again pregnant with a sixth child in 1654; Gianbattista decided to marry her, making her the wife of the procurator of San Marco, although Zanetta and the children were still not considered noble at this time. However, all the children were later legitimized. Zanetta had another girl in 1755, a second Caterina, as the first one had died at age 17 in 1653; a boy (Girolamo) was born in 1657. Gianbattista sent four separate petitions to the Venetian Doge and to the Senate, accompanied by a large sum of money, to add his two sons (Giacomo and Girolamo) to the nobility. He finally succeeded and the boys were added to the list of nobles on March 1, 1664; in Venice, this decision would also include their sisters even though they were not named separately on the document (Maschietto 2007, 19–24). Elena's father died in 1692 and her mother in 1697. They both outlived their prodigious and uniquely talented daughter.

Born on June 5, 1646, Elena was very close to her older sister Caterina, but lost her when Caterina died in 1653. Elena was found to be very curious at an early age. Her confessor Father Giovanni Battista Fabris noticed her sharp mind and, convinced of Elena's exceptional intelligence, advised Elena's father to have her taught the Classics and Greek by himself, and Latin by Giovanni Valier, a canon at the Cathedral of San Marco. Father Fabris tutored Elena for fifteen years, between 1653 and his death in 1668 at the age of eighty-six. In 1669, Father Alvise Gradenigo replaced Father Fabris, teaching Elena the classical and the modern forms of Greek. Elena learned French and Spanish, mathematics, natural sciences, astronomy, and geography. She was tutored for seventeen years by Father Carlo Maurizio Vota, a teacher from France and contemporary of the famous philosopher and scientist Pierre Gassendi (1592–1655). It is of note that Elena's family

was connected, through her great-grandfather, to Galileo who had been a friend of the family; Galilean philosophy was transmitted to each successive generation of Elena's family since then. After mastering her literary and scientific instruction, Elena studied philosophy and theology. She received private lessons on an irregular basis from Carlo Rinaldini, a professor of philosophy at the University of Padua who visited her home in Venice from time to time and was much impressed by her talent and by the extent of her knowledge. He tutored her for a period of ten years, from 1668 to 1678. He often called her his Minerva (a name also given to Laura Bassi 64 years later). Elena called him the father of her culture (Maschietto 2007, 47–52).

During her study of theology and the Bible, Elena decided to learn Hebrew so she could read original texts. Her tutor was Rabi Shemuel Aboaf who knew Hebrew, Italian, German, Spanish, and Latin. Elena learned music from Maddalena Capelli, a woman who came to stay at the Cornaro home and remained Elena's companion for about twenty years, in Venice and later in Padua, until Elena's death in 1684. After Elena's death, Maddelena was invited to stay with the Cornaro family in Venice. All Elena's teachers were eminent men; her father always chose the best. Elena had exerted so much effort for her studies that some said this had a negative impact on her delicate health and would eventually lead to an early death at age thirty-eight (Maschietto 2007, 59).

Elena initially lived with her family in Venice. Her biographer Guernsey writes:

There was nothing more Venetian than a brilliant social life, and the Cornaros had the daughter to adorn it. Elena was developing into an exceptionally beautiful woman, delicate and graceful in bearing, just over five feet tall, with elegant features in the classic mold (Guernsey 1999, 80).

Guernsey added that Elena had a pleasing soprano voice which she was frequently asked to display at the palace dinners; she was also trained in the art of canto, reciting long passages in poems. Elena was also asked to participate in discussions and to exhibit her talents as a spectacle carefully planned and staged by her father Gianbattista for his guests: leading political, academic, and religious figures of the Republic of Venice. The assembly at the Cornaro evenings often included the heads of noble houses, including the Doge and the Dogressa, and the prominent heads of learned societies such as the Academy of the Dordonei and of the Pacifici in Venice, and from the Academy of the Ricovrati in Padua. Guernsey wrote that Elena was often at the centre of rigorous debates on some of the most advanced theories of the day and on various other subjects. Guernsey added: "Despite being painfully modest in demeanor, Elena's filial duty overrode any resistance, and she submitted to her father's demands to participate" (Guernsey 1999, 83). One of her favourite subjects for discourses was astronomy, but she could also speak on geography, arts, and mathematics, among others. In astronomy, she could discuss the movement of the planets, the path of the constellations, the study of spheres, and the dynamism of the stars. The display of her talent and knowledge led to an invitation to become a member of the Academy of the Ricovrati of Padua on February 11, 1669 (Guernsey 1999, 84).

In 1678, to please her father and her tutors, Elena filled-out the application for her degree to the authorities of the University of Padua (called the Reformers); Padua was the only university that Venitians were allowed to attend. The authorities agreed with her request, and while preparing the documents and details of the ceremony that was to be slightly different than the ceremony for men, they wrote to the Chancellor, Cardinal Barbarigo on November 18, 1677 to seek his approval. The Cardinal, in spite of his being in good terms with Elena's father, flatly refused that the degree be in the field of Theology. He could not imagine a woman desiring to obtain a degree or teaching in that field. He asserted never consenting to award a degree in Theology to a woman. Barbarigo agreed Elena could defend her Theses on that subject, but she would be conferred a degree in another field. Everyone accepted to confer a degree in Philosophy to Elena. So she re-applied with the help of her sponsor Carlo Rinaldini. The date of the exam was set as June 25, 1678. On June 22, Elena travelled to Padua before her defense to swear she was a good Catholic and a faithful Christian. It was only the day before her defense, on June 24, that Elena received the topics of the doctoral examination. June 25 was a vacation period, but the University informed the entire faculty about the unique and unprecedented examination. Dignitaries from Bologna, Ferrara, Naples, Perugia, and Rome were expected to attend. The crowd started to assemble in the early hours of that morning. Nobles, knights, ladies, educated men, and ecclesiastics filled the hall of the Sacred College. Elena, accompanied by her teacher Father Alvide Gradenigo, defended her Theses in philosophy in front of the large crowd of nobles, women, and scholars who had come to the Venician Republic from all parts of the Italian Peninsula, and even from abroad for this extraordinary event (Guernsey 1999, 150).

The assembly for the defense was so large that it had to be reconvened in a larger hall: the Chapel of the Blessed Virgin in the Cathedral. Elena was introduced by four professors, Girolamo Frigimelica, Carlo Rinaldini, Angelo Montagnana, and Ermengildo Pera and was asked to respond to questions on the two topics assigned. Afterwards, the professors said they did not need to have the secret vote since they unanimously agreed the defense had been excellent. But Elena insisted they go through the same normal procedure and vote. Elena was then acclaimed as a 'teacher and doctor of philosophy' before the entire audience. Rinaldini praised her family's civil and military deeds and mentioned Elena's great intellect, her nobility, her eloquence, her knowledge, her musical talent, and her great virtue. He then gave the blushing candidate the doctoral symbols: a book for a teacher, a ring for a courageous combatant in philosophy, an ermine cape for the doctorate, and a laurel crown (Maschietto 2007, 72–74).

One sarcastic note was written by Gaspare Ottaviani Cantu who was present at the defense; however he was not one of those signing the register for the degree. He denigrated Elena's performance and called her 'mad'. On the other hand, numerous literary compositions were written to praise her virtue and knowledge, while noting the increased celebrity of the University of Padua. Elena was inducted into the College of Philosophers and Physicians on Saturday, July 9, in a ceremony presided by the four sponsors and by 43 members of the College. She

was acclaimed unanimously by all. When she took her seat in the assembly, Elena was selected by lot as one of two examiners for the degree in Philosophy of a young man, Daniele Magnavini, whose Thesis defense was accepted with 39 votes for and 5 against. This was the only duty she was ever asked to perform at the College. Although given the title of teacher and doctor, it was expected that, being from a patrician family, Elena would not hold a university Chair or teach; in any case, she had no intention of doing this. Elena had become ill even before receiving her degree and she would not have been able to withstand the physical demands of teaching. In fact, one month before her defense, Elena had hemorrhaged, bursting a vein which was thought to come from her lungs. This was the first symptom of several more attacks which increasingly weakened her and led to her early death (Guernsey 1999, 153).

After her glorious achievement, Elena preferred to keep a low profile, but she accepted to attend a celebration of her degree at the Academy of the Ricovrati on July 15, 1678. People in Lyons, Paris, Amsterdam, Leipsig, Altenburg, and Utrecht wrote about Elena's degree and admired the University of Padua for having gone through such a step; many envied the glory acquired this way by the University (Maschietto 2007, 75–77). Elena was invited to join several other academies, however she only accepted the invitation from the Accademia degli Infecondi in Rome, the Accademia degli Intronati in Siena, the Accademia degli Erranti in Brescia, and two Venitian academies: Dodonea and Pacifici. She presented three scholarly discourses at the Pacifici and even became its president in 1670. In addition, Elena's father continued to request that she dispute at public events in Latin or Greek. Like Laura Bassi, many foreign visitors wanted to meet Elena. A most eminent visitor to Venice, Cardinal Bouillon, almoner and counselor of Louis XIV, the king of France, was amazed by his conversation with Elena. After his visit to Venice, Cardinal Bouillon spoke everywhere about the great knowledge and virtue of the young noble woman he had met.

Soon after granting Elena her degree, the University of Padua refused to allow any other woman to obtain a degree, fearing that undeserving women would make the request. This created a huge obstacle for Carla Patin when her father made a request for a degree to be awarded to his erudite daughter. In this occasion, the strongest opponent to Patin's request was Elena's father who wrote a long letter claiming that Carla was far from having the knowledge held by his own daughter; Gianbattista Cornaro added that awarding a degree to Carla would greatly diminish the value of Elena's accomplishment.

Towards the end of 1679, Elena moved into a beautiful palace in the Santo district of Padua which had been inherited by her father from several generations of the Alvise Cornaro family. This move was to help Elena continue her studies and it provided a better environment for her fragile health. Elena lived there for five years until her death in 1684. She had become a Benedictine oblate, as those in a cloister, although she actually lived in the world. She was not able to enter a convent due to family circumstances (her illegitimate birth), but had decided to take a vow of chastity at age eleven. She lived like a nun, but outside convent walls. It is likely that her poor health would have made convent life impossible for

her to contemplate and her illigimacy would have been another obstacle, as mentioned above. Elena wanted to dedicate her life to her studies and to the love of God, both of which could be done in her palace in Padua. A main reason why Elena made the vow of chastity was to avoid marriage. Elena's father had received an offer of marriage from a German Prince for her hand; she was able to decline this offer by declaring having made the vow and so she joined the Oblates.

Elena's days in Padua were spent in study and in charitable works. Her sponsor for the degree, Professor Carlo Rinaldini, continued to guide her studies, but he thought she studied more than was necessary. He admitted that Elena surpassed all his numerous disciples in intelligence. He dedicated one of his major works to her (Maschietto 2007, 89).

Elena wrote some literary compositions for friends and family, but she requested that all her writings remain private. She instructed Maddalena to destroy her writings immediately after her death, which was carried-out, unfortunately. However, four academic discourses written between 1670 and 1672 were pre-served in the archives of academies. What is left of her writings are: A translation of a small work from Spanish to Italian; four academic discourses, three of which were published by the academies; 30 letters in Latin and Italian; two petitions to the Pope; 11 eulogies in various languages; five epigrams in Latin and Greek, six sonnets in several languages; and one ode (Maschietto 2007, 93).

Elena had several bouts of poor health while preparing her defense. In May 1678, one month before receiving her doctorate, as mentioned above, Elena was coughing blood and this happened again in September. Her illnesses began with scurvy, followed by an abdominal inflammation and much pain. She recovered slowly, but then was afflicted with the 'red fever' or *purpura* which covered her body with blisters. This was followed by a nephritis that lasted several months. Her physician could not help her, but drinking mineral water from a nearby source brought some relief and she expelled three large kidney stones. During her last year, she had tremors and contractions of nerves all over her body and violent pains in her groin. Her last illness was a contagious blotch of pox in her shoulder blades which burst and became gangrenous. During the last week of her life, she had a high fever, periods of delirium followed by calm, and alternating periods of unconsciousness and lucidity. Her mother came frequently to care for her and her doctors provided the best medical care at their disposal at the time. On July 26, 1684, Elena passed away. As per her wish, she was buried in the Funeral Chapel of the Benedictine fathers in Santa Giustina. Her father commissioned a gold medal for Elena and a large monument depicting the family's history. The monument was found to be too cumbersome and demolished in 1727; it was eventually replaced by a bust of Elena. Several engravings, paintings and a drawing of Elena were done during her lifetime. Six months after Elena's death, the Prior and Bench of the Sacred College of Philosophers and Physicians at Padua ordered a bronze medal in tribute to its first woman laureate (Maschietto 2007, 122–128).

Another woman considered a prodigy and an 'exceptional woman' was Maria Gaetana Agnesi (1718–1799). Her father, Pietro Agnesi, married his first wife Anna Marina Fortunata Brivio in 1717. Maria Gaetana was the first child and

Maria Teresa was the third (1720–1795). Anna had seven children before dying in childbirth on March 12, 1732. Two years later, Pietro married Marianna Pezzi who gave him two sons. She died in 1737 probably from tuberculosis. He married his third wife Antonia Bonati in 1739; they had twelve children. Of Pietro's 21 children, 13 were alive in 1755. Several became nuns or priests, and two of his daughters were married: Maria Teresa and Anna Maria. Maria Gaetana never married nor did she join a religious order.

Pietro Agnesi inherited from his uncles and father who were in trade and in real estate. He was not interested in continuing the silk trade which had been the family's business for many generations, so all the stock was sold before he inherited the family fortune. His personal goal was to join the aristocracy. However, it usually took three generations for traders to reach this status. In his plan, Pietro decided to use his daughter's talent to achieve the upward social mobility he so desired. He also bought a property that had belonged to the nobility. This move was to enhance his links with the court of Vienna, but the city patricians took very little notice of him. It was much later (1768) that the State of Milan registered the Agnesi name in the catalogue of local feudal families; their crest was registered in the name of his heir Giuseppe (1735–1818) in 1775 (Mazzotti 2007, 13).

Pietro discovered early how brilliant his eldest daughter was. By age 13, Maria Gaetana could read, write, and speak seven languages: Italian, French, Latin, Greek, German, Spanish and Hebrew. (Wikipedia_Agnesi) Pietro provided tutors for her studies in moral philosophy, mathematics, metaphysics, and other subjects considered important in that period. Some of her tutors became professors at the local universities and were chosen most carefully by Pietro Agnesi. Several were influential preachers and theologians who would become leaders in their congregations (Mazzotti 2007, 33).

Maria Gaetana began to entertain her father's guests before she was five years old. At these academic evenings, she debated on several topics that included natural philosophy (science) and she also showed quick wit in her responses to questions posed. The ambitious plan of Pietro Agnesi was to use his salon and his gifted daughter to attract prestigious foreign visitors, especially those with some tie to the Court of Vienna and to the Holy Roman Empire, since they controlled the State of Milan at this time. Although evenings in these times usually consisted of communal readings, witty conversations, and gambling, the evenings at the Agnesi home were quite different; they revolved around the two sisters: Maria Gaetana debating in Latin on serious topics in philosophy and science, and Maria Teresa playing musical instruments and singing some of her compositions.

In the summer of 1727, when Gaetana was nine years old, she delivered an oration to a group of Milan patricians on the role of sex in understanding the relationship between the mind and the body and defended the right of women to gain access to education. This oration, based on a topic that had been dealt with at the Academy of the Ricovrati in 1723, was not chosen by chance. Several academics in Milan planned to attend that evening to discuss the education of women. As usual, the evening was carefully orchestrated by Pietro Agnesi. Through the participation of the elite men of Milan, the plan was to demonstrate, with the

example of Maria Gaetana's own erudition, that women could learn as well as men. She was obviously the perfect model of a young girl with great intellectual ability and a thirst for knowledge. It is thought that she was partly inspired on this occasion by a book written by Giuseppa Eleonora Barbipiccola, published in 1722, containing a translation of Descartes' *Principles of Philosophy* (1644) and a lengthy introduction in Italian justifying women's right to be educated. A copy of this book was in the Agnesi library (Messbarger and Findlen 2005, 117–118).

Maria Gaetana was very young to be discussing such a controversial subject. It is possible that the work was a joint effort by Maria Gaetana and her tutors, where they may have suggested the outline and revised the text after it was written. But her maturity and understanding of the question were unequivocal, as demonstrated during her oration and debate on that evening. In her oration, Gaetana humbly mentioned she was just a clever girl among these distinguished men, but she dared descend in an arena full of risk and danger. In her eloquent, yet humble and respectful speech, Gaetana refuted the old arguments against the education of women and put forward the reasons why educating girls would strengthen humanity. She rejected the traditional objections to the education of women, namely the alleged inability of the female mind and the social disruption that would follow such a concession. She asserted that learned women would be better daughters and wives and more conscious of their religious and social duties (Messbarger and Findlen 2005, 120–122).

In supporting women's traditional role as dutiful daughters and wives, and stressing the importance of their religious duties, Maria Gaetana's arguments resembled those of the educated Dutch woman almost a century before, Anna Maria van Schurman (1607–1678). Van Schurman had learned several languages and was knowledgeable in mathematics, calculus, astronomy, and versed in poetry, rhetoric, dialectics and philosophy. In 1639, Anna Maria published her work *Dissertatio, de ingenii mulieribus ad doctrinam, et meliores litteras aptitudine*, (On the aptitude of the female mind for science and letters). Van Schurman was a strong supporter of equal opportunities for the education of women. She attended lectures at the University of Utrecht behind a curtain. As the best Latinist in the city, she had been asked in 1636 to write verses for the inauguration of the new University in that city. In 1646 (first in Dutch, then translated into English in 1659), she wrote *The Learned Maid or Whether a Maid may be a Scholar*. Her approach was that girls should be provided with the same classical education as boys. During her active years, she had a positive influence on other women who were also working towards a similar goal. Van Schurman believed that women should be able to study science and that women should acquire the knowledge necessary for public life in the arena of the court (law), the church, and the battlefield; but paradoxically, she believed that women should not actually enter the public sphere. (Van Schurman 1659, 119) Her message was ambiguous; her pamphlet supported the education of single women, but she did not question the assumption that women's proper sphere was in the home. Her last years were spent in a religious leader's group led by Labadie, abandoning her classical learning to concentrate on the scriptures. This life choice on van Schurman's part resembles

somewhat the life chosen by Gaetana Agnesi in Milan after her father's death in 1752 (Frize 2009, 85).

As mentioned in Chap. 2, Maria Gaetana's oration in 1727 was later published under the title *Academic Oration in Which It Is Demonstrated That the Studies of the Liberal Arts by the Female Sex Are by No Means Inappropriate*. In 1729, the text was printed again in the *Academic Discourses by Various Living Authors on the Education of women, the Majority Recited in the Academy of the Ricovrati in Padua*. Gaetana's entire oration can be found in English in the book titled *The Contest for Knowledge*. The article became part of the rebuttal to Giovanni Antonio Volpi's arguments published several years after the 1723 Ricovrati debate mentioned in Chap. 2. Her article was included with those of Aretafila Savini de' Rossi and of Volpi. Maria Gaetana's article was considered more forceful in its logic and argumentation than the other authors (Messberger and Findlen 2005, 117–140).

Like Laura Bassi, Maria Gaetana's education included science and mathematics. The Agnesi library contained a book on algebra by the Venetian Giovanni Crivelli (1728); she also studied his book on Euclidian geometry (1738). Crivelli wrote *Elements of Physics* in 1731, and was planning to write about calculus just before his death in 1743. At the age of 20, Maria Gaetana concluded her course on philosophy and published her Theses with the title of *Propositiones philosophicae* (1738), which she dedicated to her tutor Carlo Belloni. She mentioned having appreciated his guidance in philosophical and mathematical studies and eulogized his vast knowledge and his religious piety. Maria Gaetana's book contained 191 propositions, each with a dozen lines. In the prologue, she affirmed how fit it was for women to study science and the arts. Her Theses were on logic, ontology, pneumatology, general physics, and on some particular aspects of physics. In some of the Theses, Maria Gaetana made the important point that in mathematics, one can discover and contemplate truths that are derived with absolute certainty. She expressed the opinion that such intellectual contemplation was the 'greatest earthly joy available to mankind' (Mazzotti 2007, 64). We can conclude from this statement that Maria Gaetana really enjoyed her studies in mathematics and science. This is a point in common with Laura Bassi.

On July 16, 1739, when Maria Gaetana was twenty-one years old, two Frenchmen who were travelling in the Italian Peninsula, were invited to the Agnesi Palazzo. The two men were counselors at the Parliament of Burgundy: Its future president, Charles de Brosses, Comte de Tournay, baron de Montfalcon, seigneur de Vezins and Preussin (1709–1777) was a French writer; Germain Anne Loppin de Montfort was a mathematician. They were interested in works from the classical antiquity and from masters of the Renaissance, especially in Raphael (Mazzotti 2007, 1). That evening, they were among 30 or so persons placed in a circle around Maria Gaetana and her sister Maria Teresa. A difference that set apart this particular evening with usual gatherings was its special host, Count Carlo Belloni. Maria Gaetana's father, Pietro Agnesi, stayed in the background, but he made sure things unfolded as planned in every detail. The Count began by asking Maria Gaetana in Latin to speak about the nature of tides and the origin of

spring water. She responded brilliantly, also in Latin. Then the Count asked the two guests to dispute with her on any topic they wished. De Brosses asked her to speak about the nature of the soul, the problem of the relationship between the body and soul, and on the nature of light and colours. She responded again in Latin. Loppin asked her about the properties of various curves to which she also responded well in Latin. After the 'spectacle', everyone began to converse in groups and Maria Teresa played some Rameau on the harpsichord and sang some arias she had composed (Mazzotti 2007, 5–7).

Another major event occurred in 1739: His Royal Highness Fredrick Christian, heir to the throne of Poland, heard about the two young women during his visit to Milan and expressed the wish to visit the Agnesi Palazzo. Mazzotti reports that, according to the *Gazetta di Milano* of December 16, 1739, the prince left the palace perfectly satisfied and congratulated the city on their two young women so full of rare virtues and exemplary modesty. Like many of the visitors who attended Maria Gaetana's public performances, the Polish prince was fascinated by the academic bravery, debating ability, religious devotion, and virtuous modesty displayed by her. Mazzotti added: "Distant as it was from the French model of the *salonnière* and also from the ideal of a subdued and silent femininity promoted by the Counter Reformation, the public role played by Maria Gaetana had become, by the end of 1739, a fascinating and slightly unsettling attraction" (Mazzotti 2007, 21).

In December 1739, while Maria Gaetana and Maria Teresa were studying at their villa in Mascago, an urgent message arrived announcing that the prince of Braunschweig-Wolfenbüttel wished to visit the Agnesi Palazzo in two days' time and expected both sisters to perform for him. On that evening, in the presence of such an eminent guest, Maria Gaetana disputed with famous academics on the motion of planets and on the nature of colours, with musical interludes played by Maria Teresa. Maria Gaetana accompanied her sister on the viola d'amore.

Maria Gaetana published *Istituzioni Analitiche ad uso della gioventù italiana* (Analytical institutions for use by Italian youth) in Milan in 1748. The book is still regarded as the best introduction to the work of Leonhard Euler (1707–1783), a famous Swiss mathematician. It consisted of two volumes of algebra, analytic geometry, calculus, and differential equations (Kennedy 1987, 2). Among her mathematical achievements was the development of an algebraic equation which defines a curve called *la versiera*, which in Italian means a curve that turns. Due to distortions of language and translation, this was later called *l'avversiera* (which means wife of the devil in slang); this led to her equation being called the 'witch of Agnesi'. In independent work, this curve was also described by Pierre de Fermat and by Isaac Newton (Frize 2009, 170–171). But Maria Gaetana's work was original and definitely not copied from anyone else.

As the 1748 edition of her two books circulated in Europe, Maria Gaetana became quite famous; she was elected in June of that year to the prestigious Academy of Bologna. Between 1749 and 1750, she received numerous congratulatory letters. The Secretary of the Academy of Science of Bologna wrote: "What

neatness! What concision! What order! What clarity!" and showed his appreciation for her choice of the vernacular for her work (Mazzotti 2007, 120).

Laura Bassi congratulated Maria Gaetana for writing a book "to enrich not only the Learned World, a profound accomplishment and most useful work, but also to honour our sex in a special way" (Findlen 1995, 188). Laura confirmed her appreciation for Maria Gaetana's talent; Laura added that she had been aware of it for many years. Laura Bassi also sent greetings to Pietro Agnesi (Mazzotti 2007, 120).

Iacopo Beccari mentioned a visit by Pietro Agnesi to Bologna and he claimed that everyone owed him for the education of his daughters. Maria Gaetana even received congratulations from the Empress Maria Theresa through her Minister in Lombardy. Prince Fredrick Christian, who had met Maria Gaetana in 1739, wrote to her from Dresden.

Significant recognition came from the friar François Jaquier, a protégé of Pope Benedict XIV. In 1750, the Pope himself wrote to Maria Gaetana to congratulate her. In another letter in September of the same year, he informed Maria Gaetana that he had recommended her for a lectureship in mathematics at the University of Bologna, which the Senate confirmed on October 5, 1750. Maria Gaetana had never solicited this appointment and was surprised by the news. The Pope was quite proud that his home city would honour two of the most learned women in the Italian Peninsula, Bassi and Agnesi (Mazzotti 2007, 122).

Maria Gaetana sent copies of her books to Paris and London through contacts made by Francesco Maria Zanotti and by Laura Bassi. She received great compliments from some members of the academies in these cities. It was said that her text was the clearest, the most methodical, and complete presentation of calculus published to date. A French translation of the second volume was published in 1775 and an English translation of the whole work was done by John Colson (1680–1760), the Lucasian Professor of Mathematics at Cambridge, published in 1801 after her death (Findlen 1995, 190; web: apcalculusbc).

There is a remarkable parallel between Laura Bassi and Maria Gaetana Agnesi, at least concerning their great interest in science, philosophy, and mathematics. Both were considered child prodigies and had remarkable intellectual abilities. They both became interested in Newtonian philosophy, especially the concepts regarding light and colours and the modern mathematics of calculus. Both published excellent Theses and held many public disputations in Latin and in other languages. They were both elected as members of the Academy of Sciences in Bologna. Pope Benedict XIV recommended both for a Lectureship at the University of Bologna, Bassi in 1732 and Agnesi in 1750. Laura Bassi and others urged Maria Gaetana to accept this position, but she turned it down and chose to devote the rest of her life to helping the poor and the sick (Kennedy 1987, 2). The two women achieved great fame during their lifetime, in Italy and in Europe. Another point in common is that both unfortunately returned to obscurity after their death and are not well-known in our time; both have been ignored by many historians.

However, there was a quite a large difference in the personal life choice made by Bassi and Agnesi. Laura married a professional like herself and had many

children, yet she maintained an active career in science throughout her life and taught experimental physics and mathematics for thirty years. Her science activities and productivity were at an equal level to that of the best members of the Bolognese Academy of Sciences; she presented original work every year, as expected. She also published some of her work in the journal of the Academy. On the other hand, Maria Gaetana, very early in her life, expressed the wish to retire from public life. In this respect, Maria Gaetana bore more resemblance to Elena Piscopia. On the evening when de Brosses visited, she told him of her desire to abandon her life in society for the quietness of the cloister; this was at a time when she was making celebrated public performances. When he heard this, her father felt 'as if struck by lightning' and did not hide his great sorrow, as his daughter meant more to him than all his other children; she was 'the delight of his life'; she was also of course an instrument to achieve his social ambitions (Mazzotti 2007, 67).

Mazzotti mentions that De Brosses, when he heard Maria Gaetana's desire, was surprised and disappointed; he could not understand how this rich girl, who could continue to live a sparkling existence in Milan, could throw it all away. But Maria Gaetana was always uneasy and uncomfortable with the life her father had chosen for her: to be displayed as a child prodigy. As mentioned earlier, Pietro's plan was to increase his fame and visibility through his daughter, which was crucial for his social advancement. At the peak of her role as a child prodigy, between 1730 and 1732, Maria Gaetana suffered from a 'strange and persistent' disease.

In 1739, during another period of frequent public appearances, Maria Gaetana again manifested her uneasiness with the life her father imposed on her; the two had long discussions about this which resulted in a compromise: Maria Gaetana would be able to dress simply and have the permission to visit churches whenever she wanted. She wanted to be exempted from attending balls, the theatre, and other worldly pleasures. She also wished to volunteer at the hospital (Ospedale Maggiore) to take care of poor and infirm women. Pietro agreed to all Gaetana's requests in return for her continued participation in public disputations. She also promised not to abandon her studies or her writings and she kept this promise. This is when she decided to concentrate her work on mathematics, the subject she liked most.

Pietro had borrowed much money to reach the social prestige he so desired in the form of fiefs and titles. The inheritance he had received forbade him to sell any family property, so he was much in debt by the time of his death on March 19, 1752. To survive, his family began to sell several of the houses, since they were not tied like Pietro to the will of the uncles. Their standard of living changed dramatically for the worse. Maria Gaetana survived her father by almost fifty years, yet she never took the veil. Her earlier threat may have been simply an argument to obtain his permission to follow her wishes described above (Mazzotti 2007, 67–69).

After her father's death, Maria Gaetana provided spiritual and material help to women, visited several in their miserable attics, and even opened some rooms in her own palace for women who had nowhere to live.

Maria Gaetana's public disputation career came to an end after her father's death and she divided her time between writing the two volumes in mathematics and her charity works. When Maria Gaetana visited churches, it was not just to pray, but also to teach young girls. Church and schools were segregated by sex and Maria Gaetana taught girls in the church of Santa Caterina, which was close to her parents' home, and in San Calimero, a parish across the Porta Romana *corso*. On each school day, she taught reading with the catechism and using big boards with letters. Schools were open on Sundays and holidays, so for around eighty-five days a year.

Maria Gaetana attended some of the meetings of the Academy of the *Trasformati* in Milan where she met poets, essayists, playwrights, professors, and ecclesiastics. These visits to the Academy allowed her to connect with the intelligentsia of Milan. But after the death of her father, she focused mostly on her charitable activities. She signed over her inheritance to two of her brothers and kept just enough income to support her good deeds (2000 imperial lire per year) (Mazzotti 2007, 144).

In 1762, the mathematician Giuseppe Luigi Lagrange, from the Academy of Turin, sent Maria Gaetana his collected works on mathematics and asked for her criticism and encouragement, but she declined. She had set aside forever the part of her life that had been imposed by her father, but she did remain in contact from time to time with her old network and wrote some letters of recommendation to the Court of Vienna for men seeking a lectureship at the University of Pavia.

Her sister, Maria Teresa, also became quite famous. One of her operas was staged in 1771 in Milan, along with the music of other composers, including Wolfgang Amadeus Mozart's! Maria Teresa married Pier Antonio Pinottini in 1752. She died in 1995. Maria Gaetana died of pneumonia on January 9, 1799 in her rooms at the Albergo (the hotel) where she had moved in 1783 with a few of her belongings. She was eighty-one. Because of the occupation of the French troops in Italy, all ceremonies were prohibited, so she was buried during the night without a priest in attendance, in an unmarked grave, together with fifteen other women from the Albergo (Mazzotti 2007, 149).

Three other famous women lived in Laura Bassi's epoch: They were: Anna Morandi Manzolini in Bologna, Gabrielle-Émilie le Breteuil' Marquise du Châtelet in France, and Cristina Roccati in Rovigo. Anna Morandi Manzolini (1714–1774) was born on January 21 in the parish of San Martino Maggiore in Bologna, the daughter of Rosa Giovannini and Carlo Morandi. This was the same year as the birth of the Institute of Sciences of Bologna (Istituto delle Scienze) launched by General Luigi Marsili and the Bolognese Senate. At age twenty-six, Anna married the Bolognese artist Giovanni Manzolini (1700–1755). Anna met him at the studio of Giuseppe Pedretti and Francesco Motti, where both Anna and Giovanni were studying drawing and sculpture. Before her marriage, Anna had produced excellent copies of paintings of masters (Messbarger 2001, 69).

In 1730, Prospero Lambertini, the future Pope Benedict XIV, left Rome where he had been a Librarian at the Papal Government, and returned to Bologna as its Archbishop. He was determined to make Bologna a premier centre of learning in

Europe; he had a particular interest in the medical sciences and anatomy, subjects which were already strong and recognized disciplines at the University of Bologna. In 1731, Lambertini expressed his desire to the governing body of the Institute of Sciences of opening an Anatomy Museum as part of the Art section of the *Accademia Clementina*. This was established at the Poggi Palace at the University of Bologna. It still exists today. Lambertini was most impressed by Ercole Lelli's wax models of kidneys and wanted him to work at the new museum to create life-sized models of all parts of the body which could be represented in wax (Messbarger 2010, 29). A real advantage of using accurate wax models was that students and physicians could study anatomy and physiology without suffering the odour of putrefaction normally present in dissection classes.

In his own important work titled *Notificazione* published in January 1737, Lambertini discussed the importance of dissection and anatomical studies. This led him to reinterpret the Bull of Pope Boniface VIII (1299) which forbade the exhumation, sectioning, or boiling of the bodies of buried Christians (Messbarger 2010, 7). Lambertini supported the yearly dissections carried-out at the University of Bologna. As mentioned earlier, these were occasions where Laura Bassi performed disputations as part of the Carnival-like event.

In 1740, the year he married Anna Morandi, Giovanni Manzolini began an apprenticeship with Ercole Lelli, the renowned anatomical wax modeler mentioned above. In 1742, Pope Benedict XIV asked the Institute to commission Lelli to form, sculpt, and color in wax the complete myology and the osteology of the human body as a foundation for the Institute's museum of anatomy. Lelli hired Manzolini to help create the models for this immense papal commission. In 1745, a dispute arose over the acknowledgment of Manzolini's part of the work on the commission, so he left Lelli and opened his own studio at home. This is when Anna began to help her husband in the preparation and production of wax models and in the study of anatomy (Messbarger 2001, 70–71).

The couple dissected more than a thousand cadavers to learn the anatomy of each organ and body part before creating their wax models. The cadavers were mostly obtained from *Ospedale di Santa Maria delle Morte* (Hospital of Saint Mary of the Dead) which housed the City's mortuary and cared for the poor. Like Lelli, the wax models created by the couple were accurate representations of human anatomy and physiology. To do this, they had to isolate, study, and remove the part of the body under observation and then design the wax model. Messbarger describes the work: "Morandi's waxes conjoin the fine arts and surgery, sense and cognition, hands and eyes, to vividly render and theorize the workings of the human body" (Messbarger 2001, 65).

Well before her husband's death, Anna Morandi was frequently asked by the local authorities to host eminent visitors to Bologna and guide them through the anatomical collection at the Institute. When her fame reached beyond the Italian Peninsula, she received several offers from foreign courts and academies to relocate her practice and her collection. The patricians of Bologna began to fear losing one of the attractions of the 'Grand Tour' (visitors from all over Europe to the Italian Peninsula).

In 1746, a professor of surgery at the University of Bologna, Giovanni Antonio Galli (1708–1782), commissioned the Manzolinis to produce the first twenty wax models of the gravid uterus and the female reproductive system. Galli eventually used over one hundred and fifty such models for his School of Obstetrics that he opened in his home in 1753. His models included the original twenty created by the Manzolini couple who owned several books on anatomy and physiology; their models were highly accurate (Messbarger 2001, 71). The Manzolinis also received commissions from the King of Sardinia, the Doge in Venice, the Royal Society in London, and even from Catherine the Great of Russia. Their fame grew, not only in the Italian Peninsula, but far abroad.

Anna's husband Giovanni died of dropsy in June 1755. Anna took over the studio. She wrote to Pope Benedict XIV, asking him to support her request to the Bolognese Senate for an annual stipend to meet the needs of her family and to continue her wax works. She explained this would allow her to remain in Bologna rather than accept invitations from other cities offering to host her. The response was an annual honourarium of 300 lire, accompanied with the title of Public Modeler and Demonstrator of Anatomy at the University of Bologna. The university expected her to continue the anatomy lessons in her home studio. The honourarium provided to Anna was much lower than the yearly stipend awarded to Lelli of 1200 lire and Bassi's 760 lire in 1756. Anna's honourarium was too low for her and her family to survive; six months after Giovanni's death, she placed her eldest son Giuseppe (born in 1745) in an orphanage. Two and a half years later, the boy was adopted by a noble family as their heir and he was renamed Giuseppe Solemei. Her youngest son Carlo (born in 1749) continued to live with her (Messbarger 2010, 108–110).

In 1758, Anna Morandi was offered a membership in the Clementina Academy of the Arts for her talent in making accurate wax models of human anatomy. In her career path, although her work reached international fame, Anna received much less recognition, accolades, and salary than Laura Bassi. Anna never defended a Thesis, nor was she awarded a doctoral degree from the University of Bologna. But, like Laura Bassi, Anna received support for her career from Pope Benedict XIV who had intervened with the Senate to keep Anna Morandi in Bologna (Messbarger 2010, 13–14).

Whereas male anatomists like Ercole Lelli focused on the female reproduction system (many examples can still be found at the Poggi Palace), Anna Morandi created models of the male reproductive anatomy. Some men thought this was most inappropriate and an affront to her female modesty. Her loudest opponent was Petronio Zucchini, a professor of anatomy at the University of Bologna. He denigrated her work in the preface of his tract published in 1771. A completely opposite view was expressed by Giovanni Bianchi, the same man who had been very supportive of Laura Bassi. After his visit to Anna's studio in 1754, Bianchi considered that her work was much superior to that of the male anatomists. Some called Anna Morandi 'the Mother of Anatomy' (Messbarger 2010, 19).

Anna eventually created an anatomical atlas based on the wax models of most of the organs and parts of the human body. Some of these contained details that

were at the microscopic level. She modeled the heart, larynx, pharynx, muscles and bones of the face, the mouth, jaw, tongue, ear and eye, in normal and in enlarged proportions. Anna also replicated the hand, the respiratory system, kidneys, the uterus, and parts of the male urogenital system. Among her tools were a large iron saw, a small saw, a curved knife to scrape bones, a fistula to introduce air, curved iron scissors made in England, files, scalpels, forceps, and a small microscope (Messbarger 2010, 55–56).

Messbarger writes:

[Anna] developed superior wax compounds and methods of sculpture, as well as more precise techniques of human dissection. These innovations allowed her to depict anatomical traits never before visualized for the naked eye. Morandi won near-instantaneous public acclaim as the most accomplished of the three Bolognese ceroplasts (Messbarger 2001, 74).

At times, Anna challenged the prevailing anatomical theories of recognized masters like Battista Morgagni (1682–1771). In her 250 page notebook, forty-five pages were dedicated to the male reproductive system and genitalia. Anna was eventually paid (in 1769) very highly for twenty-two of the wax models in this series, which was ten times what she received for any of her other models (Zinsser 2001). Unfortunately, this series has since been lost, but it was obviously of great interest at the time (Messbarger 2010, 14–15, 54). Several of Anna's wax models and the sculpture of herself and of her husband can be found at the Poggi Palace in Bologna.

On September 3, 1765, Anna sent a letter to the senate requesting an increase of 200 lire, claiming she was seriously ill and not able to support herself financially. The Senate refused, so she began to consider transferring her models and practice elsewhere. Catherine the Great had wanted for some time to bring the anatomist and her collection to the Russian Court. But the increasingly infirm Anna did not wish to move so far away. It was four years later (1769) that an offer was made that enabled Anna to stay in Bologna. The Senator and Bolognese nobleman, Count Girolamo Ranuzzi (1724–1784), offered to buy Anna's collection for 12,000 lire. He also offered her a furnished apartment in his palace with all necessary comforts. Anna gladly accepted this opportunity and moved to Ranuzzi's palace with her son Carlo who was then twenty-one years old; she also brought her servant Lucia Grifoni with them. The Count benefitted much from this arrangement by gaining prestige and hosting numerous eminent guests to Anna's studio. There were orders from abroad for anatomical wax models which were handled by the Count. The Holy Roman Emperor, Joseph II, even came to visit her studio on May 14, 1769 (Messbarger 2010, 164–165).

Anna died on July 9, 1774 and was buried in the Church of San Procolo. Her two sons purchased a large marble headstone to mark her grave. Carlo was appointed professor of theology at the university in April 1781 after having become a deacon in 1770. Anna Morandi's wax models were eventually purchased from Ranuzzi by the Bolognese Institute for the price of 16,000 lire after he threatened to sell them to Russia (Messbarger 2010, 169–171).

Anna Morandi and Laura Bassi both taught classes for the University of Bologna; Laura's classes were mainly on the topic of experimental physics, although she did teach anatomy classes earlier in her career; Anna's classes were on anatomy and physiology. There were differences in the path taken by the two women. Unlike Bassi, Anna Morandi was mostly self-learned. She did not obtain a university degree, nor did she give public orations or disputations with academicians and the elite of Bologna. She was not celebrated like Laura Bassi nor did she have the opportunity to be escorted in the Gonfaloniere's gala carriage. Volumes of eulogious poems were not written in her honour as they were for Laura Bassi. Anna's public role was confined to the performance of dissections in her home studio for medical practitioners and foreign visitors. However, Anna was considered the best anatomist of her day (a genius some said) and the clarity of writing and scientific accuracy in her extensive notes (in Latin) were outstanding. Both Laura and Anna defined their life through their work.

Another self-learned woman famous for her work in science and mathematics in the eighteenth century was Gabrielle-Émilie Le Tonnelier de Breteuil, Marquise du Châtelet (1706–1749), born in Paris just five years before Laura Bassi. Italy was unique in its formal recognition of its exceptional women like Bassi and Agnesi in the eighteenth century. In France, the situation was quite different: No degrees were offered to women in that country until late in the nineteenth century, and no women were invited to become a member of the Académie des sciences in Paris until 1975. In spite of the difference in the formal recognition of Laura and Gabrielle-Émilie, there were common points: both women were young prodigies and they both loved physics and mathematics. They both adopted the science of Newton and Leibniz early in their career: Gabrielle-Émilie translated, commented on, adapted and disseminated these ideas in France; Laura taught these principles in her classes and used them in her own original research in experimental physics. Both women were highly skilled in the new mathematics (calculus). However, they had a very different personal life. Gabrielle-Émilie was born into aristocracy; her mother, Gabrielle Anne de Froulay was the daughter of a French noble; her father was Baron of Preuilley and chief of protocol at the French Court.

When her father noticed Gabrielle-Émilie's unusual learning abilities, he hired tutors to teach her languages. In early childhood, Gabrielle-Émilie could read Latin, Italian, English, and Flemish, in addition to her knowledge of French. She was also taught fencing, riding, gymnastics, and classical literature, but mathematics was her favourite subject (O'Connor and Robertson 2013).

After her marriage on June 20 1725 to thirty-year old Marquis du Chastellet (Châtelet), Comte de Lomont, and Governor of Semur-en-Auxois, she hired her own tutors and concentrated on the study of mathematics. She spent time between Semur and Paris. Gabrielle-Émilie had three children in the early years of the marriage: Gabrielle-Pauline (1726) who married the duke of Montenero in 1743; Louis-Marie-Florent (1727), the future Duc du Châtelet and ambassador of France, guillotined in 1793; and Victor-Esprit (1733) who lived only a few months. She had done her duty as a wife; in 1733, Gabrielle-Émilie began to seriously study mathematics with the academician Pierre-Louis Moreau de Maupertuis. These

studies awakened her keen interest in science (O'Connor and Robertson 2013; Zinsser 2006, 39).

Gabrielle-Émilie's husband, who had stayed with her for the first years of their marriage, became a career officer and was away frequently on military duty; their life drifted apart, which was quite common within the aristocracy and in arranged marriages. Gabrielle-Émilie first met François Marie Arouet (1694–1778), writer and philosopher whose pen name was Voltaire, when she was a child; he had been invited at some of her parents' dinner parties. She met him again in 1733 when he returned to France after an exile of three years in England because he had upset the King (Louis XV) and some of the nobles (O'Connor and Robertson 2013).

In May 1734, Gabrielle-Émilie and Voltaire both attended the wedding of the Duc de Richelieu, one of her past lovers. When they met, Voltaire was older and already a famous literary author, a political philosopher and activist, and he now developed some interest in the new sciences. Days after the wedding, Voltaire was forced to hide for several months, as there was a warrant for his arrest; so he and Gabrielle-Émilie moved to the estate of her husband in Cirey-en-Champagne (O'Connor and Robertson 2013). Voltaire and Gabrielle-Émilie started a relationship which lasted until her death in 1749. They lived together at Cirey except for periods when Voltaire had to flee France again for political reasons, or when she spent some time in Paris.

Regarding their move to Cirey, Voltaire wrote:

I found in 1733 a young lady who felt more or less as I did, and who resolved to spend several years in the country to cultivate her mind, far from the tumult of the world. It was the marquise Du Châtelet, the woman who in all France had the greatest disposition for all sciences. ...Seldom has so fine a mind and so much taste been united with so much ardour for learning; but she also loved the world and all the amusements of her age and sex. Nevertheless she left all this to go and bury herself in a dilapidated house on the frontiers of Champagne and Lorraine, where the land was very fertile and very ugly. She beautified the house, to which she added pleasant gardens. I built a gallery, in which I created a very fine collection of scientific instruments. We had a large library (O'Connor and Robertson 2013).

Gabrielle-Émilie, like all persons involved in science or mathematics, wished to participate in discussions on research topics, but women did not have access to the Academy in Paris nor did they have access to the cafés where mathematicians, astronomers, and physical scientists met; the most famous of these was the Café Gradot. One day in 1734 she tried to enter this café to discuss with Maupertuis, one of her teachers of mathematics, but she was not admitted. So one week later, she presented herself dressed as a man to make a statement about this ridiculous rule; she was served by the management of the café. Maupertuis was much amused by this bold act by Gabrielle-Émilie (O'Connor and Robertson 2013).

Towards the end of 1735, the Venetian Francesco Algarotti came to stay at Cirey while working on his book that would popularize Newtonian optics. He wrote most of his book *II newtoniasmo per le dame* during his long stay with Châtelet and Voltaire, which he published in 1737 (Zinsser 2006, 116). In his book, Algarotti described the marquise he created as a woman who “could follow

his descriptions, knew something of mathematics, was quick and bright, empathic and aggressive in her eagerness for knowledge of the causes of the phenomena he described" (Zinsser 2006, 163).

Unfortunately, Algarotti also made his marquise petulant, childish, easily bored, and sometimes uncomprehending. Everyone knew the marquise in Algarotti's book was referring to Gabrielle-Émilie. Voltaire rose to her defense stating that she knew more science and mathematics than Algarotti and she had actually corrected things in his book (Zinsser 2006, 163–164).

On the positive side, Algarotti's visit seems to have incited Voltaire and Gabrielle-Émilie to become involved in a plan to propagate Newton's work in France. Gabrielle-Émilie's knowledge of Latin, Italian, and English enabled her to write several literary and philosophical works that include a translation of Bernard de Mandeville's *Fable of the Bees*; the composition of a *Grammaire raisonnée*, and an *Examen de la Genèse*. She began a study of Newton's work and wrote *Essai sur l'optique*, a fragment of which is still preserved. She contributed to *Éléments de la philosophie de Newton* which Voltaire had composed in large part at the end of 1736 just before his next period of exile. In December 1736, Voltaire had to flee again, this time to The Netherlands, but he continued his work on the *Éléments de la philosophie de Newton*, written in collaboration with Gabrielle-Émilie, as she was quite knowledgeable on Newton's *Optics* and with his *Principia*; moreover, her knowledge of mathematics was much greater than his. He sent her proofs in the early part of 1737. He returned to Cirey in March 1737 and purchased many instruments from Abbé Nollet who had a large inventory of equipment necessary to perform experiments in the physical sciences. Some of the instruments acquired were prisms, a reflecting telescope, an air pump, a Copernican globe, a burning glass, and a microscope (Zinsser 2006, 153).

In 1737, the Académie royale des sciences launched the competition of 1738. The theme was on heat and fire and submissions were due in September 1737. For the competition, Voltaire and Gabrielle-Émilie did many experiments at a nearby forge, heating various metals and weighing them before and after the heating process. Newton had claimed that fire had weight, like matter. The results of the experiments were mixed: some of the metals had the same weight before and after the heating, while others changed their state and gained some weight. Voltaire concluded, as Newton did, that fire was similar to matter and had weight. But Gabrielle-Émilie believed (correctly) that fire was not like matter and did not have any weight. She disagreed with Voltaire's interpretation of their experiments and with his conclusions, believing him to be in error. So she decided unorthodoxically to submit her own manuscript for the competition on the same topic without Voltaire's knowledge. Hers was titled *Dissertation sur la nature et la propagation du feu*. The first prize was given to Euler, and both Gabrielle-Émilie and Voltaire received the second prize (an Honourable Mention) from the Academy for their separate entry (O'Connor and Robertson 2013; Zinsser 2006, 154–162).

When *Éléments de la philosophie de Newton* was published in 1738, it raised much criticism from academicians who were, for the most part, staunch Cartesians who rejected Newtonianism. Gabrielle-Émilie defended their work through letters

written to the Académie des sciences de Paris which published them in its journal; one of her letters was titled *Lettre sur les élémens de la philosophie de Newton* (1738) (O'Connor and Robertson 2013).

It is during this period that Gabrielle-Émilie produced her main work. In addition to the first joint publication mentioned above, Gabrielle-Émilie published her own book *Institutions de physique* (Lessons in physics) in 1740, a detailed and clear exposition of Leibniz's physics and mathematics, which she presented as a review of new ideas in science and philosophy; this was meant as material for her thirteen-year-old son's studies, but it incorporated complex ideas from the leading thinkers of the time.

From 1745, Gabrielle-Émilie concentrated on her other major work: the translation of Newton's *Principia* from Latin into French. This was a major accomplishment requiring a thorough understanding of the difficult treatise. Her main objective was to make it available to scientists in France in their own language, but the work was not just a translation. It also contained additions and transpositions of ideas and is said to be more intelligible than the original work by Newton. Her book was written at a time when Cartesian philosophy was still dominant in France and when Newton had few supporters in Europe (Tee 1987, 21–25).

Since Gabrielle-Émilie was never to be invited to become a member of the Académie royale des sciences de Paris, she created her own academy: 'Les Émiliens', a Salon where famous philosophers and literary men and women met and disputed on many topics (Zinsser 2006, 116). It is interesting to note that she was invited to become a member of the Academy of Sciences of Bologna in 1743. This had been arranged by Father Jacquier, who was also overseeing the translation of her *Institutions* into Italian. Zinsser argues that, because Gabrielle-Émilie would have heard that the Newtonian Laura Bassi was also a member of the Bolognese Academy and a lecturer at the University of Bologna, she would have found it a great encouragement for persons of their sex to engage in and cultivate their knowledge of the sciences, as prejudices had excluded them since time began. It is believed that Laura Bassi used *Institutions* in her physics classes. This is very likely since an Italian translation was available as mentioned above. Gabrielle-Émilie appeared in some Italian books as an example of a woman scientist well into the 1750s and several years after her death (Zinsser 2006, 210).

Like Wollstonecraft, Gabrielle-Émilie du Châtelet believed that the absence of intellectual achievements of women in her period was due to the lack of opportunities to be educated. She herself was clearly the proof that, with a good education, women could accomplish great things (Frize 2009, 171–173). In her first independent work, the preface to her translation of the *Fable of the Bees*, Gabrielle-Émilie strongly advocated for women's education, especially higher education which was available for men in the French *collèges*. She argued that, by denying women a good education, society prevented them from practicing and becoming eminent in the arts and the sciences.

As for the legacy left to the world by Gabrielle-Émilie du Châtelet, modern biographers and historians see a true contribution with the principle she put

forward on the concept of mass and velocity: that energy is proportional to the mass times the velocity squared, a relationship she recognised 150 years before Albert Einstein. Gabrielle-Émilie Du Châtelet's principle was a correct assessment of the kinetic energy in classical mechanics and is the first term in an expansion of Einstein's mass-energy equivalence. In her work, du Châtelet and her colleagues found decisive evidence from the experiments of Willem Gravesande, a Dutch researcher. He had been dropping weights on a soft clay floor at different speeds and recording the indentation the object made in the floor. Gravesande noted that if energy was equal to mass multiplied by velocity, then a weight going twice as fast as an earlier one would sink twice as deeply. One going three times as fast would sink three times as deep. But instead he found that a small brass sphere sent down twice as fast as before pushed four times as deep into the clay. If it was flung down three times as fast, it sank nine times as far into the clay. This established the relationship of $e = mv^2$ (energy equals mass multiplied by the velocity squared). Du Châtelet also deepened Leibniz's theory and then embedded the Dutch results within it. Now, finally, there was a strong justification for viewing mv^2 as a fruitful definition of energy (pbs_Chatelet).

A main-belt minor planet and a crater on Venus have been named in Gabrielle-Émilie's honor and she was the subject of two plays: *Legacy of Light* by Karen Zacarías and *Émilie: La Marquise Du Châtelet Defends Her Life Tonight* by Lauren Gunderson. The opera *Émilie* by Kaija Saariaho concerns the last moments of her life (Wikipedia_Chatelet).

In 1749, Gabrielle-Émilie gave birth to a fourth child (a girl), believed to be fathered by her last lover, the Marquis de Saint Lambert. She had been quite worried about having a delivery at the late age of forty-two. The child was born while she was writing the final parts of her last book. She was writing as if her time on earth was limited, to finish what she regarded as her most important work. She seemed well after the birth, but infection set in and she died quite suddenly on September 10, 1749. The child also died soon after her birth. Voltaire ensured the posthumous publication of her last book in 1759, ten years after her death. It is still the only French translation of Newton's *Principia* to this day. In spite of this great achievement, recognition of Gabrielle-Émilie du Châtelet's substantive work was, as for many women who lived before and after her, largely ignored. Whenever she appears in traditional historical narratives, it is her liaison with Voltaire that justifies her inclusion, not her own deep understanding of Newton's natural philosophy and Leibniz's metaphysics, or even her own additions to these works.

Concerning their life together, Charles-Jean-François Hénault (1685–1770), a historian and friend of Voltaire wrote: I also stopped at Cirey. It is a rare sight. The two of them are there alone, plunged in gaiety. One writes verse in his corner, the other triangles in hers. The architecture of the house is romantic and surprisingly magnificent (O'Connor and Robertson 2013, from Besterman 1969).

The last example in this chapter of an 'exceptional woman' is the story of Cristina Roccati (1732–1797) who had much in common with Laura Bassi and with Elena Piscopia. Cristina was the third woman in the world to be awarded a

doctoral degree which she received from the University of Bologna in 1751. Cristina was eventually appointed to a teaching position in physics at the Academy of the Concordi in Rovigo. Like Laura Bassi, she was highly knowledgeable on Newtonian physics.

Cristina was born October 24, 1732, in an aristocratic family of Rovigo; this was in the famous year when Laura Bassi's defended her Theses and received her degree in Bologna. Cristina was the daughter of Giovan Battista and of Antonia Campo. A young prodigy, she studied literature, Latin, and Greek with her tutor Pietro Bertaglia di Arquà, who later became rector of the Rovigo Seminary. Cristina soon began to compose verses and her talent was so admired that, at barely fifteen, she was invited to attend a meeting of the Accademia dei Concordi in Rovigo and honoured as a poet! Like Laura Bassi before her, Cristina developed a strong interest in science and mathematics. No tutor is mentioned for Cristina on these subjects, so perhaps this is why she had to pursue her studies at a place of higher learning (*Scienza a due voci_Roccati*).

Students from Rovigo, located in the Venitian region, were expected to attend classes at a University in that region, so Padua would have been the logical choice for Cristina, and much closer to Rovigo than Bologna. But since the University of Padua no longer allowed women to be awarded a degree after Elena Piscopia's, Cristina received her father's permission to study at the University of Bologna. His permission was quite exceptional for the period (Findlen 1999, 320). Another reason for the choice of Bologna was that it had a great reputation and several well-know professors were teaching there. Moreover, Laura Bassi and Anna Morandi were giving classes for the University and Laura Bassi had been granted a degree at that institution.

On September 25, 1747, accompanied by her tutor, Signor Bertaglia, and her aunt (a chaperone), Cristina made her way to Bologna. She was the University's first non-Bolognese student and the first woman to study in classes with male students. Between 1747 and 1751, Cristina studied literature and classes on logic from Bonifacio Collina and geometry from Brunelli. She also took courses in metaphysics and moral/ethics; and while visiting the observatory, she learned astronomy and meteorology. Like Laura Bassi, Cristina decided to dedicate most of her time to the subject of physics (*Scienza a due voci_Roccati*).

However, Cristina followed a different path than her predecessors, in that she followed classes with men, as a regular student, whereas Laura Bassi and Maria Gaetana Agnesi were educated at home with tutors. Cristina also attended the private lectures that professors gave in their homes, accompanied by her aunt and sometimes by her tutor. She even attended classes at the Bolognese Institute of Sciences and was able to observe some of the scientific experiments carried-out there (Findlen 1999, 321).

On December 30, 1749, Cristina was invited to join as a member the Accademia dei Concordi. In 1750, she was invited to become a member of the Apatisti in Florence in 1750. There were more invitations after her degree as we see later in the chapter.

In 1751, Cristina defended four Theses in Latin. Her father had asked the University of Bologna if the defense could be held in the Church of Rovigo. The University agreed. This is one more case where a father used his daughter's success to elevate his own reputation and social standing, just like Piscopia's and Agnesi's fathers had done. Holding the defense in Rovigo would clearly show the town's elite and academicians how knowledgeable and brilliant his daughter Cristina was. This would also bring fame to the town of Rovigo.

After the defense, Cristina went back to Bologna to receive her degree in Philosophy on May 5, 1751. This had been her most cherished dream and her father's. At 18 years old, Cristina was the youngest and the third woman in the world to obtain a degree. After her degree, Cristina went to Padua to study Newtonian physics, Greek, Hebrew, as well as Cartesian mathematics and philosophy under a few of its professors (*Scienza a due voci*_Roccati) [Note: Padua allowed Cristina to take courses, in spite of the fact that they would not award degrees to women]. Her studies included Euclid's *Elements* and even Agnesi's *Institutiones*. Like Laura Bassi, early in her career, Cristina Roccati continued to write poetry and sonnets.

It is believed that Laura Bassi visited Cristina Roccati to congratulate her on the achievement of her degree. It is not known what was said between them, but it is likely that Laura offered some advice to the younger Cristina on how to manage her career in this male-dominated world of academia and science. Cristina's learning was highly praised and some poems were written in her honour. There was also an article by Medoro Rossi in the Literary News. The publisher Giovan Antonio Volpi wrote a sonnet and sent his piece to Francesco Maria Zanotti at the Institute (Findlen 1999, 327).

While studying in Bologna and Padua, Cristina rarely returned home to Rovigo. She was on her way to becoming another Laura Bassi. However, her life and ambition changed completely when her family lost its fortune following an accusation against her father of pilfering the coffers of the Sacro Monte di Pietà, a municipal not-for-profit pawn shop. This forced Cristina to move back to Rovigo in May 1752, barely a year after having earned her degree. Her father fled town when the accusation was made against him. It is possible that he had 'borrowed' the money to help pay for Cristina's expensive education. The family survived through the sale of books in their library to Cristina's long-time friend Girolamo Silvestri (Findlen 1999, 331).

In her original plans, before the financial ruin of her family, Cristina had wanted to write on scientific topics and be involved in research, like Laura Bassi. But she was unable to follow this path after her family's dishonor and poverty. After 1752, the Roccati name became infamous because of her father's bad reputation in the town of Rovigo. Cristina continued to study on her own and began to give lectures at the Accademia dei Concordi in Rovigo for 27 years. Her teaching did not cover all aspects of physics. For example, she did not include fluid mechanics, since it required calculus and probabilistic mathematical approaches. However, she was very knowledgeable in chemistry and geodesy. Cristina did not have access to a laboratory or to equipment in Rovigo, so she was not able to perform experiments,

an access she would have had in Bologna. Teachers in Bologna could perform experiments on electricity, fluid mechanics, and air to support the theory they were imparting to their students. Instead, Cristina Roccati made good use of diagrams to illustrate her points, as shown in the material and texts of the lectures she left behind. This was quite adequate for teaching mathematics. Fifty-one lectures of the fifty-four that Cristina delivered on Newtonian physics between 1752 and 1777, when she retired, survive in manuscript form to this day (Wertheim 1995, 140; Findlen 1999, 336). Similarly to the rules in the Bolognese academy, the notes for each lecture at the Academy of the Concordi had to be deposited in writing on the day of the lecture, which Cristina had done for each lecture she gave.

In her 44th lecture, Cristina encouraged her audience to learn geometry in spite of their phobia of mathematics. She argued: "All the sciences have certain subjects which are murky, arid, and dry. However, they will open a path to the understanding of more beautiful and delightful things, however difficult" (Findlen 1999, 344). This could also be said today to students who find some subjects dry and boring!

A Two years after Cristina's degree, she was invited to become a member of the Academy of the Arcadia in Rome, using the name Aganice Aretusiana. In the same year, she was invited to join the Accademia degli Ardentis in Bologna and the Accademia dei Ricovrati in Padua. Cristina was elected president of Rovigo's Accademia dei Concordi in 1754, just four months after the pardon of her father on August 7, 1754. After her father's death in 1755, she was renewed in this position despite the fact that the normal term was only one year. In view of the fact that the executive committee was all male except for her, she did not attend the private meetings of the assembly which presidents normally attended; she passed the role to someone else for these meetings in order to maintain the image of a virtuous Christian noblewoman. However, she attended the public debates, and other women were usually present for those (Findlen 1999, 331–335).

By the time of her death in Rovigo, on March 16, 1797, Cristina Roccati was practically unknown, even by her own compatriots. The oration for her death was given and published by the Concordi almost twenty-years after her death. During her life, she had demonstrated a passion for sharing knowledge; she rejected Aristotelian and embraced Copernican and Newtonian philosophy as well as the new scientific method. Her professor of astronomy and mathematics in Padua compared Cristina to Laura Bassi and to Gaetana Agnesi. Cristina, like Laura Bassi before her, had several detractors during her teaching career, especially within the Academy of the Concordi. Some the members resented her election as president and revolted, leaving the academy and trying to create their own separate one. But later, they returned and her role as president ended quickly. After 1756, she never held another office position at the academy, nor did she ever attend private meetings of the members. She did give lectures in physics and read these at the public assemblies (*Scienza a due voci_Roccati*; Findlen 1999, 336).

There were more examples of extraordinary women in the Italian Peninsula in the eighteenth century. Born in Naples, Giuseppa Eleonora Barbapiccola

(1702–1740) was a poet and natural philosopher. She translated René Descartes's *Principles of Philosophy* from French to Italian in 1722. She was a member of the Accademia degli Arcadi in Bologna under the name *Myristic*. She often published her poems in collaboration with her friend, the poet Luisa Vico. In her translation of Descartes' work, Barbapiccola claimed that women, in contrast to the belief of her contemporaries, were not intellectually inferior by nature, but because of their lack of education (Ogilvie 1986; Findlen 1995, 174–176). Findlen also mentions two other Neapolitan women: Faustina Pignatelli (died in 1785), princess of Calubrano, was the second woman, after Laura Bassi, to become a member of the Academy of Sciences of Bologna in 1732; she wrote a dissertation titled *Problemata Mathematica* (1734) (Scienza a due voci_Pignatelli). The other was Maria Angela Ardinghelli (1730–1825) who became known in part for her brilliant translation of Stephen Hales works. She was a contemporary of the famous Laura Bassi, Maria Gaetana Agnesi, and Anna Morandi Manzolini (Scienza a due voci_Ardinghelli).

The next chapter provides examples of women who worked in the fields of health and medicine in nineteenth century Italy. Some women defended Theses and were awarded a doctoral degree, several of whom were at the University of Bologna. But these women were given much diminished career opportunities. The professional life of women changed for the worst at the end of the eighteenth and the beginning of the nineteenth centuries in Italy. The enlightened ideas, actions, and uniqueness of the Italian experience in the recognition of its exceptional women in the eighteenth century disappeared with the new political scene, beginning with the Napoleonic occupation in Northern Italy, and later on with new laws on education passed by the new government of a unified Italy in Milan. Italy only re-opened its university doors to women in the latter part of the nineteenth century, at a time when most of the western world also did this.

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Chapter 11

After Laura Bassi: Women in Science and Health Careers in Nineteenth Century Italy

This chapter discusses the political changes that occurred in Italy during the early part of the nineteenth century and how these had a negative impact on the access of women to post-secondary education, the awarding of degrees to women, and to potential careers women could have. The chapter presents a short biography of seven women who worked in the fields of science, medicine, and pharmacy. Several of them earned a degree while others learned as apprentices in a field of interest. Each of these stories demonstrates clearly that these women were not provided career and work opportunities that matched their talent and their education. Their professional life and career was severely limited by the political environment in Italy at the time.

After the success stories of the eighteenth century in the Italian Peninsula, of women learning science and mathematics, and being recognized for their talent and knowledge by society and academics in their region, it would be expected that bright women who came after them would find an easier path to a promising career in these fields. Laura Bassi, Maria Gaetana Agnesi, Anna Morandi Manzolini, and Cristina Roccati had made notable contributions to advancements to the fields of physics, anatomy, and mathematics. Du Châtelet, Bassi and Roccati had embraced and disseminated the new science of Newton and discarded the Aristotelian and Galenian approaches. The academies had witnessed the teaching of science, mathematics, and anatomy by women in Bologna and in Rovigo, and heard many dissertations presented on research results by Laura Bassi.

Between 1796 and 1815, the University of Bologna conferred six degrees to women: one degree was in law, while the others were in health sciences and medicine. Although it would be logical to think of this as progress, six new degrees in 19 years, reality was very different; conditions worsened for women in 1803: Women with degrees could not follow career paths that included teaching and research. The change coincided with the occupation of Bologna by Napoleon's French army that began in June 1796. The French replaced the local administration which had been under Papal governance. In May 1797, Napoleon abolished the Bolognese Senate, an institution that had been fairly autonomous during the papal authority. The Senate had control over the university and determined its role in the realm of higher education. Bologna became the regional capital of the Reno

Department that belonged to the Cisalpine Republic with its administrative centre located in Milan. The Senate was never reconstituted, even after the return of the papal government in 1815. The College of Medicine which had licensed all physicians, men and women, was abolished in 1798. There was a brief return of the Austrian rule between June 1799 and June 1800, and this brought back some of the old culture; but after the Melzi reform of 1803, all changed for the worst for women and their access to higher education (Logan 2003, 510).

An important factor that added to the obstacles for women's education in the nineteenth century was the fact that Prospero Lambertini (Pope Benedict XIV), the man who had been instrumental in the honours and academic positions offered to Agnesi, Bassi, Manzolini, and Roccati had died several decades ago, in 1758. After his death, no other influential man replaced him in the support of exceptional women. Progress for women's access to education and public roles has always depended on the attitude of people in power and has been cyclical throughout the ages, with progress often followed by regress.

The most pernicious political influence came from the reform of universities brought about on October 1st 1803 with the document titled *Piano degli Studi* (Plan of studies), which was approved by the vice-president of the Italian Republic in Milan, Francesco Melzi. The reform eliminated Aristotle from the curriculum and replaced it with experimental sciences; it also brought the Institute of Sciences under the control of the University of Bologna; the latter took over all the courses and all the laboratory equipment (Logan 2003, 511). The Institute had been far more open to having women in its midst than the university, as we saw in earlier chapters. Several women from France and Italy had been invited to join as members of the Bolognese Academy of Sciences during Bassi's time. The control of the Institute by the patriarchal University of Bologna resulted in barring women from any further academic role in the city of Bologna. The Edict also led to the demise of the Benedettina. All members of the Institute who did not have a teaching position at the university by the year 1800 were now without a job and without an income (Logan 1999, 636).

The Ministry of Public Instruction and the Government in Milan wanted to reform medicine and health care at all levels. They were definitely not concerned by women's education (Logan 2003, 510; 1999, 631). It is in the fields of medicine and health care that most of the women earned their degree in this period. Although women received a similar education than the men, they were not allowed to pursue a real academic career like the one achieved by Laura Bassi in the previous century. We now examine the studies undertaken by women who obtained a degree between 1796 and 1815, and the positions they were allowed to occupy after receiving their degree. A few examples of women working in science or health care without a degree are also presented.

Maria Dalle Donne (1778–1842) was born in a family of day labourers in Roncastaldo Bolognese, a village just outside Bologna. She was brought up by a priest, her father's cousin, who taught her Latin. Her talent and early education came to the attention of a physician, Luigi Rodati, who took her with him when he moved his practice to Medicina. Rodati taught Maria the classics and how to speak

and write in Latin. His hope, as mentioned to a friend in 1789, was to create a second Laura Bassi. Rodati eventually moved to Bologna with Maria Dalle Donne. He was given an academic appointment to teach botany, and later pathology and legal medicine at the University of Bologna. While in this city, he hired the Head of Physics at the Institute, Sebastiano Canterzani, to teach philosophy to Maria. Among professors who soon volunteered to teach her were the experimental physicist Giovanni Aldini, the pathologist Gaspare Uttini, and the anatomist, surgeon, and obstetrician Tarsizio Riviera. Rodati encouraged Maria to study medicine at the University of Bologna. She defended her Theses on December 19, 1799 in the anatomical theatre at the Archiginnasio, accompanied by the lecturer of elements of the Greek language, Clothilde Tambroni. Maria disputed on two topics given to her 4 h prior to the defense. Maria Dalle Donne was the first woman to be awarded a degree in medicine in Italy. This was under the Austrian Regency. Because her defense occurred before the reform of 1803, she was allowed to follow the same procedure as Bassi and Roccati (Logan 1999, 632–633; 2003, 517–524).

On May 23 and 24, 1800, Maria defended another set of sixty Theses on anatomy and physiology and another set of sixty Theses on universal medicine that included surgery. On May 29, 1800, she defended another set of Theses in obstetrics. These defenses all took place in the Church of San Domenico. The goal was for Maria to obtain a license to practice medicine and to teach this subject at the university. This did not happen. Since the death of Pope Benedict XIV, no woman was offered a lecturer position at the University of Bologna. However, Maria Dalle Donne was offered the extraordinary membership in the Benedettina on May 31, 1800 and a stipend of 150 lire. She was the second woman to be accepted in this special group after Laura Bassi. Although this honour did not provide a teaching position, it gave Maria funding and access to the laboratory to carry-out research and the opportunity to present her work in the form of dissertations on a yearly basis as Laura Bassi had done. Help also came from Count Prospero Ranuzzi Cospi, an amateur physicist, in the form of an annuity of fifty sequins (zucchini in Italian, approximately 7 lire when it was first coined in 1284), which had been doubled by the time of her death. Cospi also bequeathed his physics cabinet to Maria in his will. Being unmarried, Dalle Donne was in great need of an income (Logan 1999, 634; 2003, 519–520).

During her three years as a Benedettina, Maria presented four dissertations at the Academy of Sciences of Bologna; two were presented while her teacher Riviera was still alive, on the topic of cancer; the other two were in the field of chemistry; the last two dissertations were titled *On Combustion which Took Place in Vacua* and *On the Use of Albumen Found Recently in the Poretta Spa*. None of her manuscripts have survived and none were published in the journal of the Institute, so it is not possible to assess her research in detail. Maria received her degree and membership in the Benedettina during the Austrian Regency in Bologna. When the French returned to occupy Bologna after June 1800, they reconfirmed her appointment and her pension in the Benedettina. This is probably because she had already presented some of her work at the Academy. The Decreto

Melzi of October 1803 terminated Maria Dalle Donne's career in science and medicine (Logan 2003, 520).

So what happened to Maria Dalle Donne after 1803? She lost access to the laboratory and the opportunity to present her work to colleagues at the Institute. The republican government in Milan offered Maria the directorship of the school for midwives, which was to be located outside of the university, preferably in a hospital within the city. However, the hospital facilities for the school for midwives never materialized, so Maria Dalle Donne had to teach at home for the next thirty-six years. Her course was likely started in 1805, and consisted of one year of theory followed by six months of practice under a qualified midwife. Then her students were ready to take the exam set by the Faculty of Medicine and Surgery to obtain a certificate to practice (Logan 2003, 522).

Dalle Donne's students were less well-educated women than Laura Bassi's and many of them were illiterate when they started the course. The Melzi reform reduced Maria Dalle Donne, a highly qualified natural philosopher and physician, into a low level position as instructor of future female practitioners in midwifery. All the courses in medicine and surgery at the university were taught by men to all male students. It was now these men who decided, through an exam, if a woman was sufficiently trained to be awarded a certificate and a license to practice as a midwife (Logan 2003, 522).

In 1824, the Papal Government in Rome regained control of the University and its Institute and reinstated the Benedettina, but Maria was not invited to rejoin. It is not clear why Maria never practiced medicine, as she was listed in the rolls of the licensed physicians of Bologna at the time and she would have been able to establish a private practice. She never did (Logan 1999, 639; 2003, 511) Logan writes that Dalle Donne's teacher, Tarsizio Riviera, Chair of Obstetrics in Bologna, probably never intended her to practice medicine in the same way that he and other past chairs had done: as students, and then as physicians practicing surgery at Bologna's Hospital S. Orsola; Dalle Donne did not seem to have been given this privilege. In his *Sopra l'indole morale e fisica delle donne* (1796), Riviera wrote that "a woman's imagination was vivid, but empty, full of images, but poor in thought." He also stopped midwives training at the Institute, alongside surgery students, a practice initiated in the past by Benedict XIV (Logan 2003, 521–522).

Another woman from the Bolognese working class, Maria Mastellari Colizzoli Segà, received a medical degree during the French occupation. Maria Mastellari was born in Bologna in 1770, the daughter of a master mason who was working at the Institute of Sciences. She was admitted in 1803 in the second year of medicine at the University of Bologna. This was done without an exam when Maria was thirty-three years old, the widow of a physician (Giovanni Andrea Colizzoli Segà), and the mother of two children. Her admission implies that she had met the equivalence of the first year of studies in that field. Perhaps she had studied privately with Riviera, like Dalle Donne, or with her husband (Logan 1999, 639–640; 2003, 525).

A year and a half after her admission, on June 14, 1805, Maria Mastellari passed the advancement exam which was given at the end of the third year of

medicine. One year later, on June 2, she took her fourth year exam, which required responses to four questions on the topics of pathology, clinical medicine, and *materia medica* which dealt with the action of foods and medicine on the body; the fourth medical topic was not announced in advance. All students who wanted a license to practice medicine had to do a fifth year consisting of actual practice. But Maria was told she did not have to complete this fifth year. She was awarded a degree in June 1806. It was said at the time that she held the same rights as all those who received the degree. However, without the year of practice and its examination, her four-year degree would not qualify her to practice medicine. Maria Mastellari's name never appeared in the list of physicians licensed to practice in Bologna. It is possible that Maria was discouraged from taking this final step or perhaps she was not allowed to do it. There may not have been a position considered suitable for a woman at the time, such as the one provided to Maria Dalle Donne. Maria's degree can perhaps be looked upon as a reward or recognition for her excellent accomplishments during her studies (Logan 2003, 526–527; 1999, 640). Little is known about why she did not complete the final year and its examination, which would have allowed her to have a private practice in Bologna. Maria died in the same year as Maria Dalle Donne, in 1842.

The next two examples are a mother and her daughter. Maria Maddalena Petracchini (1759–1791) was the mother of Zaffira Ferretti (1785–1817). Both women received a degree in surgery. Maria Maddalena's husband, Francesco Ferretti, was head surgeon in the hospital of Bagnacavallo in the province of Emilia-Romagna. It is probable that he taught medicine and surgery to his wife, to his daughter, and to his son. Maria Maddalena was born in Florence, and after learning surgery with her husband, she studied obstetrics under professors Lorenzo and Angelo Nannoni in Florence in 1788. She continued her studies and obtained her degree from the University of Ferrara, likely in 1789, in the year she published her work: *Memorie per servire alla fisica educazione de' bambini* (Memoire on the physical education of children). This work shows that she was in favour of breast feeding and of daily bathing of the child. She also discussed the importance of exercise, and she was against the swaddling of babies. After she left Florence in 1788, she saw patients (children) independently from her husband (Logan 1999, 641; 2003, 527–528). Maria Maddalena died shortly afterwards, aged thirty-two, in 1791, when Zaffira was only six years old.

Maria Maddalena's daughter, Zaffira, studied surgery with her father and probably assisted him in his duties at the hospital in Bagnacavallo. In May 1806, he was asked by the Government to provide a massive vaccination program against smallpox. His daughter Zaffira received a degree in surgery from the University of Ferrara on November 20, 1808. Later, Zaffira and her father applied for her license to practice directly to the Ministry of Public Instruction in Milan. The Ministry would have undoubtedly heard of Francesco Ferretti, at least through his help with the vaccination program. It ordered the University of Bologna, on September 19, 1808, to set-up an exam for Zaffira. On November 14, Zaffira was questioned on surgery, surgical institutions, obstetrics, anatomy, *Materia Medica*, legal medicine, and pharmaceutical chemistry. This examination was more extensive than the one

taken by Maria Mastellari for her degree in medicine. Zaffira succeeded in two-thirds of the exam, which was sufficient to obtain the degree. She had done her practice year under the supervision of Giuseppe Atti at the Surgical Clinic of the University of Bologna; this helped her to prepare for the examination administered by the eleven professors from that institution. Zaffira passed her exam on May 15, she was given a license to practice medicine from the University of Bologna on May 16, 1810 (Logan 2003, 528–529; 1999, 642–643).

After her degree, it is believed she continued to assist her father at the hospital. When he became seriously ill and died, Zaffira was not appointed to his position. Instead, her father was replaced by the Podestà of Bagnacavallo and so she found herself without employment and in financial straits. The government in Milan sent her to Paris, perhaps for further training, and then she moved to Ancona where she was supposed to be the surgeon in charge of a school for midwives. However, she left Italy and moved to Turkey, living for a few years in Petrasso, where she died in 1817. Like Dalle Donne before her, it is possible that Zaffira was not given the space and the tools she needed in Ancona to carry-out her responsibilities. Surgeons need a hospital and tools to practice. Perhaps few women showed up to train as midwives (Logan 2003, 530). As mentioned previously, there was little support for women at this time in spite of their extensive competence and knowledge.

Sabina Baldoncelli was born in Bologna in 1781 or 1782. When she was twelve or thirteen, her father died and her mother soon remarried. Sabina ended up in the orphanage of the Putte dei Mendicanti di S. Caterina di Strada Maggiore. The orphanage pharmacy was run by Margarita Trippi since 1796. Although Trippi was examined by the College of Medicine of the University of Bologna, and she passed the exam, she was not awarded a degree; however, she was given a license to practice during a ceremony at the Church of San Matteo. Baldoncelli studied three years under Trippi, and later under Francesco Maria Coli, a professor of pharmaceutical chemistry at the university. She learned *Materia Medica* with professor Ungarelli and botany with professor Scannagatta. In her petition for the degree presented to the Public Instruction Office in Milan, she asserted having received the same education as the male pharmacy students at the University; in addition, she had three years of practical experience, something male students were not likely to have (Logan 2003, 530–531).

Baldoncelli was given the permission to take the examination in pharmacy, but if she was granted a license to practice, her work had to be restricted to the pharmacy at the orphanage. She was not allowed to practice anywhere else in the city of Bologna. She received her degree during the Napoleonic period and had to do another year of practice at the orphanage. After passing the oral and experimental parts of the exams, she was listed as a qualified pharmacist for the province of Bologna and practiced her profession at the orphanage pharmacy until 1846 (Logan 2003, 532). Once again we see a severe restriction put on a qualified woman's professional role. There was no basis for these decisions except obvious discrimination based on sex.

Teresa Passerini Monari was also born in Bologna. She was the only woman who received her degree soon after the reinstatement of the papal government in the city. Teresa was awarded a degree in dental surgery in 1818, after the death of her husband. At the time, she resided in Imola where her husband's dental practice was established. When her husband became too sick to practice, she took it over during the last years of his life. She was so successful that there was a general demand for her to continue after his death. Local physicians and surgeons wrote letters of recommendation to accompany the petition she submitted to be examined for a license to practice. She was known for using the most modern instruments and she even modified and improved some of them. The papal government eventually allowed the degree in dental surgery to be awarded to Teresa Passerini Monari (Logan 2003, 533).

After the six women presented above, no other woman was given credentials to practice in the health care field in Italy until 1884. Logan wrote that there may have been a few women receiving degrees in other fields than medicine in Bologna after 1803, but she admits that looking at lists of graduates in several fields from the University of Bologna is a daunting task, and some information may be missing. Logan concludes: "According to the surviving lists of the period, which may be incomplete, no other degrees were awarded to women in any field. (See Allegato: Elenco di figure femminili collegate alla Storia dell' Università di Bologna, in *Alma Mater Studiorum* (n. 3), pp. 207–214, esp. p. 213 n.; in Logan 2003, 533).

There are several reasons for the absence of women obtaining degrees in Bologna between 1825 and 1874. First, Latin was reintroduced as the language of examination and this may have deterred many women. Moreover, it is possible that the authorities and intellectual elite in Bologna were no longer interested in promoting women for university degrees. There was no longer a need for exceptional women to gloss over the city and its university. Moreover, the men were busy with issues surrounding the unification of Italy. Conditions in Bologna deteriorated for women in medical fields, except for midwifery, when the elite of the city lost control of the university and their related institutions like the Academy (Logan 2003, 535). The Bonghi Law of 1874 finally opened the door of higher learning to all women in Italy. But this was happening everywhere else in Europe and North America, so Italy was no longer a unique environment for brilliant women.

In the early part of the nineteenth century, a few women were involved in science in Italy. Caterina Scarpellini (1808–1873) was born in Foligno in the Papal States. She moved to Rome in 1826 and became the assistant of her uncle, Feliciano Scarpellini (1762–1840), an Abbott and astronomer who created and directed the Campidoglio Observatory in that city. While in Rome, she met one of Feliciano's students, Erasmo Fabri. After their marriage, he took the name Scarpellini since she was from a higher social class than he was. Caterina was the dominant figure in their partnership and the principal contact with foreign scientists. There is no evidence that she was paid a salary or recognized as an assistant to the Director, and even though she was highly educated in the field of astronomy, no degree was ever given to her. Caterina had extensive knowledge of the solar

system, which included the eclipses of 1860 and 1867, the appearance of comets, of Saturn's rings, of the asteroid belt, of the constellations and their stars. When her uncle died in 1840, the Papal Government bought the instruments from the Scarpellinis, but left the couple in their position at the Observatory. But they chose a new Director, Ignazio Calandrelli, who had a teaching position at the university as a professor of astronomy (Logan 2005, 198–199).

Catarina published two articles: The June 1857 article in *Corrispondenza Scientifica* was based on a dissertation she had presented at the Academy of the Quiriti, which she had been invited to join in 1854. The article dealt with contemporary science in the Papal States in which she described the latest optical instruments from Russia and from England. These instruments had also been acquired recently by Campidoglio and by Collegio Romano in Rome (Logan 2005, 200). It was helpful that her husband was the founder and director of the *Corrispondenza Scientifica*. The journal was printed free of charge by the Papal Government's printing press until 1861, after which it received some help, but suffered financially. Gaps in the publication appeared as early as 1849 and increased considerably in the 1860s and 1870s (Logan 2005, 201).

Caterina Scarpellini's article in 1860 in *Bullettino Nautico e Geografico* discussed instrumentation used to measure magnetic variation, atmospheric electricity, pressure, humidity, temperature, and direction of the wind. Caterina published ozone levels she had measured and many other important data. However, she was never accepted as a member of the Pontifical Academy of the New Lincei in Rome which had been re-started by her uncle, even though she was considered qualified enough in science to have been elected a member of the Accademia dei Georgofili in Florence. When the Lincei became a national Italian institution, no women were accepted as members, just like the academies in London, Paris, and everywhere else.

Caterina collaborated with other scientists, among whom there was Lambert Alphone Jacques Quételet, the permanent secretary of the Academy of Sciences of Brussels, who made frequent contributions to the journal. In 1850, he had sent a paper on his observations on the influence of atmospheric pressure on atmospheric electricity, which Caterina published in 1851. In 1852, she wrote a summary of his notes on atmospheric waves. In 1855, she printed his notes on the effect of the Aurora Borealis on telegraph wires and his ideas of the effect of temperature on vegetation growth (Logan 2005, 203–204).

There is so much more to say about Caterina Scarpellini's research contributions, her impeccable scientific methods and excellent data acquisition and interpretation. More can be found in Logan's (2005) article and on the website of *Scienza a due voci*.

As mentioned above, after the Bonghi law of 1874 in the Italian Republic, all women could attend university in Italy. But we must remember that first Padua, and then even more so Bologna, were unique in the recognition given to exceptional women in the eighteenth century in the form of doctoral degrees, teaching positions, and membership in academies. No other country in the world had the courage and boldness to do so before the late 1870s.

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Epilogue

Laura Maria Caterina Bassi-Veratti, a prodigy and an ‘exceptional woman’, was awarded a degree following the defense of many theses on science and philosophy topics. Along with this achievement, she was provided with honours: a membership in the Bolognese Academy of Sciences, and a Lecturer position at the university. Although these appointments were meant to remain honorary, Laura turned them into career opportunities and she taught and did original research in experimental physics for thirty years. Laura embraced Newtonianism from its early days, repeating the light and colour experiments, and becoming familiar with Newton’s *Principia*. In 1776, she was appointed to the Chair in physics, which today would be similar to a full professor position. Laura Bassi was the first woman in the world to hold such a position and she was the highest paid academic at the University of Bologna. Considering that women could not even attend as students in most parts of the world in the eighteenth century, this was definitely an amazing feat both on her part and on the part of the powerful men who supported her career and her ascent.

It must be remembered that Laura’s path was not an easy one. She had to prove her abilities and knowledge at each and every step of her progress towards the career and work in science that she dreamed of. She was taken seriously by many of her peers and colleagues, but she also faced several detractors throughout her professional life between 1732 and 1776. Contemporary men who worked on important topics as she did, like Luigi Galvani and Alessandro Volta, are still remembered today. But how many people know Laura Bassi? She was well-known while she lived, but soon forgotten after her death. When I visited the church of Corpus Domini in Bologna, to visit her place of rest, there was a plaque outside the church stating that Galvani’s remains were in this Church. Inside the Church, his tomb was clearly marked, easy to find. But going around the entire church, I did not see a plaque or an indication of where Laura Bassi’s tomb was, although I was told that her body was laid to rest in this church. I asked the nuns who had just finished attending a service, but none had heard of Laura Bassi and they did not know where her remains were. I also asked the caretaker of the church, but he had never heard of her. It was only on my second visit in 2012, when Professor

Cavazza mentioned where her tomb was, that I finally discovered it. It is under the floor in the middle aisle of the Church, and a main pathway for church goers. The letters bearing her name and others buried with her have paled over the years. It would have been more appropriate for her remains to lie, like Galvani's, in one of the chapels in that Church, with a clear plaque and an epitath.

To summarize Laura Bassi's career, she is an important example of a woman who broke the mould imposed on her sex for thousands of years. Laura received the same humanistic education as contemporary men. As a prodigy, she showed early interest and abilities in philosophy, science, mathematics, languages, and rhetoric. She was one of the earliest Italian philosophers to become interested in Newtonian physics and in the new mathematics (calculus). She made the transition from humanism and literature to science during the years that followed her Theses defense in 1732. She strongly believed in the value of experimentation to demonstrate concepts and principles. Laura made the transition from the 'old science' to the 'new science'.

Laura Bassi was the second woman in the world to be granted a doctoral degree, and she was definitely the first woman to obtain a paid lecturer position in a university. In spite of having had nine babies (five of whom survived infancy), and possibly twelve pregnancies, she was seriously engaged in her work in science throughout her entire adult life until the day she died. She had attended a meeting of the Academy of Sciences of Bologna on the evening before her death.

Laura Bassi built a successful career, step by step, in spite of her opponents and detractors. She used her powerful friends and patrons when needed and managed to eliminate barriers put in her way. She was determined from a tender age to be involved in the type of science that would help her city and her community. Her curiosity and energy were boundless and led her to work on several science problems that would be useful for her city and its people.

Her reputation reached far and wide during her lifetime. Famous men knew of her; in their letters, they showed much respect for her knowledge and talent. However, it is unfortunate that her life and work did not open doors to other women. In fact, the University's intent had not really been to open the door to women in general when they provided Laura with a position, and later with a Chair. Both the University and the City benefitted greatly from the extraordinary talent she publically displayed, which increased their profile and their fame all over Europe. But Laura also took advantage of opportunities offered to her and developed a lifetime career that reached much beyond the honorary role they expected her to be satisfied with. She developed a strong curriculum on experimental physics and taught these classes for thirty years. Laura and her husband acquired important tools and instruments to carry-out scientific experiments, enabling her to publish results on original work in areas of science that were 'hot topics' in her time and in her city.

Following Laura Bassi's exceptional career, it would take over one hundred years before a woman reached similar heights; Marie Curie was awarded a Nobel

Prize in 1903. In Bologna, in the years following Laura Bassi's death, the women who either obtained a degree or worked in science, pharmacy, or medicine without the degree were not provided the position or the recognition they deserved. These women were kept in subordinate roles and were not able to perform to the height of their capabilities and their full potential.

On several aspects of the personal life of the women whose work in science was recognized in Bassi's time, there is a wide gulf. Notions of women's virtue in both France and the Italian Peninsula were ambiguous. In France, Gabrielle-Émilie du Châtelet had several lovers, which was a common occurrence for women in her social class. Among her lovers we find Richelieu, Voltaire, and the Marquis de Saint-Lambert who is said to have fathered her fourth and last child. Her husband had his own affairs. The main point was discretion, especially when husband and wife were in the same city (Zinsser 2006). Of course, King Louis XV was a prime example of men with loose morals. In Italy, there was also a paradoxal situation, with a strong religious morality, yet with the existence of the *cicisbei* in the eighteenth century. A *cicibeo* was "the cavalier servant who openly kept company with a married noblewoman, not only in public, but also in private" (Bizzocchi 2009, 35). *Cicisbeismo* was seen by certain authors as innocent men accompanying women to the theatre, *salons*, and parties. To others, it connected the gallantry of the *cavaleri servanti* to the sociability of conversations and salons. To others it was a response to arranged marriages and the lack of freedom in choosing a spouse; in these cases, *cicisbeismo* offered a "controlled outlet for impulses of physical attraction, friendship, and sympathy" (Bizzocchi 2009, 38). This practice was not an option for Laura Bassi and Gaetana Agnesi as they were not aristocrats and both were said to be highly virtuous women. Bassi and Agnesi would not likely have had the support of Pope Benedict XIV if they had not been known to be virtuous and pious.

As Gabriella Berti Logan wrote in *American Historical Review*, "What made Bassi unique was that she made use of rewards, that would normally have remained symbolic, to carve out a position for herself in the scientific community of her town and to contribute to its intellectual life through her research and teaching" (Logan 1994, 811).

Sadly, Laura died quite suddenly on the morning of the February 20, 1778, of what Fantuzzi called *attacco di petto* (an attack in the chest); at the time, this vague medical term may have referred to a number of conditions such as a heart attack, pulmonary emboli, or attack of apoplexy, among others. Laura was sixty-six years old. Fantuzzi mentioned that she had been weakened over time by several illnesses and by her numerous pregnancies and childbirths.

For her funeral, silver laurels were placed on her head and her body was accompanied by the members of the *Benedettina* of the Academy to the church of Corpus Domini where she was interred. Fantuzzi mentioned that this great loss was barely two months after another, that of Francesco Maria Zanotti in December 1777 (Fantuzzi 1778, 16–17).

We may wonder if Laura's children followed in her footsteps. Her last son Paolo is the only one who did. Giovanni Veratti (1738–1800), the first born to the couple, lectured on moral theology and on the Scriptures. He was a canon and dignitary custodian of the San Petronio church, where his parents had been married. In addition, he was Vice-Rector of College Montalto. He named his brother Paolo and Paolo's male descendants as heirs in his will. In the archives in Bologna, there is a sonnet written in honour of Giovanni's doctorate in 1761 and a list of the books he left to Paolo and his sons (Busi 2001, 303).

The second son Ciro (1744–1827) married Maria Anna Margherita Cappi in 1772. They had no children. A third son, Giacomo (1749–1818) took the habit of the Fathers of the Oratorio di San Filippo Neri and was a canon in the Basilica of San Petronio, like his older brother Giovanni. He is said to have been very close to his brother Paolo, supporting him during Paolo's family-related problems. In the family archives, there is a list of furniture and other belongings that Giacomo left to his brother Paolo (Busi 2001, 303). Caterina (the fourth girl with this name, and the only one who survived infancy) was born in 1750. She became a nun and died at age eighteen (1768).

Paolo (1753–1831) married Maria Marchesini in 1781. Maria was born in 1757. They had five children, four of whom survived infancy: Giuseppe (1783–1816) married Anna Mondini and they had a girl (Margherita) and a son Carlo (1807–1881) who became a pharmacist. This profession was passed down from father to son for several generations. Paolo's second son, Gaetano (1786–1828) was a lawyer, like Laura's father. He married Luigia Marconi and they did not have any children. Paolo's third son Francesco (1788–1831) became a doctor like his grandfather Giuseppe Veratti and his father Paolo. He married Adelaide Marchesini and they had two children: a son Giuseppe who also became a doctor and a daughter Leonida, of whom little is known. Paolo's only daughter, Laura Maria Caterina Anna was born in 1793. She married Giorgio Benati di Imola and no children are listed for the couple (Busi 2001, 303).

Like his parents, Paolo undertook an academic career. He lived under the reflection of his mother's image, always citing the most significant moments of her life and of her professional work. He worked since an early age in the physics laboratory headed by his parents at the Institute of Sciences of Bologna where he studied philosophy and medicine. Then he spent some time at the school of Doctor Gaetano Uttini in whose house was held semi-public disputations. Paolo entered the Academy of Sciences as a student in 1773 and obtained his degree in philosophy and in medicine on June 20, 1780. In an assignment, he investigated the bovine disease that raged in the countryside. He presented his findings at the University of Bologna in 1785 and in 1786, following the several memoirs he had written. He was named as a replacement (substitute) professor in experimental physics for the course of Prof. Sebastiano Canterzani (the professor who took over the other section of the Chair in physics and mathematics when the Chair formerly held by Balbi was split as mentioned earlier) (Busi 2001, 304).

Paolo was never appointed to the Chair in physics that his mother held and to whom his father was appointed after Laura Bassi's death. At this time, his financial situation was dismal, so he applied for some financial help to the *Opera Pia dei Poveri Vergognosi*, a charity organization that offered financial help to the poor. Paolo obtained an amount sufficient to enable him to pursue his career and to take care of his family.

In 1793, Paolo was appointed lecturer in medicine at the University of Bologna and gave his first lecture at the Anatomical Theatre, where his mother had also taught. He was also elected to the still existing *Benedettina*, like his parents. In 1796, he became associated with the College of Medicine, and in 1799, with the College of Philosophy. By this time, he had attained the highest stage of his career, recognition, and financial stability. But the arrival of the French army changed all of this. The College of Medicine and all institutions linked to this profession were suppressed. The same fate happened to the Pontifical College of Montalto where Paolo was a teacher of physics. In 1803, with the establishment of the new university rules, Paolo was not considered for an appointment to a Chair; he was only asked to substitute for other professors and was given the position of guardian of the laboratory of experimental physics (Busi 2001, 305).

Paolo's situation improved between 1804 and 1807, as he began to give public lectures on experimental physics at the University, replacing regular professors when they were absent. In 1808, he gave the complete course of lectures in that subject because the Chair was vacated by its previous holder. In 1812, the Santa Lucia secondary school was created in Bologna and needed professors to teach elements of physics, chemistry, and natural history. Paolo remained in the Chair position in this institution until it was abolished. During this time, he ensured students had access to the laboratory and to the instruments he had inherited from his parents, a collection to which he had constantly added more equipment. Under the French governance, he earned enough with the secondary school chair to support his family (Busi 2001, 305–306).

When the Pontifical government returned, Paolo was appointed custodian of three science laboratories at the University; this was quite contrary to his expectation of a proper recognition and a university academic appointment. All of this rendered him quite poor and he again had to ask for financial help from the same charity organization in order to support his family (Busi 2001, 304–306).

In the archives at the Archiginnasio, there are letters written by Paolo and by his brother Giacomo to Pope Pio VII and to others, through Feliciano Scarpellini, about the poverty state of Paolo between 1816 and 1818. It was in 1818 that Paolo sold the instruments inherited from his parents to Count Carlo Filippo Aldrovandi Marescotti; this was unfortunately followed by a lawsuit in court by his brother Ciro to obtain a portion of the amount from the sale that Giovanni would have received if he was alive at the time. Paolo died on December 12, 1831 (Busi 2001, 312).

It appears that the political situation in Bologna greatly affected its professional men and women and the opportunities available to them. In Laura's time, although there were some periods of occupation by the Spanish and the Austrian, the City and its University had more control over their activities. The powerful clergy, the Legate Flaminio Scarselli and Pope Benedict XIV all supported recognition of Laura Bassi's great talent and knowledge and provided her with large financial support; she was the highest paid professor at the time. They showered honours upon her and appointed her in an academic position at the University and at its Institute of Sciences. Anna Morandi, who was also teaching at the University of Bologna, had a very low salary and had given up her oldest son to the orphanage as she could not afford to support her two boys. She did not have the same level of support as Laura from powerful men.

Laura's son Paolo, who followed in his parents' footsteps, being a physician like his father and experimental physicist like his mother, lived in a difficult period with wars and occupation by the French and the suppression of all activities related to medicine and its College. Paolo struggled almost continuously except while he held the Chair at the secondary school. Otherwise, he was only able to obtain a substitute teaching position and the guardianship of science laboratories. He and his family lived in poverty and he had to beg a charitable organization for financial support during various periods of his life. Little is known about the other children of the Bassi-Veratti couple and their descendants.

The Dark End of Laura Bassi's Laboratory

After Laura's death in 1778, the laboratory was maintained by Giuseppe, and upon his death in 1793, the laboratory was used by their son Paolo until 1818, when he reached the age of sixty-five. In August 1818, Count Carlo Filippo Aldrovandi Marescotti acquired from Paolo Veratti five cabinets with laboratory instruments and accessories that had belonged to Laura Bassi and Giuseppe Veratti. The Count desired to perform experiments in physics. The instruments were said to be in good working order at the time. The fact that Count Aldrovandi agreed to pay 1,100 crowns (scudi) was remarkable, considering his precarious financial situation. He had recently sold a large part of the family property to a rich bourgeois family (Giuseppe Zucchini). Zucchini agreed to pay Paolo 600 crowns for a portion of the debt and the remaining 500 crowns were to be paid by the Count in monthly installments of 100 crowns. However, the payments by the Count occurred more slowly than planned, so by March 1820 Paolo Veratti was still owed 300 crowns. Another complication arose after the sale agreement had been made which caused both parties some embarrassment. Ciro Veratti, Paolo's brother, filed a court case against Paolo to seek a portion of the money acquired by the sale of the laboratory. In a notary deed of 1785, regarding the inheritance of his sons, Giuseppe had insisted that the collection of physics books and instruments be kept whole and not be divided among the four. In his law suit, Ciro claimed one quarter of the

proceeds of the sale for himself, and one quarter of the part that was meant for his eldest brother Giovanni who had died in 1800. The reference specifically stated that the laboratory sold to the Aldrovandi-Marescotti family had belonged to the deceased Dottoressa Laura Bassi-Veratti. This equipment now took on a symbolic value which the Count had not considered at the time of the purchase. The Count had just wanted to add to his existing collection of instruments, not necessarily for disinterested means, but to be used for an industrial project he had in mind. When the Count died on May 7, 1823, his brother Ulisse made an inventory of all the Count's belongings, but there was no mention of the five cabinets and instruments he had acquired from Paolo Veratti (Cavazza 1995, 732–739).

On May 30, 1826, the will was opened and published upon the application by the widow Campeggi (Maria Gaiani Campeggi) on behalf of her young daughter, Angiola Campeggi, whose dream was to become the Laura Bassi of the nineteenth century. To this girl who was around ten years old, a daughter of one of the servants, the Count had left the entire collection of instruments acquired from Paolo Veratti, as well as any additional ones he had acquired himself. The Count had instructed that an inventory of the instruments be provided to the father of the young girl. The heiress would retain all the equipment for her lifetime, with a monthly payment of three Roman crowns, which was to be guaranteed by a mortgage on the family's fund. The opening of the will angered Ulisse. His nephew, Luigi Aldrovandi, asked the Cardinal Legate to extend the execution of the will by two months so that he could investigate its validity. In the meantime, Ulisse died on October 12, 1826, and on the same day, Luigi delegated all questions relating to the inheritance to a lawyer, Filippo Canuti. On March 3, 1827, the matter of the legacy to the young Campeggi was concluded. The lawyer, acting for Luigi Aldrovandi, convinced the girl's mother to surrender all the rights accruing to her daughter in exchange for a single lump sum payment of one hundred and fifty crowns. The Gaiani-Campeggi family was facing expensive legal proceedings with an uncertain outcome. An estimate of the value of the instruments was made by two engineers from the University of Bologna on behalf of the two parties. Unfortunately, these two engineers only looked at the poor condition and the obsolescence of the laboratory equipment and did not take into account the fact that they had belonged and been used by the famous Laura Bassi. This fact should have given these instruments additional historical value. The results of their short-sighted evaluation condemned Laura Bassi's laboratory to an obscure end. It appears that the belongings of the estate were sold by Luigi, including all the equipment, either together or piece by piece. The instruments had still been in the inventory of 1827 (Cavazza 1995, 737–739).

In a world that valued (and still does) men's work more than women's, it is not surprising that we can still find some of Alessandro Volta's and some of Luigi Galvani's instruments at the Poggi Museum of the University of Bologna. Unfortunately, nothing remains of Laura Bassi's instruments. So in the shadows went the laboratory, its instruments, and the unique opportunity for the poor girl, Angiola Campeggi, to become a serious scientist.

The story of Laura and of her laboratory ends with her. But it should be remembered forever. This book and other biographies of her will bring back her memory for all time. She should be included in all historical documents describing people involved in science activities in the eighteenth century.

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Appendix A

List of Academies in Which Laura Bassi was a Member

Accademia delle Scienze dell'Istituto di Bologna, 1732;
Accademia dei Dissonanti di Modena, 1732;
Università degli Apastiti, Firenze, 1732;
Accademia degli Arcadi di Roma, 1737;
Accademia dei Fluttuanti di Finale di Modena, 1745;
Accademia degli Ipocondriaci di [Reggio Emilia], 1750;
Accademia degli Ardenti di Bologna, 1752;
Accademia degli Agiati di Rovereto, 1754;
Accademia dell'Emonia di Busseto, 1754;
Accademia degli Erranti di Fermo, 1755;
Accademia degli amanti della Botenica di Cortona, 1758;
Accademia Fulginia di Foligno, 1760 and 1761;
Accademia dei Teopneusti di Correggio, 1763;
Accademia dei Placidi di Recanati in 1774;
(From Busi [2001](#), 297).

Appendix B

The List of Laura Bassi's Presentations at the Academy

In the *Catalogo dei lavori dell'Antica Accademia raccolti sotto i singoli Autori à cura di Domenico Piani*, (prepared in 1852), pp 15–17; also from Logan (1994, 64–65)

Date	Title
April 28, 1746	On the compression of air
April 27, 1747	On the air bubbles which are observed in fluids relieved from air pressure
April 25, 1748	On the centre of gravity
April 30, 1750	Latin dissertation (topic not known)
April 29, 1751	On two problems of hydrometry
April 13, 1752	Mathematical dissertation
April 19, 1753	On the exit of water from the holes of one container
April 25, 1754	On the evacuation of water through various holes
April 24, 1755	On hydrodynamics
April 25, 1756	On a problem in hydrodynamics
April 28, 1757	Algebraic dissertation
April 20, 1758	On analytical problems
April 26, 1759	On different fluids exiting from one hole
April 24, 1760	Dissertation on hydrodynamics
May 2, 1761	On experiments on electricity
April 29, 1762	On island glass used for refraction experiments
April 28, 1763	On a manner to correct in telescope the inconvenience derived from the different refraction of rays which unite at different points in the axis depending on their colour
May 2, 1764	On the phenomena of liquids in thin tubes of various materials
June 14, 1765	On experiments and observations in hydrometry and hydrostatics
May 1, 1766	Some hydrometric experiments dealing with Genette's observations
May 7, 1767	On the speed of a water jet in a container
May 8, 1768	On electricity
May 6, 1769	On a series of experiments to improve the art of dyeing
May 17, 1770	On electricity
June 7, 1771	On <i>vindex</i> electricity
May 7, 1772	On an experiment proposed by Villanova Spagnolo
May 14, 1773	On the repulsion of fescues on the surface of the water produced by a drop of spruce juice
April 28, 1774	On electricity, especially on some experiments by Halles
May 11, 1775	On fire and the facility of various fluids to receive it
May 2, 1776	The relation of flame to fixed air (carbon dioxide)
June 5, 1777	On the property of various bodies which retain heat more than others while also retaining electricity

Appendix C

The List of Giovanni Giuseppe Verati

Presentations at the Academy

In the Catalogo dei lavori dell'Antica Accademia raccolti sotto i singoli Autori à cura di Domenico Piani, (prepared in 1852), pp 137–138; also from Logan (1994, 66–67)

Date	Title
April 2, 1733	On blistering medicines
December 17, 1733	On the Aurora borealis
November 5, 1734	On some cats nursed by a bitch
December 3, 1734	A medical history
March 17, 1735	On the disease of a woman who had undergone surgery
November 6, 1735	A medical paper
March 4, 1745	On the death of animals in vacuum
November 9, 1746	On the death of animals in closed containers, but not vacuum
April 6, 1747	On a bovine disease of 1746
March 7, 1748	On electricity
December 8, 1748	Observations on curing with electricity
March 5, 1750	On electricized glass coated with various substances
December 3, 1750	On the death of various animals
January 20, 1752	On the death of animals in the full
November 29, 1752	On medical electricity
April 11, 1754	On electricity (lightning)
November 14, 1754	On medical electricity
April 29, 1756	On adulterated mofette
March 31, 1757	Latin dissertation (unknown)
April 20, 1758	On various experiments in electricity
November 16, 1758	On electrical matter
May 5, 1759	On magnetism (same as above)
March 13, 1760	On milk
February 19, 1761	On milk coagulated in the stomach of animals
April 29, 1762	On the magnetic virtue of iron
October 25, 1762	On the directional force of iron
April 5, 1764	On the air contained in the fluid of animals
April 18, 1765	Other dissertations on the air contained in the fluid of animals
December 19, 1765	On the acceleration of the heart beat due to electricity
March 5, 1767	On solutions contained in an enclosed container
April 21, 1768	On the relations of solvents
April 20, 1769	On electricity as regards animals
January 4, 1770	On the effect of electricity on animals

(continued)

(continued)

Date	Title
April 18, 1771	On the air contained in bodies, especially in the egg, in vegetables and in the solid part of animals
December 5, 1771	On various medical histories
March 18, 1772	On various medical histories
December 16, 1773	On the nature of milk
January 26, 1775	On the changes in milk under different circumstances
March 14, 1776	On fixed air
March 20, 1777	On nitrous air
April 2, 1778	On fixed air

Appendix D

Other Correspondence to Laura Bassi from Flaminio Scarselli

The correspondence continued between Laura Bassi and Flaminio Scarselli for many years. Now that her career was well established after 1745, and most obstacles were removed for her full participation in the academic life of the city of Bologna, the correspondence between them were more like letters between friends (Cenerelli 1885, 106–125).

Rome, May 27, 1747: This was a brief letter in which Scarselli said Mrs. Veronica Tagliazucchi wished to print her poems (*le Rime*) and to decorate and ornate them with the clear name of Her Illustrious Lady Laura. Moreover, Signora Veronica entrusted Scarselli with a letter and a sonnet to be given to Laura.

Rome, September 18, 1748: Scarselli explained that Abbot Radonvilliers, a very dear friend he accompanied to Bologna and who later followed Cardinal de la Rochefoucauld to France, would like to know the fate of the patient under the care of Laura's husband and what results he obtained with the experiments using electricity; he also wanted to know the effect of electricity in relation to a variety of diseases. Scarselli wished to transfer the information to his friend so he dared ask Laura to ask her husband for a response.

Rome, October 5, 1748: Following-up on his previous request, Scarselli felt he was too demanding and abusing of Laura's kindness. He did not know how he could ever thank her enough. (Laura had quickly provided detailed information to satisfy Abbot Radonvilliers' requests!) Scarselli complimented Laura's husband for his discoveries and for his wonderful dissertation which would enrich the science of medicine. He advised that such work should be swiftly printed. Monsignor Laurenti had already read the dissertation and was extremely satisfied. (This is likely Giuseppe's work on the use of electricity to cure various diseases.)

Rome, November 30, 1748: Scarselli mentioned that Abbot Radonvilliers was greatly satisfied with both the letter and the dissertation of Laura's husband.

He asked Laura to pass on the message to her husband and asked if he (Giuseppe) could answer the Abbot's questions whenever possible. Scarselli had told the Abbot to wait for an authorization from Veratti before mentioning the discoveries in the newspaper of Trévoux. He again recommended that her husband publish his discoveries as quickly as possible.

Letter with no date or place: Scarselli wrote that Laura's letter with further information for Abbot Radonvilliers arrived late; Scarselli said he would send it immediately to the Abbot, because it is certainly worth the acute and intelligent scrutiny of the Abbot's eyes than his. Scarselli thanked Laura and her husband for their collaboration and trust, and awaited with trepidation the printing of the dissertation which, he repeated, should be done as soon as possible. He also asked Laura to communicate to her husband the following thought: Since Laura was aware of his wife's tribulations (health issues) he wondered if his wife could benefit from the experiment with electricity. He hoped the idea could come up in natural conversation, explaining that by no means his wife should know it was originally his idea, as he was already having issues with her, because unfortunately he was forced to fire their maid for whom his wife cared deeply. If they were to proceed with the experiment with electricity, he suggested that Veratti also consult Dr. Beccari, their family physician.

Rome, 18th (no month), 1749: There were more problems with the mail. Scarselli said he would give copies of Veratti's dissertation to Abbot Radonvilliers and to Monsignor Laurenti. He reminded Laura that it is custom, when sending a copy of a work to His Holiness, to send one also to the 'Maestro di Camera', the Treasurer of the Papal Court. Moreover, the Ambassador and the Cardinal Secretary of State would love to receive a copy. Scarselli suggested that it would be preferable if the author (Veratti) hand over the copies. As for the sale of copies, he promised to help as much as possible. He thanked Laura and her husband for their help in regards to his wife and insisted that they work in concert with the family physician, Dr. Beccari. He also thanked them for keeping him out of the picture so that his wife did not suspect that the experiment was his idea.

Rome, February 15, 1749: In this brief letter, Scarselli said he received the case with the books (Veratti's) and would distribute the copies to the various dignitaries. He would also take care of selling the books. He received nine scudi for the sale of the book to a certain Mrs. Elena Virgilii de Romanis. He almost forgot to say the most important thing: all the dignitaries who received the book were extremely pleased and thanked Dr. Veratti. As for his wife's tribulations, he would await Dr. Veratti's and Dr. Beccari's advice on what to do next.

Rome, February 26, 1749: The Cardinal Secretary of State wished to thank Veratti for the book. Scarselli informed Laura that the Cardinal had read the complete book with diligence and was very pleased with it. The discoveries were beautiful and extremely important; the experimentation with electricity provided a

last hopeful solution for certain desperate and chronic illnesses. His wish to try these experiments to cure his wife was even stronger now, but he would await the physicians' opinion on the matter. Of special interest was the use of electricity as a purgative, avoiding the need to take internal medication. It may also work as a diuretic or promote sweating. Of course it was desirable that the dose of electricity not do any damage, only help. Scarselli apologised for his musing on the topic, a musing which was a testimony of his interest in the work of Laura's husband to whom she should reiterate his most sincere congratulations. Scarselli mentioned that the books have been delivered and the book-seller suggested printing twenty or thirty title pages to place in the most visited places in Rome to advertise the book.

Rome, April 26, 1749: Scarselli offered a summary of how Veratti's book was being distributed and advertised. He received twenty copies, and he would send others to Naples; eight title pages were already posted. Scarselli gave ten copies of the book to a bookseller. Of the first twelve, one copy was given to Abbot Radonvilliers, and eight were sold.

Rome, October 18, 1749: Scarselli did not forget his chores: he recently checked and found out that eleven copies were sold for which he received a payment. He also wished to take advantage of this letter to inform Laura that Abbot Nollet, a well known physics professor, has discredited the use of electricity in medicine and has publicly called the experiment using electricity as a purgative an imposture. He added that since Nollet was in Bologna, he offered to repeat the experiment himself, but heard that her husband (Veratti) had refused. Scarselli informed Laura that, to those Prelates who asked about the accusation, he replied that one has to verify if the fact had really happened, and if it did, to understand the reason for it. In any case, he wished to remain out of this quarrel on a subject matter that was not his own. Once he was told the truth about the matter, he would have no problem to explain it to those who asked.

Rome, June 21, 1755: Scarselli apologised because he would not be able to help Laura with her request, considering he had already sought His Holiness' grace to have his wife enter the monasteries of S. Pietro Martire and S. Guglielmo. He was convinced that, when the occasion presented itself, Laura's son, who already showed his talent and inclination toward higher education and a vocation towards ecclesiastical life, he would be considered with particular interest by the Cardinal and by the Pope. Scarselli was incapable of answering also Laura's second request. He wrote that it was certainly appropriate for Laura to receive compensation for all the work and experimentation she was doing in physics, which was very costly, but he pondered on who she should address. He suggested the Regiment of Bologna. (Salaries for professors were often coming from revenues obtained by the Regiment.) Unfortunately, he had been away for too long to know if the circumstances were favourable for such a request at this time. Scarselli concluded that he preferred to be direct and honest than to promise more than he could do.

Rome, July 19, 1755: Scarselli wrote to Laura that he was taking the liberty of sending her his six tragedies, (published in Rome in 1755), in the hope that his work would be well received by her. He dared not ask for her extremely precious opinion for two reasons: first, it would force her to read the tragedies; second, he could face an unpleasant truth. Talking about unpleasant truths, he was worried because he had not yet received an answer to his previous letter, and he hoped that he was not too honest and direct. He begged Laura to free him of this doubt.

Laura Bassi's correspondence shows a dramatic change in the years before 1745, and the letters written after that year. Before becoming a Benedettina, she corresponded mostly with people in the literary world, whereas after 1745 her letters involved men in science and medicine. The exceptions were letters to Flaminio Scarselli, which were more political at times and friendly at other times. The correspondence from famous scientists, men like Beccari, Caldani, Fontana, Nollet, Spallanzani, Volta, and Zanotti consisted of exchange of information on instruments, experiments, methods. An example was a letter from Marsilio Landriani in 1777 on the design of a portable barometer.

Men frequently asked for her opinion on their articles and manuscripts; sometimes they asked to see her writings. The letters from Laura to Giovanni Bianchi were also very informative of the path she followed in her intellectual development. It clearly showed how she embraced the new way to do science, believing that experiments were a fundamental approach to establishing a scientific principle, a theory, or a law. She was clearly adopting Newtonianism versus the older approaches of philosophers like Aristotle and Galen. Cenerelli has provided many letters from famous people to Laura Bassi, but it is unfortunate that there are none in this edition (1885) written by her.

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