**UNIVERSITY OF GONDAR
INSTITUTE OF BIOTECHNOLOGY
DEPARTMENT OF BIOTECHNOLOGY**

**MODULE SYLLABUS FOR ADVANCED BIOCHEMISTRY**

**. Module syllabus**

Module Title: Advanced Biochemistry

Module code: Biot. 605

ECTS: 7

Lecture: 3 hours/wk

Laboratory: 3 hours/wk

Collaborative learning: 2 hours/wk

Independent learning: 5 hours/wk

Length of time: 16 weeks

Co-requisite module: None

Pre-requisite module: None

Barred combination module: None

**Module Description**

**This module covers four major parts viz. the molecules of life, central metabolic pathways, signal transduction pathways, and biosynthetic pathways. The part on the molecules of life include parts on the chemical and physical properties of amino acids, the three dimensional structure of proteins, protein purification and characterization methods, enzymes and their role in catalysis, lipids, and carbohydrates. Biological membranes, transport across membranes, etc. The part on signal transduction covers mechanisms of includes a discussion on receptors and second messengers, protein phosphorelation and dephosphorelation, and impact of defects on signal transduction pathways. The part on central metabolic pathways covers the glycolytic, citric acid, pentose phosphate pathways and their regulation. Fatty acid and amino acid oxidation and their regulation is discussed in detail. The mechanism of electron transport system and ATP synthesis through oxidative phosphorelation and photophosphorelation is discussed. The part on biosynthesis covers synthesis of carbohydrates, biosynthesis of fatty acids,** eicoanoids **and other lipids, and biosynthesis of amino acids, nucleotides, and other nitrogen containing compounds.**

**Learning outcomes**

Upon a successful completion of this module students will be able to:

* Good understanding of the chemistry of life
* Able to perform analysis of biological molecules such as protein purification, enzyme assay, lipids and carbohydrate analysis
* Understand signal transduction pathways and its role for the interaction of cells among themselves and with their surrounding
* Obtain detailed understanding of different metabolic pathways and their regulation
* Able to make the connection between the biochemistry of organisms and their biotechnological applications of cells and biomolecules

**Module Content**

The cellular foundation of life

***Proteins***

Amnio acids, peptides, and proteins: Chemistry and structure; The molecules of life: Amino acids, peptides, and proteins; Synthesis of proteins, protein sequences, and evolution; The three dimensional structure of proteins and determination of protein structure; Methods to study proteins: purification, sequencing, detection, etc.;

***Enzymes***

Enzyme kinetics; Regulation of enzyme catalyzed reaction;

***Carbohydrates***

Monosaccharide and disaccharides; Polysaccharides; Glycoconjugates: proteoglycans, glycoproteins, and glycolipids; Carbohydrate binding proteins and their biological significance.

***Lipids***

Storage lipids; Lipids as signals, cofactors, and pigments; Working with lipids.

***Biological membranes and transport across membranes***

Membrane composition and architecture; Membrane dynamics; Solute transport across membrane

***Signal transduction pathways***

Gated ion channels; Receptors and second messengers; Protein phosphorelation and dephosphorelation; Defects in signalling pathways and its relation to cancer; Signal transduction in microorganisms.

***Central metabolic pathways and energy transduction***

Glycolysis, gluconeogenesis, and the pentose phosphate pathway; The Citric Acid Cycle; Fatty acid catabolism; Amino acid oxidation; Nitrogen excretion and the urea cycle; Oxidative phosphorelation; The electron transport system; Photosynthesis.

***Biosynthesis***

Carbohydrate biosynthesis in plants and bacteria; Lipid biosynthesis; Biosynthesis of fatty acids and eicoanoids; Biosynthesis of triglycerides; Biosynthesis of membrane phospholipids, cholesterol, steroids, and isoprenoids; Biosynthesis of amino acid, nucleotides, and other nitrogen containing compounds; Regulation of nitrogen metabolism

**Module Delivery**

Delivery of this module involves lectures, group discussions, laboratory exercises, student collaborative learning and student self-learning.

**Mode of evaluation**

Evaluation of the module is based results of exam (mid and final exam), laboratory reports, module assignments, oral presentations.

**Reference**

1. Berg, JM, Tymoczko, JL and Stryer, L. (2007). *Biochemistry*, 6th ed. W.H. Freeman and Company, New York
2. Nelson, DL and Cox MM (2005). *Lehninger Principles of Biochemistry*, 4th ed. W.H. Freeman and Company, New York
3. Voet D, Voet JG, and Pratt CW (1999*). Fundamentals of Biochemistry*. John Wiley & Sons, Inc. New York

**Module Title: Molecular Biology**

Module code: Biot. 616

ECTS: 9

Lecture: 4 hours/wk

Laboratory: 4 hours/wk

Collaborative learning: 3 hours/wk

Independent learning: 6 hours/wk

Length of time: 16 weeks

Co-requisite module: None

Pre-requisite module: None

Barred combination module: None

**Module Description**

This module covers DNA and RNA structures, functions; various types of RNA; detailed DNA replication, transcription and post-transcriptional processing; translation; protein structure and function; organization of the genetic material; chemical synthesis, sequencing and amplification of DNA. The module consists of lectures, laboratory sessions and independent student activities. In the laboratory sessions, the students will learn basic and advanced molecular biology techniques including DNA, RNA and protein extraction; electrophoresis; PCR; Southern, Northern and Western blotting.

**Learning outcomes**

Upon successful completion of this module students will be able to:

* Discuss the chemical compositions, physical and chemical properties and functions of DNA
* Explain the structure and function of RNA
* Become familiar with how DNA replication, transcription, mRNA post-transcriptional processing and translation
* Describe the structure and function of different types of proteins
* Acquire knowledge of internal organization of the structural genes, repetitive sequence, clusters of related genes and gene family
* Discuss regulation of gene expression
* Demonstrate how DNA is synthesized using PCR and RT-PCR and how DNA is sequenced
* Explain how restriction enzymes work
* Extract DNA, RNA and protein from bacteria, plants and animals
* Carry out electrophoresis, PCR, Northern, Southern and Western blotting

**Module Content**

DNA structure and function

RNA structure and function

DNA replication, transcription and posttranscriptional processing

Translation, post-transcriptional modification

Protein structure and function

Organization of the genetic material

Chemical synthesis, sequencing and amplification of DNA

**Module Delivery**

This module is based on lectures, group discussions, laboratory exercises, student mini-projects, student collaborative learning and student self-learning.

**Assessment Criteria**

There will be regular student assessment of module assignments, oral presentations, laboratory reports and final written exam. Grades are computed based on the results of these module assignments, presentations, laboratory reports and the final exam.

**Role of Instructors and Students**

***Instructors***

Give lectures

Moderate and guide interactive learning

Supervise student self and collaborative learning

Instruct laboratory sessions

Assess the performance of students

***Students***

Attend lectures

Actively participate in interactive, self and collaborative learning

Work laboratory exercises

Read materials that enrich their knowledge of subject area such as books, journal articles, etc.

Prepare term papers in groups or individually and present orally

Prepare laboratory reports

**Teaching Support and Inputs**

***Class room teaching-learning***

White board

White board markers and other stationeries

Board erasers

LCD projector

Transparency projector

Laptop

***Practical***

All molecular biology apparatus, kits and various types of chemicals including reagents, plasmid vectors, autoclave, centrifuges, PCR machines, 4 °C refrigerator, -20 °C freezer, -80 °C deep freezer, pipettes (various volumes), laminar airflow cabinet, incubator (37 °C), water bath (that can be adjusted to different temperatures), shaker, heating blocks, magnetic stirrers, pH meter, sensitive balance, electronic balance, various glassware, disposable items.

**Module requirements**

Students are expected to:

Attend lectures regularly

Actively participate in student self and collaborative learning

Read books, journal articles, etc. of the subject area

Work on assignments and make oral presentations

Carry out laboratory exercises regularly and prepare laboratory reports

**Reading Materials:**

1. Brown, T., A. (2001). *Gene cloning and DNA analysis: An introduction*. 4th edition. Blackwell Science Ltd.
2. Glick, B. R. and Pasternak, J., J. (1998). *Molecular biotechnology: Principles and applications of recombinant DNA*. 2nd edition. ASM press. Washington, D.C.
3. Primrose, S., Twyman, R., M. and Old, R., W. (2001). *Principles of gene manipulation*. 6th edition. Blackwell Science Ltd.