Republic of the Philippines
OFFICE OF THE PRESIDENT
COMMISSION ON HIGHER EDUCATION

CHED MEMORANDUM ORDER (CMO)
No. 24
Series 2005

SUBJECT: MINIMUM POLICIES AND STANDARDS FOR BACHELOR OF SCIENCE IN BIOLOGY (BS BIO)

In accordance with the pertinent provisions of Republic Act (RA) No. 7722, otherwise known as the "Higher Education Act of 1994," and for the purpose of rationalizing the undergraduate biology education in the country with the end view of keeping apace with the advances in science and the demands of globalization, the following rules and guidelines are hereby adopted and promulgated by the Commission.

ARTICLE I
INTRODUCTION

Section 1 Biology is the study of life. The concerns of biology ranges from the systematic description of organisms in the entire ecosystem to the minute internal structures and inherent molecular processes within cells.

Biology has evolved into a diversified field of study. The traditional specialties are botany, zoology, natural history (evolution, systematics and taxonomy), and microbiology, while the modern day specialties are biotechnology, genetic engineering, cell biology, computational biology, genomics, molecular biology and neurobiology. There are also cross disciplinal specialties such ecology, anatomy, physiology and pathology.

The diversity of fields in the biological sciences provide solutions for many of the present day problems. Pollution, food security, ageing, spread of diseases, overpopulation, etc. may be addressed by the application of biological knowledge. It is within this context and the backdrop of recent discoveries that the French President Valery Gisca d'Estaing declared the twentieth century as the "century of biology."

Biology programs offered in Philippine higher education institutions (HEIs) need to be updated on the latest trends in the teaching of biology. This document (the policies and standards) recommends the minimum course requirements of the BS Biology program and an optimal way of organizing them .

ARTICLE II
AUTHORITY TO OPERATE

Section 2 All private higher education institutions (PHEIs) intending to offer the Bachelor of Science in Biology must secure proper authority from the Commission in accordance with existing rules and regulations. State universities and colleges (SUCs), and local colleges and universities should likewise strictly adhere to the provisions in this policies and standards.

ARTICLE III
PROGRAM SPECIFICATIONS

Section 3 Degree Name

The degree program herein shall be called Bachelor of Science in Biology (BS Biology).

Section 4 Program description

a. Nature of the Program

The BS Biology program herein is structured as a generalized framework for biological study with the end view of grounding students on the fundamental concepts, principles, and theories of the biological sciences and introducing them to the conduct of biological research. It goes beyond the thinking that BS Bio is a premedical program.

b. Objectives

The B.S. Biology program is structured to meet the needs of professional biologists who:

1. can be employed in government, private or self-enterprises where scientists with biological expertise are needed;
2. Teach at the tertiary level; and,
3. Undertake research in the various areas of biology.

In addition, the B.S. Biology program satisfies the requirements for admission to medical education.

c. Specific professions/careers/occupations or trades that BS Biology graduates may go into.

The biological sciences present exciting and worthwhile career opportunities. With the wide range of areas of interest offered in the discipline, the workplaces are likewise varied from universities,

zoos, hospitals, government, and laboratories in tropical rainforests to ocean depths.

A graduate of BS Biology may be engaged in basic and applied research where they can be employed as research assistants or biological laboratory technicians in government agencies, museums, zoos and aquaria, and private organizations. They can also go into industrial research work involving product development, management, or inspection particularly in agriculture, biotechnology, food and nutrition, pharmaceutical and other health care related industries.

The bachelor's degree is adequate for some nonresearch jobs such as testing and inspection, and technical sales or service representatives. Some private and non-government organizations also hire BS Biology graduates for advocacy and communication work involving science, technology and the environment.

Graduates may also be engaged in biology-based industries such as production, food science and technology, management, marketing, and bioprospecting, public lectures and workshops, writing science articles in newspaper, magazines and books, production of educational software or multimedia applications, development of educational films and television programs, and collection, preservation and sale of biological specimens.

The program qualifies one to work as a teaching assistant in a college or university. With additional courses in education and passing of the Licensure Exam for Teachers, a BS Biology graduate can also be employed as a high school biology teacher.

Section 7 Allied Programs

Biology is closely related to the fields of agriculture, fisheries, forestry, nutrition, medicine, pharmacy, veterinary medicine, animal science, and environmental science.

ARTICLE IV
COMPETENCY STANDARDS

Section 8 Competency Standards

Graduates of a BS Biology program must

- have an in-depth understanding of the basic principles governing biological science;
- be able to extend knowledge and understanding to a critical assessment of current views and theories in selected areas of the biological sciences;
- be able to perform basic biological and chemical techniques in either a laboratory or fieldwork research setting;

- be able to carry out basic mathematical and statistical computations;
- have adequate technical writing skills and effective oral communication abilities;
- develop critical, analytical and problem solving skills ;
- develop the skills required for both autonomous practice and team-work;
- be able to think critically, solve problems, and appreciate the limitations and implications of science in everyday life;
- develop an objective viewpoint for discerning information and analyzing biases of other people;
- be precise in making observations and able to distinguish small differences between samples and events, and most importantly;
- have a strong sense of ethical behavior.

ARTICLE V
CURRICULUM

Section 9 Curriculum Description

The curriculum below presents a balanced treatment of all branches of biology with the inclusion of recent advances in biology such molecular biology. It does not emphasize a particular specialty such as those in ecology, microbiology, zoology or botany. Institutions may opt to implement a specialty when resources are warranted.

Section 10 Curriculum Outline (150 or 147 Units)

General Education Courses	39*
Non-biology Tool Courses	35
Core Courses	40
Science Electives	24
Free Electives	6
Undergraduate Thesis or Special Problem	6 or 3
Total units	**150 or 147 units**

*Note: The required 51 Units for GEC B (CMO 4 series 1997) should be fulfilled by the 39 units of courses specifically labeled as GE Courses and by the General Biology I & II in the Core Courses, and Mathematics, Chemistry and Physics in the Non-Biology Tool Courses.

Section 11 General Education Courses (39 Units)

Fields of Study	Specific Courses	Total Units
1. Language and Humanities	English - 6 units Filipino - 6 Units Humanities Subjects (e.g. Literature, Art, Philosophy) – 9 units	21
2. Mathematics, Natural Sciences and Information Technology	Information Technology - 3 units **Note:** Natural Sciences (6 units) and Mathematics (6 units) requirements are fulfilled by General Biology I & II in the Core Courses, and Mathematics, Chemistry and Physics in the Non-Biology Tool Courses.	3
3. Social Sciences	Consist of subjects such as Political Science, Psychology, Anthropology, Economics, History and the like, provided that the following topics are taken up in appropriate subjects: Taxation and Land Reform, Philippine Constitution, Family Planning and Population Education.	12
4. Life and Works of Rizal	Mandated Subject	3
	TOTAL	**39**

Section 12 Non-Biology Tool Courses (35 Units)

The non-biology tool courses component has a total of 35 units. These are courses in other basic science fields needed to enhance the understanding of biology concepts.

Non-Biology Tool Courses	Lec	Lab	Total
Chemistry			**15 units**
General and Inorganic Chemistry	3	2	5
Organic Chemistry	3	2	5
Biochemistry	3	2	5
Physics			**8 units**
General Physics (Mechanics, Electricity and Magnetism)	2	2	4
	2	2	4
Modern Physics			**12 units**
Mathematics			3
College Algebra		3	3
Trigonometry		3	3
Calculus and Analytical Geometry		3	3
Statistics		3	
		TOTAL	**35 Units**

Section 13 Core Courses (40 Units)

The core courses are the basic, foundation courses in biology covering essential topics. Laboratory is required in all courses.

Core Courses	Lec	Lab	Total
General Biology I	3	2	5 units
General Biology II	3	2	5 units
Morphoanatomy I (Plant)	2	1	3 units
Morphoanatomy II (Animal)	2	1	3 units
Physiology I (Plant)	2	1	3 units
Physiology II (Animal)	2	1	3 units
Systematic Biology (Plant or Animal)	2	1	3 units
Developmental Biology (Plant or Animal)	2	1	3 units
Genetics	2	1	3 units
Ecology	2	1	3 units
Microbiology	2	1	3 units
Cell and Molecular Biology	2	1	3 units
	TOTAL UNITS		40 units

Section 14 Suggested Electives in Biology (24 Units)

Electives are the courses that provide in-depth knowledge in various branches of biology and may concentrate on specific themes that the HEI may choose. Below is a list of suggested areas of study where HEIs may choose to offer as their electives. Other areas of biology may be included.

Entomology
Histology
Immunology
Theoretical Biology
Evolution
Freshwater Biology
Marine Biology
Molecular Biology and Biotechnology

(Over and above the core courses)
Genetics
Systematics
Microbiology

Section 15 Free Electives (6 Units)

Free Electives **6 units**

Science, Technology and Society or its equivalent is strongly suggested (3 units)

Section 16 Undergraduate Thesis (6 Units) or Special Problem (3 Units)

Institutions may choose a thesis (6 units), or a special problem (3 units) to comply with this section. Both the thesis and the special problem options include a seminar course which shall be offered in any of the last two terms of the program. Undergraduate seminar may either be a presentation of the students' Thesis/ Special Problem proposal or a progress report of their Thesis/ Special Problem research work to fulfill the requirements of the undergraduate seminar course.

Undergraduate Thesis or Special Problem 6 or 3 units

Section 17 Sample Program of Study (Minimum Units)

The program of study herein is *only an example*. HEIs may use this sample and modify it according to its needs. They may also add other preferred courses.

FIRST YEAR

First Semester			
Descriptive Title	Lecture	Laboratory	Total Units
General Chemistry	3	2	5
Math Tool Course 1	3		3
GE course 1*	3		3
GE course 2 *	3		3
GE course 3 *	3		3
GE course 4*	3		3
Physical Education I (PE I)		(2)	(2)
NSTP		(3)	(3)
Total	18	2	20

Second Semester			
Descriptive Title	Lecture	Laboratory	Total Units
General Biology I	3	2	5
Math Tool Course 2	3		3
GE course 5 *	3		3
GE course 6 *	3		3
GE course 7*	3		3
GE Information Technology	3		3
Physical Education II (PE II)		(2)	(2)
NSTP		(3)	(3)
Total	18	2	20

SECOND YEAR

First Semester			
Descriptive Title	Lecture	Laboratory	Total Units
General Biology II	3	2	5
Organic Chemistry	3	2	5
GE course 8 *	3		3
GE Course 9*	3		3
Math Tool Course 3	3		3
Physical Education III (PE III)		(2)	(2)
Total	15	4	19

Second Semester			
Descriptive Title	Lecture	Laboratory	Total Units
Morphoanatomy I (Plant)	2	1	3
Biochemistry	3	2	5
Systematic Biology	2	1	3
Elective 1 in Biology	2	1	3
Physics I	2	2	4
Math Tool Course 4	3		3
Physical Education IV (PE IV)		(2)	(2)
Total	14	7	21

THIRD YEAR

First Semester			
Descriptive Title	Lecture	Laboratory	Total Units
Morphoanatomy II (Animals)	2	1	3
Physiology I (Plant)	2	1	3
GE Course 10*	3		4
Ecology	2	1	3
Free Elective 1	3		3
Free Elective 2	3		3
Total	**15**	**3**	**18**

Second Semester			
Descriptive Title	Lecture	Laboratory	Total Units
Physiology II(Animals)	2	1	3
Physics II	2	2	4
Elective 2 in Biology	2	1	3
Microbiology	2	1	3
GE Course 11*	3		3
GE Course 12*	3		3
Total	**14**	**5**	**19**

FOURTH YEAR

First Semester			
Descriptive Title	Lecture	Laboratory	Total Units
Genetics	2	1	3
Developmental Biology	2	1	3
Elective 3 in Biology	2	1	3
Elective 4 in Biology	2	1	3
Elective 5 in Biology	2	1	3
Undergraduate Thesis I	3		3
Total	**13**	**5**	**18**

Second Semester			
Descriptive Title	Lecture	Laboratory	Total Units
Cell and Molecular Biology	2	1	3
Elective 6 in Biology	3		3
Undergraduate Thesis II with Seminar		3	3
Elective 7 in Biology	2	1	3
Elective 8 in Biology	2	1	3
Total	**13**	**6**	**19**

Grand Total: 153

*GE courses in the Languages, Humanities, Social Sciences, and Life and Works of Rizal.
NSTP and PE courses are not included in the total number of units.

Article VI
Course Specifications

Section 18 The following course specifications are only for the major courses. HEIs may follow their own course specifications in the implementation of the program but must not be less than those specified for the major courses.

1. GENERAL BIOLOGY I

1.1 Course Description

Logic, nature, methods, concepts and principles of biology with emphasis on the molecular, cellular and organismic levels of organization.

Credit: 5 units (3 lecture/2 laboratory)
Prerequisites: General Chemistry

1.2 Course Content

1.2.1 Lecture

I. Introduction
- A. Scientific Method
- B. Concepts of Life
- C. Brief History of Biology

II. Cellular Structures: Molecules and Organization
- A. Cell Theory: Its origin, meaning and implications
- B. General Attributes of the Cell
- C. Prokaryotic and Eukaryotic Cells
- D. Organelles and Processes
  1. Cell Membrane: Transport
  2. Cytoplasmic Matrix and Vacuolar System
  3. Chloroplast: Photosynthesis
  4. Mitochondria: Respiration
  5. Nucleus: Control of the Cell Cycle

III. Differentiation and Development
- A. Molecular Basis of Differentiation
- B. Cellular Basis of Differentiation

IV. Plants: Form and Function
- A. Plant Cell Types and Tissues
- B. Plant Organs and Processes
  1. Nutrition
  2. Transport

V. Animals: Form and Function
- A. Animal Cell Types and Tissues
- B. Animal Systems and Processes
  1. Support and Protection
  2. Movement
  3. Digestion and Nutrition
  4. Gas Exchange
  5. Transport/Circulation

6. Excretion and Osmoregulation
7. Regulatory Mechanism

1.2.2 Laboratory

I. Microscopy
II. The Cell Organelles and Processes
III. Energy-Matter Interconversion Reactions
  A. Photosynthesis
  B. Respiration
IV. Cell Division: Mitosis
V. Plant Cell Types and Tissues
VI. Plant Processes
  A. Absorption
  B. Transport and Nutrition
  C. Transpiration and Guttation
VII. Animal Cell Types, Tissues and Organs
VIII. Animal Forms and Function
  A. Support and Movement
  B. Nutrition and Transport
  C. Coordination and Control

2. GENERAL BIOLOGY II

2.1 Course Description

Continuation of General Biology I with concentration on reproductive biology, developmental biology, genetics, evolution, taxonomy and ecology

Credit: 5 units (3 lecture/2laboratory)
Prerequisites: General Biology I

2.2 Course Content

2.2.1 Lecture

I. Introduction
II. Plant Reproductive Biology
  A. Thallophytes
  B. Embryophytes
III. Plant Development Biology
  A. Morphogenesis
  B. Growth and Development
IV. Animal Reproductive Biology
  A. Invertebrates
  B. Vertebrates
V. Animal Development Biology
  A. Fertilization
  B. Cleavage and Early Development
  C. Organogenesis
  Differentiation

VI. Taxonomy/Systematics
   A. Concepts
   B. Plant Diversity
   C. Animal Diversity
VII. Genetics
   A. Areas and Methods in Genetics Studies
   B. Cytological and Mathematical Basis of Inheritance
   C. Mendelian and Non-Mendelian Modes of Inheritance
VIII. Evolution
   A. Concepts and Significance
   B. Processes, Evidences and Issues
IX. Ecology
   A. Ecosystem Concept
   B. Major Ecosystems
   C. Human Ecology and Environmental Issues

2.2.2 Laboratory

I. Reproductive Patters in Plants

II. Gametogenesis and Fertilization in Angiosperms

III. Plant Growth and Development
   A. Seed Germination
   B. Distribution of Growth
   C. Factors Affecting Seeding Development
   D. Tropisms
   E. Growth movements
   F. Abscission

IV. Reproductive Patterns in Animals

V. Gametogenesis in Frogs

VI. Development of a Frog
   A. Early Development
   B. 7-mm Frog Embryo

VII. Plant and Animal Diversity
VIII. Genetics
   A. Types of Variation
   B. Probability
   C. Pedigree Study
   D. Problem Solving

IX. Ecology
   A. Animal Associations/Succession (Hay Infusion)
   B. Plant Associations
   C. Special Studies in Ecology

2.3 Laboratory Equipment and Facilities

The laboratory facilities shall provide the proper atmosphere for long hours of laboratory work such as adequate space, ventilation, lighting and safety measures.

A. Basic glassware and supplies for experiments
B. Basic Equipment:
   Compound microscopes (with histologic slides), one per student
   Balance, one unit per lab
   Oven, one unit per lab
   Stove, one unit per lab
   Refrigerator, one unit per lab
   Dissecting/Binocular Microscopes, one unit per group of 5-6 students
C. Optional Equipment: Television and VCR, one unit
   Overhead projector (slide and transparency), one unit

2.4 Suggested References (dated not earlier than 1985)

1. Audrisk, G.and T. Audrisk. 1993. Biology. Life on Earth. 3rd ed or latest edition. McMillan Publishing Co.
2. Campbell, N.A. 1996. Biology. 4th Ed or latest edition. The Benjamin Cummings Publishing Co., Inc.
3. Hickman, C.P. Sr., C.P. Hickman, Jr. and F.M. Hickman. 1987. Integrated Principles of Zoology. C.V. Mosby Co.
4. Kimball, J.W. 1994. Biology. 6th ed or latest edition. Wm. C. Brown Communications, Inc.
5. Mauseth, J.D. 1995. Botany: An Introduction to Plant Biology. 2nd ed or latest edition. Saunders College Publishing Co.
6. Miller, S.A. and J.P. Harley. 1992. Zoology. McGraw-Hill Book Co.
7. Morgan, J.G. and R.F. Evert and S.E. Eichorn. 1992. Biology of Plants. Worth Publishers, New York
8. Raven, P.H., R.F. Evert and S.E. Eichhorm. 1992. Biology of Plants. Worth Publishers, N.Y.
9. Starr, C. and R. Taggart. 1987. Biology. The Unity and Diversity of Life. 4th ed. Wadsworth Publishing Co.

3. PLANT MORPHOANATOMY

3.1 Lecture

3.1.1 Course Description

Basic course on the form and external features (morphology) and internal structure (anatomy) of vascular plants taking representative examples from Divisions (1) Psilopsida, (2) Sphenopsida, (3) Pteropsida (ferns, gymnosperms and angiosperms. The origin and development of the various kinds of cells and tissues of the roots stems and leaves will also be covered.

3.1.2 Course Objectives

(1) To provide knowledge for a basic foundation in the morphology and anatomy of lower and higher vascular plants.
(2) To provide students the opportunities through laboratory work to acquire a practical basis for the knowledge gained in the lectures on the morphology and anatomy of vascular plants.

3.1.3 Course Outline

I. Introduction — Week 1 & 2
   A. Highlights of plant evolution
   B. Terrestrial adaptations of vascular plants
   C. Terrestrial adaptations of seed plants

II. The Plant Body
   A. General Structure and life cycle of vascular plants (Psilopsida, Lycopsida, Sphenopsida, Pteropsida, Gymnosperms, Angiosperms)
   B. Gross Morphology of higher vascular plants
      1. Growth and differentiation of meristems (shoot and root meristems) in the embryo
      2. Gross morphology of roots, stems and leaves and their modifications (specialized organs)

III. The Plant Cell
   A. Review of various organelles of a plant cell (reading assignment)
   B. Cell wall
      1. Importance of the cell wall
      2. Gross structure of the cell wall
      3. Composition of the cell wall
      4. Formation of the cell wall
      5. Secondary cell wall
   C. Ergastic substances
      1. Reserve materials
      2. Crystals
      3. Tannins
      4. Pigment
      5. Silica

IV. Meristems — Week 3
   A. Definition of a meristem
   B. Characteristics of meristems
   C. Classification of meristems
      1. Apical meristems
         a) Vegetative shoot apex
            (1) Apical cell
            (2) More complex apices of gymnosperms and angiosperms. Descriptions based on cell differentiation, apical geography (Histogen theory, Tunica-corpus theory) and the growth zones (cyto-histological zonation)
         b) Reproductive apex
         c) Root apex
      2. Lateral meristems
      3. Intercalary meristems

Exam I

V. Epidermis — Week 4
- A. Uniseriate and multiseriate epidermis
- B. Composition
- C. Wall structure
- D. Stomata
  1. Types of stomata
  2. Development of stomata
- E. Epidermal appendages
- F. Root hairs

VI. Periderm — Week 5
- A. Components and structure of components of the periderm
- B. Development of the periderm
- C. Commercial cork
- D. Lenticel
- E. Protective tissues of monocots

VII. Parenchyma — Week 6
- A. Occurrence
- B. Shape and arrangement of cells
- C. Development of intercellular spaces
- D. Structure and contents of parenchyma (See lecture notes on the cell)

VIII. Collenchyma — Week 7
- A. Occurrence
- B. Types of collenchyma cells
- C. Wall thickening of the collenchyma

IX. Sclerenchyma — Week 8
- A. Occurrence
- B. Types of sclerenchyma (sclereid and fiber)
- C. Development of fibers
- D. Structure and use of commercial fibers
- E. Types of scleried
- F. Development of sclereids

X. Xylem — Week 9
- A. Tracheary elements
- B. Secondary wall patterns
- C. Vessels and perforated plates
- D. Protoxylem and metaxylem
- E. Secondary xylem
  1. Basic structural characteristics
  2. Secondary xylem of angiosperms
  3. Secondary xylem of gymnosperms

XI. Phloem — Week 10
- A. Sieve elements
- B. Companion cells and albuminous cells
- C. Protophloem and metaphloem
- D. Secondary phloem
  1. Basic structural characteristics
  2. Secondary phloem of angiosperms
  3. Secondary phloem of gymnosperms

Exam II

XII. The Root — Week 11
- A. Primary and secondary growth (review)
- B. Structure of specialized roots

XIII. The Stem — Week 12
- A. Primary vascular system
- B. Types of stele
- C. Anatomy of the node
- D. Anomalous secondary growth
- E. Root-stem transition

XIV. The Leaf — Week 13
- A. Development
- B. Histology
- C. Anatomy of specialized leaves

Exam III

3.1.4 Suggested References

1. Fahn, A. 1990. Plant Anatomy. Butterworth-Heinemann Ltd. Oxford.
2. Esau, K. 1965. Plant Anatomy. John Wiley and Sons, New York. Second Edition
3. Eames, A. and L. Mac Daniels. 1947. An Introduction to Plant Anatomy. McGraw-Hill Book Co., Inc.

3.2 Laboratory

3.2.1 Course Outline

Exercises (Week)	Title
1	General Morphology of Vascular Plants
2	Organs and their Modifications
3	The Cell
4	The Meristems
5	Epidermis
6	Periderm
FIRST LABORATORY EXAM	
7	Parenchyma
8	Collenchyma
9	Sclerenchyma
10	Xylem
11	Phloem
SECOND LABORATORY EXAM	
12	Root
13	Stem
14	Leaf
THIRD LABORATORY EXAM	

3.2.2 References

1. Fahn, A. 1990. Plant Anatomy. Butterworth-Heinemann Ltd. Oxford.
2. Esau, K. 1965. Plant Anatomy. John Wiley and Sons, New York. Second Edition
3. Eames, A. and L. Mac Daniels. 1947. An Introduction to Plant Anatomy. McGraw-Hill Book Co., Inc.

4. Physiology I (Plant Physiology)

4.1 Course Description:

Principles and fundamental aspects of vital plant functions, including nutrition, photosynthesis, absorption and translocation of materials, growth and development, with emphasis on adaptive mechanisms.

Credit: 4 units (2 units lecture; 2 units lab)
Class hours: 8 hours (2 hours lecture; 6 hours laboratory)
Prerequisites: General Biology I and II or General Botany and General Zoology (10 units)
Plant Morphoanatomy (or Plant Anatomy) (4-5 units)
Elementary Biochemistry (4-5 units lecture and laboratory)

4.2 Objectives

1. To expose students to what plants do and what physical and chemical factors cause them to respond as they do.
2. To explain the physiology of plants, i.e., their functions, from seed germination to vegetative growth, maturation, flowering and senescence.
3. To provide students with a firm foundation in the major concepts of plant physiology, in the context of traditional and contemporary biology.
4. The information derived from the course will be useful for careers in agronomy, horticulture, forestry, seed science and plant pathology.

Course Outline

4.3.1 Lecture

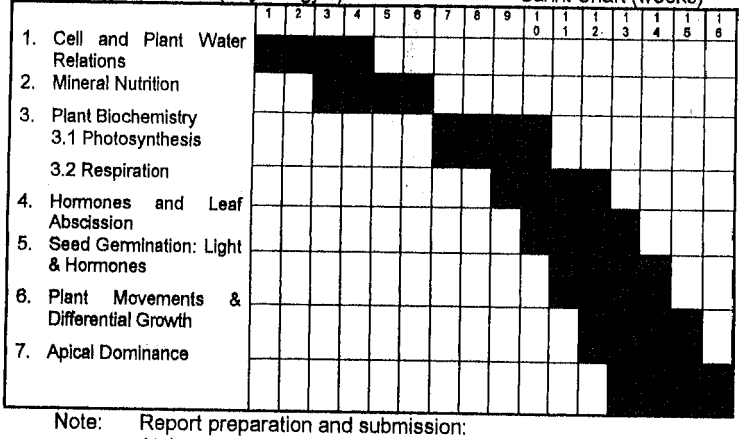
No. of meetings	No. of Hours	
1	1*	I. Plant and Cell Architecture: The Bio-organization A. Plant Life: Unifying Principles B. The Plant: An Overview of Structure C. The Plant Cell: Attributes and Functions
4	2	II. Plant-Water Relations A. Water and Plant Cells 1. The Structure and Properties of Water 2. Importance of Water in Plant Life 3. Transport Processes and Driving Forces
	2	B. Water Balance of the Plant 1. Water in the Soil 2. Water Absorption by Roots 3. Transpiration
2	1	III. Mineral Nutrition A. The Plant Root System and Its Interaction with the Soil B. Mycorrhizal Fungi and their Association with Plant Roots
	1	C. Essentially of Elements: concepts, criteria, problems D. Uptake and Assimilation of Mineral Elements E. Functions of Mineral Elements and Symptoms of Deficiencies
2	1 1	IV. Solute Transport A. Passive, Facilitated Diffusion and Active Transport B. Transport Across Biological Membranes C. Phloem Translocation 1. Phloem Loading and Unloading 2. Mechanism of Sieve Tube Translocation
1	1	FIRST EXAMINATION
Total 10 meetings, 10 hours		

*first half = class orientation on course requirements; 2nd half = Topic I

No. of meetings	No. of Hours	
7		V. Photosynthesis: the Chemical Basis of Life
	2	A. The Light Reaction
		1. Photophosphorylation
		2. Reduction of NADP
		3. Photolysis of water
	2	B. Carbon Metabolism
		1. C_3 cycle
		2. C_4 pathway
		3. Crassulacean Acid Metabolism
	2	C. Factors Regulating the Process
		D. Photorespiration
	1	E. Physiological and Ecological Considerations
2		VI. Respiration: The Maintenance of Life
		A. Aerobic and Anaerobic Pathways
	1	B. Energy Production: Oxidative Phosphorylation
	1	C. Factors Controlling the Process
		D. Lipid Metabolism
1		VII. Secondary Plant Products
	1	A. Terpenes
		B. Phenolic Compounds
		C. Nitrogen-Containing Compounds
		D. Chlorophylls and Haems
1	1	SECOND EXAMINATION
Total 11 meetings, 11 hours		
10		VIII. Growth and Development
	2	A. Cellular Basis of Growth and Development
		B. Phytohormones and Related Compounds
	1	1. Auxins
	1	2. Gibberellins
		3. Cytokinins
	1	4. Abscisic Acid
		5. Ethylene
	1	6. Other Plant Growth Regulators
	1	C. Secondary Messengers and Signal Transduction Pathways
	1	D. Phytochrome, Photomorphogenesis and
	1	Photoperiodism
	1	E. Control of Flowering
		F. Seed Germination and Dormancy
		G. The Biological Clock: Rhythms of Life
		H. Senescence
1	1	THIRD EXAMINATION
Total 11 meetings, 11 hours		
32 meetings	32 hours	GRAND TOTAL

4.3.2 Laboratory

Laboratory Exercises (Physiology 1) Gannt Chart (weeks)



Note: Report preparation and submission:
At the end of 4 weeks (= period for 1 lab exercise)

4.4 Laboratory Equipment, Facilities, Supplies and Chemicals

Basic glassware for experiments

1. Burets
2. 250ml and 500 ml graduated cylinders
3. Test tubes and caps/stoppers
4. Funnels
5. 50 ml, 100ml, 200ml, 500ml, 1000ml beakers
6. 1000ml brown bottles
7. petri dishes

Minimum Laboratory Equipment/Materials (Required)

1. analytical balance
2. pH meter
3. UV-VIS spectrophotometer with appropriate cuvettes
4. refrigerator
5. rough platform/pan balance
6. magnetic stirrer/hot plate with magnetic bars
7. mortar and pestle
8. water bath
9. autoclave
10. centrifuges (varying speeds/temperature ranges)
11. oven
12. light meter
13. cold cabinet
14. leaf area meter
15. growth chambers
16. pipettors, variable colume capacities
17. Cork borer, a set (variable sizes)

18. Blender
19. Thermometers
20. latex gloves
21. aspirators
22. forceps

Desired Equipment:
1. shaker
2. fume hood
3. Clark Type Probes (Multi Probes)

Required Chemicals
1. Petroleum Ether
2. Acetone, 100%
3. Chloroform
4. Resazurin Dye
5. Potassium Cyanate (KCN)
6. Carbonyl Cyanide-Chlorophenyl
7. Hydrozone (CCCP) in di-methyl sulfide (DMSO)
8. Petroleum Jelly/Paraffin
9. Sodium Phosphate (Na2PO4)
10. Potassium diphosphate (KH2 PO4)
11. mannitol
12. Potassium chloride (KCl)
13. Magnesium Chloride (MgCl2)
14. succine acid
15. Adenosine triphosphate (ATP)
16. 2, 4-dinitrophenol (DNP)
17. ethanol, 95%
18. sucrose
19. Sodium Chloride (NaCl)
20. Chlorine bleach
21. indole-3-acetic acid (IAA)
22. Naphthalene acetic acid (NAA)
23. Tween 20
24. lanolin
25. 6-benzylaminopurin (BA)
26. Trilodobenzoic acid (TBA)
27. Abscisic acid (ABA)
28. cytokinin (CK)
29. gibberellic acid (GA)

4.5 Recommended Texts/References for Physiology I (Plant Physiology)

A. Books

1. Hopkins, W. 1991. Plant Physiology.
2. Taiz, L. and E. Zeiger. 1991. Plant Physiology. The Benjamin/Cummings Publ. Co. California, Reading, N.Y.
3. Salisbury, F. and C. Ross. 1992. Plant Physiology. 3rd Edition. Wadworth, Inc. N.Y.

4. Mohr, Hans and Peter Schopfer. 1995. Plant Physiology. Springer Verlag
5. Ridge, I. 1991. Plant Physiology. Hodder and Stoughton Ltd. The Open University
6. Fosket, Donald E. 1994. Plant Growth and Development. A Molecular Approach. Academic Press. San Diego, Toronto, London, Sydney, Tokyo, New York, Boston.
7. Lawlor, D.W.. 1993. Photosynthesis, Metabolism, Control and Physiology. London Longman Sci. & Tech. John Wiley & Sons. Inc. N.Y.
8. Devlin, R.M. and F.H. Witham. 1983. Plant Physiology. 4th Edition. PWS Publishers: USA
9. Bonner, J. and A.W. Galston. 1952. Principles of Plant Physiology. W.H. Freeman and Company USA
10. Campbell, N.A. 1996. Biology. 4th Edition or latest edition. The Benjamin/Cummings Publishing Co. California
11. Leopold, A.C. and P.E. Kriedmann. 1975. Plant Growth and Development. 2nd Edition. McGraw-Hill Series in Organismic Biology. Reprinted under Authority of Presidential Decree No. 285 as amended by P.D. No. 400.
12. Kramer, P.J. 1969. Plant and Water Relations - A Modern Synthesis. McGraw-Hill, Inc.: India
13. Noggle, G.R. and G.J. Fritx . . 1983. Introductory Plant Physiology. 2nd Edition Prentice-Hall, Inc.: USA
14. Ting, Erwin P. 1982. Plant Physiology. Addison-Wesley, Reading, Massachusetts
15. Becker, W.M., J.B. Keece and M.E. Poenie. 1996. The World of the Cell. The Benjamin/Cummings Publishing Company Inc.: California
16. Raven, P.H., R.F. Evert and S.E. Eichlom. 1992. Biology of Plants. 5th ed or latest edition. Worth Publishers, Inc.: New York.
17. Goodwill, T.W. and E.I. Mercer. 1988. Introduction to Plant Biochemistry. 2nd ed or latest edition. Pergamon Press (or the latest edition) Oxford, New York, Beijing, Frankfurt, Sao Paulo, Sydney, Tokyo, Toronto.
18. Lea, P.J. and R.C. Leegood (Eds.) 1993. Plant Biochemistry and Molecular Biology. John Wiley and Sons Ltd.: England

B. Journals:
1. Plant Physiology
2. Planta
3. Physiologia Plantarum
4. Plant Cell Physiology
5. Annual Review of Plant Physiology and Molecular Biology

C. Laboratory Manual
1. Reiss, C. 1994. Experiments in Plant Physiology. Prentice-Hall, Inc. A Simon & Schuster Co.: Englewood Cliffs, New Jersey

5. PHYSIOLOGY II (ANIMAL PHYSIOLOGY)

5.1 Course Description

Animal Physiology deals with the principles of animal functions with emphasis on physiologic regulation and adaptation.

Credit: 5 units (3 lecture /2 laboratory)
Prerequisites: General Biology I and II or General Zoology and General Botany: 10 units (lecture and lab)
Morphoanatomy II: 5 units (lecture and lab)
Biochemistry

5.2 Course Content

5.2.1 Lecture

I. Introduction
   A. The Animal and its Environment
   B. Concept of Homeostasis and Physiologic Mechanism
   C. Biological Control System/Regulatory Mechanism
II. Review
   A. Cell Physiology
   B. Transport through Membranes
III. Nerve Physiology
   A. Nerves and its Properties
   B. Resting Membrane Potential
   C. Depolarization and Transmission of Signals/Impulse
IV. Neurophysiology
   A. Basic Organization
   B. Sensory Physiology
   C. Motor and Integrative Physiology
V. Movement
   A. Non-muscular Movement
   B. Different Muscle Types
   C. Structural Basis of Contraction
   D. Chemistry of Muscle Contraction
   E. Mechanical Properties of a Contracting Muscle
   F. Neural Control of Muscle Contraction
VI. Circulation
   A. General Plan of Circulation
   B. Types of Heart and their Circulatory Patterns
   C. Physiologic Properties of the Heart
   D. Cardiac Cycle
   E. Body Fluids and the Blood
   F. Control of Cardiovascular Functions
VII. Respiration
   A. General Considerations
   B. Respiratory Mechanisms of Aquatic and Terrestrial Animals
   C. Phases of Respiration
   D. Regulation of Respiration

VIII. Digestion
- A. Nutritional Requirement and Feeding Types
- B. Digestion
- C. Movement of the Alimentary Tract
- D. Secretory Functions of the Alimentary tract and Digestive glands
- E. Absorption
- F. Egestion
- G. Coordination and Control of Digestive Processes

IX. Metabolism and Thermoregulation
- A. Energy Metabolism
- B. Major Metabolic Pathways
  1. Carbohydrates
  2. Proteins
  3. Lipids
- C. Metabolic Rate and Thermoregulation
  1. Temperature Relations of Ectotherms
  2. Temperature Relations of Endotherms
  3. Thermostatic Regulation of Body Temperature

X. Excretion and Osmoregulation
- A. Problems of Osmoregulation
  1. Aquatic and Terrestrial Animals
  2. Osmoregulatory Organs
- B. Vertebrate Kidneys
- C. Urine Function
- D. Renal Regulatory Organs

XI. Endocrine and Other Chemicals
- A. The Concept of First and Second Messengers
- B. Hormone and Hormone Actions
- C. Nature of the Different Chemical Regulators
  1. Neurotransmitters
  2. Hormone
  3. Neurosecretions
  4. Others
- D. The Different Hormones and their Actions (with emphasis on the reproductive hormones)

Laboratory

I. Structure and Function in a Unicellular Animal
II. Transport through Membranes
III. Nerve Physiology
- A. Reflex Action

IV. Nervous Physiology
V. Nervous-Muscle Physiology
- A. Skeletal Muscle
- B. Cardiac Muscle
- C. Smooth Muscle

VI. Vascular Physiology
- A. Circulation
- B. Control of Blood Vessels

VII. Blood
VIII. Enzyme Kinetics
IX. Respiration
  A. Oxygen Utilization-Carbon Dioxide Functions
  B. Respiration in the Frog
  C. Respiration in Man
X. Renal Physiology
  A. Osmoregulation in the Earthworms
XI. Endocrine Physiology

5.3 Laboratory Equipment, Facilities, Supplies and Chemicals

Basic glassware and supplies for experiments- 1 set per group of 5 students

Complete Set: Beaker (5,10,50,100,250,500,1000 ml),1 of each
Erlenmayer Flask (50,100,250,500 ml),1 of each
Petri Dish, 6 pairs
Glass droppers, 6 pcs.
Test Tubes (5 and 10 ml), 12 pcs.
Test Tube Holders
Hematocrit tubes (heparinized and plain types)

Basic Equipment: at least one unit per lab as listed above with the addition of the following equipments:

1. Kymograph 70006-000 Phipps and Bird (recommended brand),1 set per of 5 students
   Complete Set: Heart lever, Muscle lever, Inductorium, Signal Magnets, Writing stylus (smoke/ink type), Student Tambour, Pneumograph, Drum and Smoker
2. Respirometer
3. Stove, one unit per group of 5 students
4. Dissecting Instruments, 1 set per group of 5 students (ideal)
   Complete Set: scissors (regular and iris type), forceps (thumb and pean type), probe (spatula and exploratory type)
5. Dissecting Pans, 1 piece per group of 5 students
6. Turtle holder, 1 piece per group of 5 students
7. Spot plate (6 well type), 6 pcs. per group of 5 students
8. Thermometers (0-100°C) , 1 piece per group of 5 students
9. Stereozoom microscope
10. Compound microscope with ocular micrometer, 1 unit per student (ideal)
11. Stage Micrometer, 1 piece per group of 5 students
12. Electrophoresis Kit and Power Supply
13. Air conditioner, 1 unit
14. Electric Fans, 4 units
15. Exhaust Fans, 2 units
16. Fume, 1 unit
17. Holding pond for frog and turtle specimens
18. Glass Aquaria with aerators, 1 set per group of 5 students
19. Fire extinguisher
20. First Aid Kit

5.4 Recommendations

I. Animal physiology must be offered as a 5-unit course, 3 units for the lecture (3 hours/week) and 2 units for the laboratory (6 hours/week) as to accommodate necessary discussions on mammalian/human systems.

II. The general outline given, including sequencing should be followed as much as possible but flexibility as to details of discussions is allowed.

III. Perform at least one experiment per general topic as outlined.

IV. No one good book for Animal Physiology is recommended and other references/texts may be allowed for use by students provided date of publication is not beyond 10 years.

5.5 Recommended Texts/References for Physiology II (Animal Physiology)

1. Best and Taylor. Physiological Basis of Medical Practice (Latest Edition)
2. Bullock, J., J. Boyle, M.B. Wang. 1995. Physiology. (3rd ed. or latest edition). U.S.A.: Williams & Wilkins, Co.
3. Eckert, R. 1988. Animal Physiology Mechanisms and Adaptations. New York: W.H. Freeman & Company.
4. Fregly, M.J. & C.M. Blatteis. 1996. A Critical, Comprehensive Presentation of Physiological Knowledge and Concepts. New York; Oxford University Press.
5. Ganong, F.W. Review of Medical Physiology. (Latest Edition). U.S.A.: Lange Medival Publications.
6. Guyton, A.C. & J.E. Hall. 1996. Textbook of Medical Physiology. (9th ed. or latest edition). Philadelphia: W.B. Saunders Co.
7. Hoar, W.S. General and Comparative Physiology. New Jersey: Prentice-Hall, Inc.
8. Rhodes, R. & R. Pflanzer. Human Physiology. 1996. Philadelphia: Saunders College Publishing Harcourt Brace College Publishers.
9. Samueloff, S. & M.K. Yousef. 1987. Adaptive Physiology to Stressful Environments. Boca Raton, Fla.: CRC Press
10. Schmidt-Nielsen, K. Animal Physiology. 1990. New Jersey; Prentice-Hall, Inc.
11. Thibodeau, G.A. 1987. Anatomy and Physiology Laboratory Manual. St Louis: Times Mirror/ Mosby College Publishing.
12. Tortora, G.J. & S.R. Grabowski. Principles of Anatomy and Physiology. (8th ed. or latest edition). New York: Harper Collins College Publishers.
13. Tortora, G.J. et al. Principles of Human Physiology. New York: Harper & Row Publishers.
14. Withers, P.C. 1992.Comparative Animal Physiology.

6. DEVELOPMENTAL BIOLOGY

6.1 Course Description

Early development of representative vertebrates, processes and principles.

Credit: 5 units (3 lecture/2 lab)
Prerequisite: General Biology 1 and 2 or General Zoology and General Botany: 10 units (lecture and lab)
Morphoanatomy
Biochemistry, if possible

6.2 Course Outline

I. Nature and Scope of Development
   A. Historical Review
   B. Phases of Ontogenetic Development

Genetic Background of Development
   A. Cell Cycle: A Review
   B. Eukaryotic Genome and its Utilization in Development and Differentiation

III. Gametogenesis and Hormones in Reproduction and Development
   A. Spermatogenesis
      1. Spermatogenetic Cells, Meiosis
      2. Differentiation of Spermatozoa
   B. Oogenesis
      1. Growth and Accumulation of Food Reserves
      2. The Egg Programmed for Development
         Polarity and Specialized Cytoplasmic Zones
         Cortical Layer
   C. Changes in the Nucleus, Ovulation, Egg Transport
   D. Hormonal Regulation

IV. Fertilization
   C. Significance of Fertilization
   D. Biochemical and Physiologic Events
   E. Activation and Parthenogenesis

V. Cleavage: Becoming Multicellular and Developmental Consequences
   A. Characteristics of Cleavage
   B. Cleavage Types and Blastulas
   C. Cytoplasmic Localization as a Mechanism Regulating Differentiation
   D. Maternal Regulation of Early Development

VI. Gastrulation and the Formation of the Primary Organ Rudiments
   A. Presumptive Organ-Forming Areas (Fate Maps) of Embryos
   B. Rearrangement of Presumptive Germ Layers during Gastrulation in Amphibia, Aves and Mammals
   C. Physiology of Gastrulation

VII. Determination and Differentiation
   A. Potencies of the Ectoderm of an Early Gastrula
   B. Embryonic Induction and Mechanism of Action
   C. Creation of Form during Gastrulation and Subsequent Development
VIII. Development of the Nervous System
   A. The Brain and the Spinal Cord
   B. The Cranial and Spinal Nerves
   C. The Autonomic System
   D. Other Derivatives of the Neural Crest
   E. The Sense Organs
IX. Development of the Integumentary System
   A. Epidermis-from the Epidermal Ectoderm
   B. Dermis-Development of Connective Tissue from the Dermatome
X. Development of the Skeletal System
   A. Notochord
   B. Differentiation of Cartilage and Bones from Sclerotome
XI. Development of the Muscular System
   A. Visceral Muscles
   B. Skeletal Muscles
   C. Cardiac Muscle
XII. Development of the Excretory and Reproductive System
XIII. Extra-embryonic Membranes and the Circulatory System
   A. The Extra-embryonic Membranes
   B. Origin and Development of Blood, Blood Vessels and Heart
   C. Changes in the Circulation at Parturition
XIV. Development of the Digestive System from the Primitive Mesenteron
   A. The Digestive Tract
   B. The Digestive Glands
XV. Development of the Respiratory System: Gills, Lungs and Larynx
XVI. Development of the Endocrine Glands

6.3 Laboratory Equipment and Facilities

A. Basic Equipment: Compound microscopes (10x, 40x and 100x objectives) and slides, one per student
B. Optional Equipment: Television and VCR, one unit
   Overhead projector (slide and transparency), one unit

6.4 Suggested References

1. Gilbert, SD.F. 1997. Developmental Biology. Fifth Edition. Sinauer Associates, Inc., Sunderland, Massachusetts
2. Oppenheimer, S. and G. Leferre Jr., 1989. Introduction to Embryonic Development. Third Edition. Prentice Hall, Englewood Cliffs, New Jersey 07632
3. Balinsky. An Introduction to Biology. Latest edition. Saunders.
4. Carlson, B.M. Patten's Foundation of Embryology. latest edition. McGraw-Hill.NY.

5. Sussman, M. 1973. Developmental Biology: It Cellular and Molecular Foundations. Prentice-Hall. Englewood Cliffs, NJ.
6. Nelsen, O.E. Comparative Embryology of the Vertebrates. McGraw-Hill Book Company
7. Rugh, Roberts. Experimental Embryology: Techniques and Procedures, Burgess Pub., Minneapolis.
8. Billet, F.S. 1982. Egg Structure and Animal Development (Contemporary Biology Series). E. Arnold. London.
9. Current Journals in the discipline like "Development Biology," Academic Press or general scientific journals like "Nature," "Science" and "Scientific American."

7. GENETICS

7.1 Course Description

Mechanisms of heredity and variation, cytogenetics, mutation, nature of genes, population genetics and evolutionary genetics; biometrical procedures.

Credit:	3 units
Prerequisites:	Biology 2 or Biology 3 or Botany 1 and Zoology 1
No. Of Hours:	5 hours a week (2 hrs. Lecture and 3 hrs. Laboratory)

7.2 Course Objectives

To enable the students to understand the following basic principles underlying heredity and variation.

1. The nature, expression, and regulation of genes in the individual.
2. The mechanisms of genetic transmissions.
3. The sources of variation in individuals and populations.
4. The behavior of genes in populations.

7.3 Course Outline

7.3.1 Lecture

Lecture No.	No. of Hours
I. Genetics : The Science of Heredity and Variation A. Definition of Genetics B. The Beginnings of Genetics C. The Scope of Genetics D. Application of Genetics	2
II. The Chromosomal Basis of Heredity A. The Cell B. The Chromosome Structure C. Cell Division : 1. Mitosis 2. Meiosis	2

D. Life Cycles :
    1. Terminal or Gametic Meiosis
    2. Intermediary or Sporic Meiosis
    3. Initial or Zygotic Meiosis

III. Gene Segregation and Interaction 3
A. Law of Segregation
B. Law of Independent Assortment
C. Segregation and Assortment in Haploid Organism
D. Dominance Relationship:
    1. Complete Dominance
    2. Incomplete or No Dominance
    3. Overdominance
    4. Co-dominance
E. Multiple Alleles
F. Lethal Genes :
    1. Recessive Lethals
    2. Dominant Lethals
G. Modifier Genes
H. Gene Interactions:
    1. Novel Phenotypes
    2. Recessive Epistasis
    3. Dominant Epistasis
    4. Complementary Genes
    5. Duplicate Genes
I. Pseudoalelles
J. Environmental Influence on Gene Expression :
    1. Definition of Terms
    2. External Environment
    3. Internal Environment
K. Twin Studies: Concordance and Discordance
L. Probability and Statistical Testing:
    1. Level of Significance
    2. Chi-Square Test
    3. Binomial Distribution

IV. Linkage and Recombination 2
A. Definition of Linkage
B. Determination of Linkage
C. Chromosome Mapping: Linkage Maps
D. Factors Affecting Recombination Frequencies
E. Mechanisms of Crossing Over
F. Sex Determination
G. Sex Linkage

V. The Chemical Basis of Heredity 2
A. The Concept of the Gene
B. Chemical Composition of the Chromosome
C. DNA as the Genetic Material
D. Chemical Composition of the DNA
E. Molecular Structure of DNA
F. Organization of DNA in Chromosomes:
    1. Prokaryotic Chromosomes
    2. Eukaryotic Chromosomes

G. Replication or Synthesis of DNA:
    1. Mode of Replication
    2. Process of DNA
    3. Replication
    4. Confirmation of DNA
    5. Replication
H. Error Correction in DNA Replication
I. RNA as the Genetic Material

VI. Gene Function: Proteins and Enzymes 3

A. Genetic Control of Proteins:
    1. Gene - Enzyme Relationship:
    2. Inborn Errors of Metabolism
    3. One-Gene - One Enzyme Hypothesis
    4. Protein Structure
    5. Colinearity of DNA and Proteins

B. Protein Synthesis
    1. Central Dogma of Molecular Biology
    2. General Information Transfers
        2.1. Transcription
        2.2. Translation
    3. Special Information Transfers
    4. Interrupted Genes

C. The Genetic Code:
    1. The Triplet Code
    2. The Universality of the Genetic Code

D. Regulation of Gene Action:
    D.1.Regulation of Gene Action in Prokaryotes
        1. Definition of Terms
        2. Negative Transcriptional Control Systems
        3. Positive Transcriptional Control Systems
    D.2. Regulation of Gene Action in Eukaryotes
        1. The Britten-Davidson Model
        2. Control of Specific Gene Expression by Hormones

VII. Genes in Development 2

A. Differential Gene Action:
    1. The Basis of Cell Differentiation
    2. Gene Amplification
    3. Transcriptional Control
    4. Translational Control
    5. Epigenetic Control Mechanisms

B. Neoplasmic Interactions :
    1. Molecular Exchanges Between Nucleus and Cytoplasm
    2. Control of Macromolecular Synthesis in the Nucleus by the Cytoplasm

C. Genes and Morphogenesis:
   1. Gene Effects on System of Embryonic Induction
   2. Gene Effects on Endocrine Systems
   3. Gene Effects on Migrating Cells
   4. Gene Effects on the Regulation of Growth and Metabolism

VIII. Mutation 2
A. Variation in Genome Structure or Numerical Changes of the Chromosomes
Euploidy:
   1. Autopolyploidy
   2. Allopolyploidy
   3. Physical Characteristics of Polyploids
   4. Segregation and Linkage in Polyploids
   5. Aneuploidy

B. Changes in Chromosome Structure or Chromosomal Aberrations
   1. Deficiencies or Deletions
   2. Duplications or Repeats
   3. Inversions
   4. Interchanges and Reciprocal Translocations

C. Gene Mutations
   1. Microlesions: Base Pair Substitution
   2. Frameshift Mutations
   3. Mutator Genes
   4. Transposons or Jumping Genes

D. Reverse Mutations
E. Mutagenic Agents
F. Evolutionary Significance of Mutations

IX. Delayed Chromosomal and Extrachromosomal Inheritance 1
A. Delayed Chromosomal Inheritance
B. Extrachromosomal Inheritance:
   1. Cytoplasmic Inheritance
   2. Cytoplasmic Particles
   3. Chloroplasts
   4. Mitochondria

C. Plasmids of Extracellular Origin:
   1. Infective Heredity
   2. Episomes

D. Criteria for Extrachromosomal Inheritance

X. Quantitative Inheritance 2
A. Inheritance of Quantitative Characters:
   1. Multiple Genes
   2. Number of Genes in Polygene Systems
   3. Regression to the Mean
   4. Effects of Dominance and Gene Interactions
   5. Effects of Genes in Multiplying Effects

B. Analysis of Quantitative Characteristics
C. Components of Phenotypic Variance

D. Heritability:
1. Heritability in the Narrow Sense
2. Heritability in the Broad Sense

XI. Genes in Populations 2
A. Population Genetics
B. Gene Frequencies and Equilibrium:
1. Gene Frequencies
2. Gene Pool
3. Model System for Population Stability:
(Hardy - Weinberg Law)
C. Changes in Gene Frequencies
1. Mutation
2. Selection
2.1. Relative Fitness
2.2. Selections and Variability
2.3. Selection and Mating
3. Systems
4. Migration
5. Genetic Drift
D. Race and Species Formation
1. The Concept of Races
2. The Concept of Species
2.1. Reproductive Isolating Mechanisms
2.2. Rapid Speciation

XII. Genetics and Man 2
A. Cytogenetics
B. Inborn Errors of Metabolism
C. Behavioral Genetics

XIII. Genetic Engineering and Biotechnology 2
A. Recombinant DNA/Genetic Engineering
B. Applications of Genetic Engineering:
1. Researches on Human Genes
2. Researches on Animal Genes
3. Researches on Plant Genes
4. Researches on Microbial Genes
C. The Release of Genetically Engineered Organisms:
1. Biosafety and Ecological Implications:
1.1. Potential Ecological Concerns
1.2. Regulatory Policies

7.3.2 Laboratory

Laboratory Exercises in Genetics

Exercise No.	Title	No. of Meetings
1	The Physical Basis of Heredity	2
2	Gene Segregation and Interaction	2

3	Linkage and Recombination	1
4	Molecular Basis of Heredity	1
5	Central Dogma of Molecular Biology Replication and Gene Action	2
6	Regulation of Genes and Their Products	1
7	Mutations	1
8	Extrachromosomal Inheritance	1
9	Quantitative Inheritance	1
10	Genes in Populations	2
11	Human Genetics	1
12	Recombinant DNA Technology	1

7.4 Laboratory Equipment and Facilities

A. Basic glassware and supplies for experiments
B. Equipment

Required:
1. Microscope good for students in one laboratory section at one unit per student
2. Measuring tools
3. Hot plate
4. Refrigerator
5. Incubation oven
6. Fumehood
7. Homogenizer

Desired:
1. Multi hotplate stirrer
2. Laminar flowhood
3. Autoclave
4. Water bath shaker
5. Micro centrifuge
6. Electrophoresis apparatus with power supply
7. Spectrophotometer
8. pH meter
9. Vacuum pump
10. Micropipette
11. Tran illuminator
12. Polaroid camera
13. Microscope with mounted camera assembly

C. List of Chemicals/Supplies for Genetics

Required:
Chemicals
1. Glacial acetic acid
2. Carmine powder
3. Ethyl alcohol
4. Ether
5. Colchicine

Supplies

1. Dissecting needles with curved ends
2. Alcohol lamp
3. Blades
4. Forceps
5. Cover slip
6. Glass slides
7. Refluxing apparatus
8. Culture bottles
9. Cotton
10. Absorbent paper
11. DNA-RNA KIT
12. Replication kit
13. Gene action kit
14. Colored cartolina
15. Scissors
16. Seed box
17. Graphing paper
18. Calculator
19. Black and white buttons
20. Laboratory glassware (beakers, flasks)

Desired:

Chemicals:

1. Tissue culture media
2. Electrophoresis buffer and staining systems for isozyme analysis
3. Starch or polyacrylamide
4. Agarose
5. Chemical reagents for DNA Extraction
6. Chloroform
7. SS phenol
8. Sodium acetate
9. Restriction endonucleases
10. Ethidium bromide

Supplies

1. Blotting membrane
2. Non-radioactive labeling & detection kit
3. Films and developing supplies
4. Laboratory wares (pipette tips, disposable centrifuge tubes, Saran wrap, plastic trays, etc.)

7.5 Suggested References

1. AYALA, F.J. and J.A. KIGER, JR. 1984. Modern Genetics (2nd ed. or latest edition). Benjamin Cummings Pub. Co., Inc. Calif.
2. BURNS, G. And P.J. BOTTIN. 1989. The Science of Genetics. MacMillan Pub. Co., N.Y.
3. ETIENNE-DECANT, J. 1988. Genetic Biochem: From Gene to Protein. Ellis Harwood Ltd., Great Britain.

4. GARDNER, (1984) and D.P. SORUSTAD. 1984. Principle of Genetics. 7th ed or latest edition. John Wiley and Sons, N.Y.
5. GOODENOUGH, U. 1984. Genetics. (2nd Ed.)
6. HAWLANS, J. A. 1985. Gene Structure & Expression. Cambridge Univ. Press: Cambridge.
7. KLUG, W.S. and M.R. CUMMINGS. 1994. Concepts of Genetics, 4th Ed or latest edition. MacMillan Publishing Co., New York.
8. LAUDE, R.P., A.A. BARRION, M.S. MENDIORO, M.G.Q. DIAZ, N.N. BEBING and D.A. RAMIREZ. 1997. Genetics Laboratory Manual. Seven Lakes Printing Press, San Pablo City, 125 pp.
9. LEWIN, B. 1997. Genes VI (6th ed. or latest edition). Oxford Univ. Press.
10. RAMIREZ, D.A. 1991. Genetics (7th ed. or latest edition) UPLB-SEARCA SEAMEO. 217 pp.
11. ROTHWELL, N.V. 1993. Understanding Genetics: A Molecular Approach. Wiley-Liss: A John Wiley & Sons, Inc., New York.
12. RUSSEL, P.J. 1993. Genetics. Harpes Collins Publisher.
13. STRICKBERGER, M.W. 1985. Genetics (3rd ed. or latest edition) MacMillan Pub. Co., New York.
14. SUZUKI, D.F., J.F. GRIFFITH, J.H. MILLER and R.C. LEWONTIN. 1989. An Introduction to Genetic Analysis, 4th ed. or latest edition. W.H. Freeman & Co., New York.
15. WEAVER, R.F. and F.W. HEDRICK. 1992. Genetics. 2nd ed. or latest edition . Wm & C. Brown Publishers, Dubuque, IA., USA.

8. GENERAL ECOLOGY

Credit: 5 units (3 lecture/2 lab)
Prerequisite: General Biology 1 and 2 or General Zoology and General Botany: 10 units (lecture and lab)
Analytical Chemistry
Statistics

8.1 General Ecology, Lecture

8.1.1 Course Description

General Ecology lecture is 3-unit introductory course on the biology and properties of ecological systems. It consists of three lecture hours per week on the general concepts and principles pertaining to the complex pattern of interactions between the physical environment and the communities on Earth. Emphasis is given on the current issues, especially in the Philippine context.

8.1.2 Course Objectives

At the end of the term, the student should be able to:
1. Articulate the general concepts and principles of ecology; and
2. Integrate ecological concepts and principles to current environmental issues and practice.

Values Aims:

1. To increase the student's awareness of his role in nature;
2. To help the student realize our special power to alter the biosphere and special responsibility for its health; and
3. To help the student develop respect and nurturing of Mother Nature.

8.1.3 Course Outline

I. Introductions — Week 1-2
- A. Definitions
- B. Why and How to Study Ecology
- C. Scientific Method
- D. The Effects of Scale
- E. Evolutionary Ecology
  - 1. How Variation Originates
  - 2. How Variation is Maintained
  - 3. How Much Variation Exists in Nature
  - 3. Reduction in Variation

II. Natural Selection and Speciation — Week 3
- A. Phylogenetics
- B. The Fossil Record
- C. Extinction: Causes and Patterns

III. Behavioral Ecology — Week 4-5
- A. Group Selection
- B. Altruism
- C. Living in Groups
- D. Resource Assessment
- E. Animal Communication
- F. Foraging Behavior and Optimality in Individuals
- G. Maintenance of Sex Ratios
- H. Sexual Selection
  - 1. Polygyny
  - 2. Polyandry

IV. Population Ecology — Week 6-8
- A. Physiological Ecology
- B. Abiotic Factors
- C. Population Growth
- D. Mutualism and Commensalism
- E. Competition
- F. Predation
- G. Hervivory and Parasitism
- H. Causes of Population Change

V. Community Ecology — Week 9-11
- A. Species Diversity and Community Stability
  - 1. Island Biogeography
- B. Community Change
- C. Ecosystems (Main types of Communities)

VI. Applied Ecology — Week 12-15

A. The Effects of Humans
B. Human Population Growth
C. Loss of Wildlife through Human Activity
D. How to Solve Ecological Problems
E. Patterns of Resource Use
   1. Water Catchment Areas
   2. Forestry
   3. Agricultural Land
   4. The Sea
F. Waste and Pollution
   1. Wastes Emitted in the Atmosphere
   2. Economic Poisons
   3. Contamination by Organic Substances
   4. Eutrophication

VII. Introduction of Exotic Species, Epilogue Week 16

8.2 General Ecology, Laboratory

8.2.1 Course Description

General Ecology laboratory is 2-unit introductory course on the biology of the ecosystems. It consists of 6 laboratory hours per week dealing with the basic principles and methodologies pertaining to population and community structure and the assessment of environmental quality.

8.2.2 Course Objectives

At the term, the student should have familiarized themselves with the basic ecological laboratory procedures and be able to apply such in a real ecosystem setting.

Value Aims:
1. To increase the student's awareness of the place of humans in nature;
2. To help the student realize our special power to alter the biosphere and special responsibility for its health; and
3. To help the student develop respect and nurturing of Mother Nature.

8.2.3 Course Outline

I. Assessment of the Aquatic Environment Week 1-5

A. Physical Characteristics of Water
   1. Temperature
   2. Depth
   3. Suspended solids
   4. Color
   5. Transparency

B. Chemical Characteristics of Water
   1. pH
   2. Dissolved Oxygen
   3. Hardness
   4. Alkalinity
   5. Acidity
   6. Salinity
   7. Conductivity
   8. Nitrate content
   9. Orthophosphate content
   10. Silicate content

C. Biological Characteristics
   1. Primary Productivity Studies
      1.1. Plankton Productivity Estimation
      1.2.Chlorophyll Analysis
      1.3. Light and Dark Bottles Technique
   2. Population and Community Structure Studies/Plankton Cell Count using the Sedgwick Rafter method or the haemocytometer method

II. Assessment of the Terrestrial Environment Week 6-10

A. Climatological Measurements
   1. Light Intensity
   2. Wind Velocity
   3. Atmospheric Pressure
   4. Air Temperature

B. Physical Properties of the Soil
   1. Soil Temperature
   2. Soil Texture
   3. Composition

C. Chemical Properties of the Soil
   1. pH
   2. N, P, Ca and humus content

D. Biological Properties
   1. Primary Productivity Studies
      1.1 Macrophyte Productivity Estimate and Harvest
   2. Population and Community Structure
      1.2 Plant Population Studies (line intercept, transect and point quarter methods)

III. Field Study Week 11-13
IV. Biodiversity Studies Week 14-15
V. Tolerance to Environmental Factors Week 16

8.3 Laboratory Equipment and Facilities

A. Basic glassware for experiments
B. Equipment:

1. Required

1. sling psychrometer	9. salinometer/ refractometer	17. compass
2. thermometer	10. sieves	18. spectrophotometer

(soil and air)
3. barometer
4. light meter -- LICOR
5. wind meter
6. oven/incubator
7. weighing scale
8. pH meter/pH paper
11. plankton net
12. dessicators
13. centrifuge
14. refrigerator
15. dissecting microscope
16. transect line (50 m)
19. furnace
20. quadrats (0.25m2 & 1m2)
21. vacuum pump
22. secchi disc
23. BOD bottles/ burettes, pipettes, flask

2. Desired
1. DO meter (digital) & accessories (O2 probe & mechanical stirrer)
2. sediment sampler
3. mechanical shaker
4. water sampler

C. Desired Chemicals and Supplies:
1. ascorbic acid
2. acetone
3. ammonium molybdate tetrahydrate
4. antimony potassium tartrate
5. 1-amino-2 naphtol-4 sulfuric acid
6. EDTA
7. EBT-powder
8. methyl orange
9. hydrochloric acid
10. sodium thiosulfate
11. sulfuric acid
12. manganous sulfate
13. ammonium hydroxide
14. potassium iodide
15. sodium iodide
16. potassium hydroxide
17. sodium hydroxide
18. phenolphthaline indictor
19. potassium dihydrogen phosphate
20. sulfanilamide
21. N-1 napthyl ethylene-diamine
22. potassium nitrate
23. ammonium chloride
24 borax.
25. sodium sulfite
26. spongy cadmium
27. cadmium sulfate
28. tartaric acid
29. starch
30. formalin
31. silica
32. GF/C Filter Paper

8.4 Recommended Texts/References

1. Begon, M., Harper, J.L. and C.R. Townsend. 1996. Ecology: Individuals, Populations and Communities. 3rd ed. or latest edition. Blackwell.
2. Brewer, R. 1994. The Science of Ecology. 2nd ed. or latest edition. Saunders College.
3. Bush, M.B. 1997. Ecology of A Changing Planet. Prentice Hall.
4. Caldsa, M.P., Cervencia, C.R., Cuevas, V.C. and Z.N.Sierra. 1994. Laboratory Guide in Ecology. 2nd ed. or latest edition. UPLB Pub. Center.
5. Colinvaux, P. 1993. Ecology 2. John Wiley and Sons Inc.

6. Jackson, A.R.W. and J.M. Jackson. 1996. Environmental Science. Longman
7. Kupchella, C.E.1993. Environmental Science: Living Within the System of Nature. 3rd ed. or latest edition. Prentice Hall.
8. Lobbman, C.S., Chapman, D.J. and B.P. Kremer Eds. 1988. Experimental Phycology. A Laboratory Manual. Cambridge Uni. Press.
9. Miller,G.T., Jr. 1997. Living in the Environment. Principles, Connections and Solutions. Wadsworth Pub. Co.
10. Miller, G.T. Jr. 1997. Environmental Science. 6th ed. or latest edition. Prentice Hall.
11. Nebel, J.B. and R.TR. Wright. 1998. Environmental Science. The Way the World Works. 6th ed. or latest edition. Prentice Hall.
12. Odum.E.P. 1971. Fundamentals of Ecology. 3rd ed. Saunders
13. Stiling, P.D. 1996. Ecology. Theories and Applications. 2nd ed. Prentice Hall
14. Smith, R.L.1974. Ecology and Field Biology. 2nd ed. Harper Row.
15. Umaly, R. and M.L.V. Cuvin. 1988. Limnology Laboratory and Field Guide. Physico-chemical Factors. Biological Factors. National Bookstore.

9. MICROBIOLOGY

Credit: 4 or 3 units (2 lectutre/2 or 1 lab)
Prerequisite: General Biology 1 and 2 or General Zoology and General Botany: 10 units (lecture and lab)

9.1 General Microbiology, Lecture

9.1.1 Course Description

General Microbiology is a two-unit course on the anatomy, physiology and genetics of microorganisms, i.e. bacteria, algae, fungi, protozoans, viruses, viroids and prions. It also involves the study of their roles in the environment, in industry and medicine. Since algae, fungi and protozoans are usually taken up in other biology courses, emphasis may be placed on the study of bacteria, viruses, viroids and prions.

9.1.2 Course Objectives

At the end of the course, the student is expected to know:

1. The structure of microorganisms as they relate to their functions.
2. The physiology and genetics of microorganisms, also how they relate to biotechnology.
3. The roles played by microorganisms in relation to man and his environment.

9.1.3 Course Outline

		No. of Hours
I.	Origin and Evolution of Life	1
II.	History of Microbiology	1
III.	Microbial Diversity/Survey of Microbial World	2
	A. Cellular	
	1. Prokaryotes: archaebacteria, eubacteria	
	2. Eukaryotes: fungi, algae, protozoans	
	B. Acellular	
	1. Viruses	
	2. Viroids	
	3. Prions	
	C. Classification Schemes	
	1. Two-Kingdom System	
	2. Three-Kingdom System	
	3. Four-Kingdom System	
	4. Five-Kingdom System	
	5. Six-Kingdom System	
IV.	Microbial Anatomy	3
V.	Microbial Growth Requirements	2
	A. Microbial Nutrition	
	B. Physical Factors Affecting Growth	
VI.	Microbial Growth and Reproduction	1
VII.	Microbial Metabolism	4
	A. Aerobic Metabolism	
	B. Anaerobic Metabolism	
	1. Anaerobic respiration	
	2. Fermentation	
	C. Photosynthesis	
VIII.	Microbial Genetics	4
	A. Mechanisms of Processes Involved in the Flow of Genetic Information (Central Dogma)	
	1. Replication	
	2. Transcription	
	3. Translation	
	B. Genetic Variation	
	1. Mutation	
	2. Genetic Recombination	
	C. Applications in Biotechnology	
IX.	Viruses	2
X.	Viroids	1
XI.	Prions	
XII.	Control of Microorganism (may be discussed in the laboratory class together with the corresponding lab exercises)	3
	A. Chemotherapeutic Agents	
	B. Physical Agents	
	C. Chemical Agents	

XIII.	Microorganisms in Environmental Science A. Role in Geochemical Cycles B. Role in Biodegradation of Solid Wastes, Liquid Wastes	3
XIV.	Microorganisms in Industry	3
XV.	Microorganisms in Disease Causation	2
		29+3 meetings for long exams (including final exam)

9.2 General Microbiology, Laboratory

9.2.1 Course Description

The laboratory course introduces the students to hands-on study of microscopic and colonial morphology of microorganism, as well as their growth and other physiological characteristics. Aseptic techniques and preparation of laboratory materials, e.g. culture media, glassware, are emphasized. It also includes procedures for control of microbial growth, the identification of microorganisms, exercises in food, water and industrial microbiology.

9.2.2 Course Objectives

At the end of the course, the student is expected to:

1. Have mastered the techniques in microbiology, e.g. aseptic techniques, culture media preparation, staining, microscopy, etc.
2. Know the structure, morphology and physiology of microorganisms and relate these information to identification of the microorganisms.
3. Know the useful and harmful effects of microorganisms on man and his environment.

9.2.3 Course Outline

For one unit course

		No. of Meetings
I.	Microscopy	1
II.	Culture Media Preparation/Sterilization	1
III.	Aseptic Techniques/Study of Microorganisms from the Surroundings, Normal Body Flora	1
IV.	Microscopic Examination of Microorganisms A. Wet Mount B. Staining Techniques 1.Gram Stain 2. Special Stains (spore stain, capsule stain, flagellar stain)	2
V.	Physical Factors Affecting Microbial Growth	1
VI.	Biological Activities of Microorganisms	1

VII.	Antibiotic Susceptibility Testing	1
VIII.	Screening of Mutation to drug resistance or auxotrophy	1
IX.	Bacteriology	1
X.	Wine Fermentation	1
XI.	Yoghurt production/Kimchi or sauerkraut production	1

Additional Exercises for 2-unit course

XII. Bacterial Genetics Exercises
- A. Genetic Recombination Studies
  1. Transformation
  2. Conjugation

XIII. Environmental Microbiology Exercises
- A. Isolation of Soil Microorganisms and Screening for Antimicrobial Activities
- B. Winogradsky Column Study
- C. Isolation and Study of *Rhizobium* sp.

XIV. Medical Microbiology Exercises
- A. Gram (+) Pyogenic Cocci
- B. Enterobacteriaceae
- C. Acid Fast Bacilli
- D. Sexually Transmitted Diseases

9.2.4 Laboratory Equipment, Facilities, Chemicals and Supplies

A. Basic glassware/materials for experiments: test tubes, petri dishes, Erlenmeyer flask, serological pipettes, inoculating loops, inoculating needles

B. Required Equipment

1. Compound microscope one per student
2. Balance, one unit per lab
3. Oven, one unit per lab
4. Incubator, one unit per lab
5. Stove, one unit per lab
6. Refrigerator, one unit per lab
7. Bunsen burner or alcohol lamp
8. Autoclave

C. Desired Equipment

1. Television and VHS, one unit
2. Overhead projector (slide and transparency), one unit

D. Required Chemicals and Supplies

1. Culture Media
2. Biochemical Test Media
3. Staining reagents

9.2.5 Suggested References

1. Alcano, E. 1991. Fundamentals of Microbiology. 3rd ed. or latest edition. Benjamin/Cummings Publishing Company, Inc.

2. Finegold, SX.M. and E.J. Baron. 1995. Bailey and Scott's Diagnostic Microbiology. The C.V. Mosby Company.
3. Joklik, W.M., H.P. Willet, D.B. Amos and C.M. Wilfert.1992. Zinsser Microbiology. 20th ed. or latest edition. Prentice-Hall Interantional Inc.
4. Kimball, J.W. 1994. Biology. 6th ed. or latest edition. Wm. C. Brown Communications, Inc.
5. Madigan, M.T., J.M. Martinko, J. Parker. 1997. Brock's Microbiology. 8th ed. or latest edition. Prentice-Hall.
6. Pelczar, Jr., M.J., E.C.S Chan and N.R. Kreig. 1993. Microbiology. 6th ed. or latest edition. McGraw-Hill.
7. Perry, J.J., J.T. Staley.1997. Microbiology: Dynamics and Diversity. Saunders College Publishing
8. Prescot, L.M. J.P. Harley and D.A. Klein. 1993. Microbiology. 2nd ed. or latest edition. Wm.C. Brown Communication, Inc.
9. Schelegel, H.C. 1992. General Microbiology. 3rd ed. or latest edition. Benjamin Cummings Pub. Co.
10. Talora, P. and A. Talaro. 1999. Foundations in Microbiology. 3rd ed. or latest edition. Mc-Graw-Hill Co., Inc.
11. Tortora, G.J., B.R. Funke and C.L./ Case. 1992. Microbiology and Introduction. 4th ed. or latest edition. Benjamin/Cummings Publishing Company, Inc.
12. Volk, W.A. and M.F. Wheeler.1988.Nbasic Microbiology. Harper and Rows Publishers, Inc.

10. CELL AND MOLECULAR BIOLOGY

10.1 Course Description

A study of the biochemical and molecular basis of cell structure and function. It also includes the study of the techniques used to arrive at the understanding of cell structure and function.

Credit: 3 units (lecture); *optional 2 units lab*
Prerequisites: General Biology 1 and 2 or General Zoology and General Botany: 10 units (lecture and lab)
General Chemistry
Organic Chemistry
Biochemistry (optional)

10.2 Course Objectives

At the end of the course, the student must be:

1. Able to understand the basic concepts of cell structure and function.
2. Familiar with the methods and techniques used in the study of cell structure and function.
3. Familiar with the applications of studies on cell structure and function especially in the field of biotechnology.

10.3 Course Outline

10.3.1 Lecture

I. Introduction (Overview)
   - A. The Cellular Basis of Life
   - B. Techniques and Methods of Studying Cells

II. Biochemistry of the Cell
   - A. Water, the Aqueous Environment
   - B. Biomolecules

III. Cell Surface and Extra Membrane Components
   - A. Nature and Composition of Plasma Membrane
   - B. Functions and Activities of Cell Membrane
   - C. Extramembrane Components (including Extracellular Matrix)

IV. Endomembrane System
   - A. The ER and its Derivatives
   - B. The Golgi Complex
   - C. Lysosomes and Peroxisomes
   - D. Membrane Flow and Sorting (Trafficking)

V. The Cytoskeleton and Cell Motility
   - A. Microtubules
   - B. Microfilaments
   - C. Intermediate Filaments
   - D. Cell Motility

VI. Bioenergetics
   - A. Mitochondria and Cell Respiration
   - B. Chloroplast and Photosynthesis

VII. Cell Nucleus
   - A. Chromosome Structure and Genes
   - B. Cell Cycle and DNA Replication
   - C. Transcription and RNA Processing
   - D. Organization and Evolution of the Nuclear Genome

VIII. Molecular Biology of the Gene
   - A. Gene Expression: Protein Synthesis and Sorting
   - B. Regulation of Gene Expression
   - C. Recombinant DNA

IX. Selected Topics (optional)

10.3.2 Laboratory (Optional)

Exercises	Hours																			
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1. Micrometry	■	■	■																	
2. Vital Staining	■	■	■																	
3. Microbial Population Growth	■	■	■	■	■	■	■	■	■	■	■	■								
4. Protein Extraction and Concentration	■	■	■	■	■	■														
5. Bradford Assay	■	■	■																	
6. Column Chromatography	■	■	■	■	■	■	■	■	■											
7. SDS PAGE	■	■	■	■	■	■														
8. Western Blotting	■	■	■	■	■	■														
9. DNA Extraction & Electrophoresis	■	■	■	■	■	■														

Exercises	Chemicals/Supplies	Equipment
1. Micrometry	- prepared slides	-Micrometer eyepiece (R) -Stage micrometer (R) -Microscope (R)
2. Vital Staining	- Janus green - Methyl green - Charcoal powder - Neutral red - Slides and cover slips	-Phase contrast microscope (R)
3. Microbial Population Growth	-*Tetrahyma* culture or Yeast culture - haemocytometer - 250 ml flasks	-Autoclave (R) -Microscope (R)
4.Protein Extraction and Concentration	-Animal and Plant Specimens -Na2HPO4 for PBS -KH2PO4 for PBS -KCl for PBS -NaCl for PBS -Dialysis bags -Eppendorf tubes -Tips (blue, yellow, white) -PBS -(NH4)SO4 -Centrifuge Tubes	-Centrifuge (R) -Micropipettes (R) -Stirrer/Hotplate (R) -Balance (R) -Refrigerator (R) -Homogenizer (R) -Vortex Mixer (R) -pH meter (R)

Exercises	Chemicals/Supplies	Equipment
5. Bradford Assay	-Coomassie Blue G250 -Phosphoric acid -BSA -Eppendorf tubes -Tips (blue, yellow, white)	-Spectrophotometer (Vis) (R) -Vortex mixer (D) -Micropipettes (R) -Centrifuge (R) -Balance (R) -Glass/plastic cuvettes (R)
6. Column Chromatography	-Matrix Sephadex G200 -Matrix Sephadex G100 -Tips (blue, yellow, white) -PBS -Eppendorf Tubes	-Column Tubes (R) -Peristaltic pump (D) -Micropipettes (R) -Fraction collector (D)
7. SDS PAGE	-Acrylamide -Bisacrylamide -Tris -Glycine -SDS -APS (Ammonium Peroxide Sulfate) -Eppendorf tubes -Filter paper -Temed -□-mercaptoethanol -Bromphenol blue -Commassie Blue R250 -Ethanol -Acetic acid -Tips (blue, yellow, white) -Molecular weight marker	-Glass plates with accessories (R) -Power supply (R) -Vortex mixer (D) -Electrophoresis set-up (R) -Centrifuge (R) -Micropipettes (R)
8. Western Blotting	-Nitrocellulose membrane -PBS -Tween 20 -Eppendorf tubes -Transfer buffer -ABC and DAB or other alternative coloring agents -Tips (blue, yellow, white) -Filter paper	-Micropipettes (R) -Power supply (R) -Transfer apparatus (R)
9. DNA Extraction and Electrophoresis	-Agarose -Bromphenol blue -Tris -EDTA -Cyclene xyanol -Ethidium bromide -NaCl -Boric acid -SDS -Ficoll -Eppendorf tubes -Tips (blue, yellow, white) -Centrifuge tubes	-Centrifuge (R) -Homogenizer (R) -Micropipettes (R) -Spectrophotometer (UV) (R) -UV transilluminator (R) -Glass/plastic cuvettes (R)

(R) – required (D) – desired

10.3.2.1 Recommendations

1. Laboratory portion (2 units) is optional depending on the capability of the school.
2. Sequencing of topics in the syllabus may not be the same as above. The school or the teacher is given the option for such re-arrangements as to its/his needs.
3. Textbooks outlined below are not required but rather suggested ones.
4. The school library must have scientific journal subscriptions, at least Scientific American.
5. The minimum faculty qualification for teaching cell and molecular biology is a BS Biology graduate that has taken Cell Biology. Ideally lecturers must be M.S. Biology graduates.

10.4 Laboratory Equipment and Facilities

A. Basic glassware and supplies for experiments:
   1. beakers - various sizes
   2. flasks - various sizes
   3. Test tubes and racks
   4. Pipettes - various sizes
   5. Graduated Cylinders - various sizes
   6. Petri dishes

B. Basic Equipment: (at least one unit per lab)
   1. Autoclave
   2. Balance - top loading and analytical
   3. Centrifuge (up to 20,000 rpm) plus accessories
   4. Electrophoresis equipment and power supply
   5. Hood (laminar flow, if possible)
   6. Hot plate/ stirrer plate
   7. Microscope - compound (with 10x, 40x, 100x lenses)
   8. Micropipettors (various volumes or adjustable volume) plus pipette tips
   9. pH meter plus accessories
   10. Refrigerator

C. Optional Equipment: Television and VCR, one unit
Overhead projector (slide and transparency), one unit

10.5 Suggested References

Texts

1. Alberts, B., et.al. 1994. 3rd ed. or latest edition. Molecular Biology of the Cell. Garland Pub.
2. Becker, W.M. and D.W. Deamer. 1991. The World of the Cell.
3. Becker, W.M., J.B. Reece and M.F. Poonie. 1996. The World of the Cell. 3rd ed. or latest edition. Benjamin/Cummings Pub. Co. N.Y.
4. Cooper, G.M. 1997. The Cell: A Molecular Approach. ASM Press. Washington D.C.
5. Karp, G. 1996. Cell and Molecular Biology. John Wiley.

6. Smith, C.A. and E.J. Wood. 1992. Cell Biology. Chapman and Hall.
7. Wolfe, S.L. 1993. Molecular and Cell Biology. Wadsworth Pub. Co..

Journal

1. Scientific American. October 1985 issue. The Molecules of Life.

ARTICLE VII
OTHER REQUIREMENTS

Section 19 Program Administration. The minimum qualifications of the head of the unit that implements the degree program are the following:

A. Dean of the unit/college. The dean of a unit/college must be at least a master's degree holder in any of the disciplines for which the unit/college offers a program; and a holder of a valid certificate of registration and professional license, where applicable.

B. Head of the Biology unit/department. The head of the department must be master's degree holder in the discipline for which the unit/department offers a program or a master's degree holder in an allied program identified in the policies and standards; and a holder of a valid certificate of registration and professional license, where applicable.

Section 20 Faculty

A. General Requirements

(1) As a rule, a master's degree in the discipline or its equivalent is required for teaching in the tertiary level.

(2) A minimum of 50% of the full-time faculty must have a Master's degree in the discipline or its equivalent

B. Qualification of faculty

Faculty teaching in a BS Biology program must have an appropriate master's degree from any of the allied fields in Section 7.

Teacher qualification for Physiology is listed below in the order of their priorities:

Lecture:

Ph.D.	-	Animal Physiology
	-	Zoology, Biology (Major in Animal Physiology)
M.S.	-	Animal Physiology
	-	Zoology, Biology (Major in Animal Physiology)
DVM	-	with teaching experience

MD - with teaching experience
Laboratory : as listed above, following the same order
BS - in Zoology, Biology with experience in Basic Biology Laboratory teaching

C. Full time faculty members
The institution shall maintain 50% of the faculty members teaching in the BS Biology program as full time.

D. Teaching Load
A faculty for the BS Biology program should not be assigned more than four (4) different courses/subjects within a semester.

E. Faculty Development.
The institution must have a system of faculty development. It should encourage the faculty to:
(1) Pursue graduate studies
(2) Undertake research activities and to publish their research output
(3) Give lectures and present papers in national/international conferences, symposia and seminars
(4) Attend seminars, symposia and conferences for continuing education

The institution must provide opportunities and incentives such as:
(1) Tuition subsidy for graduate studies
(2) Study leave with pay
(3) Deloading to finish a thesis or carry out research activities
(4) Travel grants for academic development activities such as special skills training and attendance in national/ international conferences, symposia and seminars.
(5) Awards & recognition

Section 21 Library

A. Policy
Libraries service the instructional and research needs of the staff and students making it one of the most important service units within an HEI. It is for this reason that libraries should be given special attention by HEI administrators by maintaining it with a wide and up-to-date collection, qualified staff, and communications and connectivity portals.

B. Library Staff
The Head Librarian should: 1) have an appropriate professional training; 2) be a registered librarian; and 3) have a Master's degree.

The library should be: 1) staff with one full time professional librarian for every 1,000 students and 2) a ratio of 1 librarian to 2 staff / clerks should be observed.

C. Library Holdings
Library holdings should conform to existing requirements for libraries. For the BS Biology program, the libraries must provide 5 book titles per professional course found in the curriculum at a ration of 1 volume per 15 students enrolled in the program. These titles must have been published within the last 5 years.

The HEI is likewise encouraged to maintain periodicals and other non-print materials relevant to environmental science to aid the faculty and students in their academic work. CD-ROMs could complement a library's book collection but should otherwise not be considered as replacement for the same.

D. Internet Access. Internet access is encouraged but should not be made a substitute for book holdings.

E. Space Requirements
At least 126 m^2. or approximately 2 classrooms shall be required for the library. It should include space for collections, shelving areas, stockroom, office space for staff and reading area

The library must be able to accommodate 5% of the total enrollment at any one time.

F. Finance.
All library fees should be used exclusively for library operations and development for collections, furnitures and fixtures, equipment and facilities, maintenance and staff development.

G. Networking
Libraries shall participate in inter-institutional activities and cooperative programs whereby resource sharing is encouraged.

H. Accessibility
The library should be readily accessible to all.

I. Office Hours
The library should be open to serve the needs of the users.

Section 22 Facilities and Equipment

A. Laboratory requirements
Laboratories should conform to existing requirements as specified by law (RA 6541, "The National Building Code of the Philippines" and Presidential Decree 856, "Code of Sanitation of the Philippines"). List of required and recommended equipment are listed in the course specifications above.

B. Classroom requirements

Class Size.

(1) For lecture classes, ideal size is 35 students per class, maximum is 50.
(2) For laboratory and research classes, class size shall be 20-25 students per class.
(3) Special lectures with class size more than 50 may be allowed as long as the attendant facilities are provided.

C. Educational Technology Centers
The institution should provide facilities to allow preparation, presentation and viewing of audio-visual materials to support instruction.

Section 23 Admission and Retention

The basic requirement for eligibility for admission of a student to any tertiary level degree program shall be graduation from the secondary level recognized by the Department of Education. Higher education institutions must specify admission, retention and residency requirements. They should ensure that all students are aware of these policies.

Article VIII. Repealing Clause

Section 24 All pertinent rules and regulations or parts thereof that are inconsistent with the provisions of this policy are hereby repealed or modified accordingly.

Article IX. Effectivity Clause

Section 25 These policies and standards for Bachelor of Science in Biology shall be effective first semester of school year 2005-2006.

Article XX. Transitory Provision

Section 26 HEIs with existing program in the Bachelor of Science in Biology shall be given a 3-year grace period to comply with these policies and standards.

For strict compliance.

Pasig City, Philippines July 22, 2005

FOR THE COMMISSION

CARLITO S. PUNO
Acting Chairman