FOUN004 Biology

Section 1: General Information

1.1 Administrative Details

Subject:	Biology
Code:	004
Stream	Health Science and Life Science
Points	12
Pre-requisite	Bridging Programme/ Level 2 Biology

1.2 Subject Workload

Number of timetabled hours per week	Number of Personal study hours per week	Total workload hours per week
4	4	8

1.3 Pre-requisites

Students are required to have undertaken a pre-requisite subject.
The pre-requisite is Bridging Programme or some science/biology at senior high school.

1.4 Other resource requirements

List specialist facilities and/or equipment required for the delivery of this subject:

Use of University Laboratory/ own lab coats

Section 2: Academic Details

2.1 Subject Overview

The aim of this paper is to provide students with the necessary knowledge and skills to successfully study biology at undergraduate university level.
Focus areas for this paper include the fundamentals of:

- cell biology
- biological molecules
- cell processes including osmosis, diffusion, active transport, photosynthesis, respiration, DNA replication and protein synthesis.
- biotechnology techniques
- an introduction to ecology

By the end of this paper, students should be able to:

1. Demonstrate an understanding of the basic ideas and language of biology.
2. Describe the structure of cells and biological molecules,
3. Describe cell processes and understand the significance of these processes.
4. Understand the processes involved of a range of biotechnology techniques.
5. Perform a range of biological activities including the use of the microscope.
6. Demonstrate critical thought in the analysis of biological data.

2.2 Learning Objectives and Outcomes

Lecture 1 – Introduction to Biology: Life Processes and Plant and Animal Cell Structure

- Understanding the paper format: the lecture, laboratory and assessment programme and how to use the tutorial book.
- Explain what is meant by living and non-living and the characteristics of living things (life functions).
- Explain the distinction between plants and animals on the basis of autotrophic/heterotrophic nutrition.
- Outline the cell theory.
- Use labelled diagrams to describe the basic structure of plant and animal cells, as seen through the light microscope*.
- Define the term organelle.
- Describe the function(s) of the cell membrane, cell wall, nucleus, vacuole, chloroplast and cytoplasm.
- Describe the meaning of the term cell metabolism.
- Estimate cell/organelle sizes using scales.
  *The first two lab sessions involve using the light microscope to examine plant and animal cells; also cell division and the transport of substances in and out of cells.

Lecture 2 Prokaryotic and eukaryotic cells.

- Describe the parts of prokaryotic and eukaryotic cell using labelled diagrams and describe the key features of these parts.
- Identify the key features of plant, animal, fungi, protest and bacterial cells.
- Describe the structure of viruses and evaluate the evidence used to classify them as acellular and as living or non-living.

Lecture 3 Cell Division: Mitosis

- Explain why cell division is important for unicellular organisms (reproduction).
- Explain why cell division is important for multicellular organisms (growth, repair, replacement).
- Outline binary fission in prokaryotic cells.
- Outline cell division in eukaryotic cells as mitosis (division of the nucleus) followed by cytokinesis (division of the cytoplasm).
- Describe the stages of mitosis (prophase, metaphase, anaphase, and telophase).
- Describe cytokinesis in plant and animal cells.
- Outline the cell cycle as interphase (G1, S, and G2) followed by cell division.
- Describe the process of cell differentiation and why it is important in multicellular organisms.
- Outline the hierarchy of: cells-tissues-organs systems-organism.

Lecture 4 Cell Processes.

- Describe the structure and function of the cell membrane.
- Describe the effect on plant and animal cells of hypotonic, isotonic and hypertonic solutions.
- Describe the movement of substances into and out of cells by passive transport (diffusion and osmosis) and active transport.
- Explain the importance of diffusion gradient and the factors that affect the rate of diffusion.
- Explain the importance for cells in having a high surface area to volume ratio. Relate this to cell size, cell division and cell shape.

Lecture 5 Inorganic Molecules.

- Explain the difference(s) between organic and inorganic substances.
- Explain the importance of water and inorganic ions to cells and organism.
- Distinguish between macronutrients and micronutrients.
- Describe the major function(s) in the human body of calcium, phosphorus, sodium, iron and iodine and the symptoms if the element is deficient.
- Define a vitamin and their role as co-enzymes.
- Discuss the effects of vitamin B12, C, D and K deficiencies in humans.

Lecture 6 Biological Molecules 2: Organic molecules.

- Describe the variety of elements that can combine with carbon to form organic compounds.
- Distinguish between monomers and polymers.
- Distinguish between dehydration (condensation) and hydrolysis reactions.
- Describe the structure and functions of carbohydrates (monosaccharides, disaccharides, polysaccharides).
- Describe the basic structure of amino acids and proteins (polypeptides) as linked chains of amino acids.
- Describe the structure of: proteins, lipids, nucleotides and nucleic acids..
- Explain the functions of: proteins, lipids, nucleotides and nucleic acids.

Lecture 7 Enzymes.

- Define an enzyme and understand the importance of enzymes in cell metabolism.
- Explain enzyme structure in terms of their specific 3D shape and specific active site.
- Define the term substrate and describe the lock and key model (active site-substrate) of enzyme action.
- Recognise that enzymes lower the activation energy barrier when catalysing a reaction.
- Describe the factors that affect enzyme activity with special emphasis on temperature (denaturation) and pH *.
- Describe the role played by cofactors and coenzymes.
- Explain how competitive and non-competitive enzyme inhibitors work to block enzyme activity.

The third lab session explores enzyme action and the effect of temperature and pH on the enzyme peroxidase.

Lecture 8 Microscopes and cell ultrastructure 1.

- Distinguish between magnification and resolution.
- Compare the light and electron microscopes in terms of magnification and resolution, and identify the advantages and disadvantages of each.
- Identify the following organelles as seen with an electron microscope and describe their structure and function: nucleus, nucleolus, nuclear envelope, nuclear pore and cell membrane.

Lecture 9 Cell ultrastructure 2

- Identify the following organelles as seen with an electron microscope and describe their structure and function:
  mitochondria
  endoplasmic reticulum
  golgi bodies
  lysosomes
  chloroplasts
  vacuoles

Lecture 10 Photosynthesis

- Write the full word and chemical equation for photosynthesis.
- Draw a labelled diagram of a chloroplast as seen with a transmission electron microscope.
- Describe the light phase and the Calvin cycle (light-dependent stage), biochemical detail not required, with emphasis on:
    - where the stages occur
    - the starting substances and the end products of each stage
    - how the stages link together
- Describe the light spectrum and relate this to photosynthesis.
- Analyse the absorption spectrum of chlorophyll and relate this to photosynthesis.
- Analyse graphs investigating the factors affecting the rate of photosynthesis.

Lecture 11 Respiration

- Describe the chemical nature of ATP (and ADP+P) and its importance for cell metabolism.
- Describe the ATP/ADP cycle.
- Distinguish between aerobic and anaerobic respiration.
- Write the full word and chemical equation for aerobic respiration.
- Draw a labelled diagram of a mitochondrion as seen with a transmission electron microscope.
- Describe the three stages of aerobic respiration, no biochemical detail required, with emphasis on:
    - where the stages occur
    - the starting substances and end products of each stage
    - the amount of ATP produced
    - the role of NAD+, FAD and O_2
- Describe anaerobic respiration in fungi and plants (alcoholic fermentation)*.
- Describe anaerobic respiration in animals using human muscle cells as an example (lactic acid fermentation).
- Compare aerobic and anaerobic respiration in terms of efficiency of ATP production.

Lecture 12 DNA structure and replication.

- Describe the structure of DNA using the terms: double helix, nucleotides, deoxyribose sugar, phosphate and nitrogenous bases (adenine, thymine, cytosine, and guanine).
- Explain the importance of the complementary base pairing: A-T and C-G.
- Explain how DNA replication occurs, the meaning of the term semi-conservative replication and why DNA replication is important.
- Explain the role of the following enzymes in DNA replication: helicases, topoisomerase, primase, DNA polymerases and DNA ligases.
- Explain why DNA structure involves many levels of coils and folding.
- Describe the structure of a nucleosome

Lecture 13 RNA and ribosomes.

- Compare the structure of RNA with DNA.
- Outline the process of RNA transcription, explaining the role of RNA polymerase.
- Define the terms promoter and transcription unit.
- Describe the structure and function(s) of:
  messenger RNA (mRNA), transfer RNA (tRNA) and ribosomal RNA (rRNA).
- Explain the terms triplet, codon and anticodon.
- Link the structure of a ribosomes to its function in protein synthesis.

Lecture 14 Genetic code and protein synthesis.

- Explain the terms triplet, codon and anticodon.
- Explain how redundancy in the genetic code occurs.
- Interpret the genetic code identifying amino acids from mRNA codons using examples.
- Explain the importance of the start and stop codons in protein synthesis.
- Describe the processes of transcription and translation using labelled diagrams.
- Explain how DNA carries the genetic code and how the code is expressed through protein synthesis.

Lecture 15 Meiosis

- Explain the meaning of the following terms: chromosome, homologous pair, species chromosome number, autosomes, sex chromosomes, karyotype, haploid, diploid, gametes, fertilization, zygote and somatic cell.
- Understand that meiosis is cell division that:
  - halves the number of chromosomes (diploid becomes haploid)
  - produces genetically unique sex cells leading to genetically unique offspring after fertilization.
- Describe the stages of meiosis (meiosis 1 and meiosis 2).
- Explain how crossing over and random assortment of chromosomes produce genetic variation in the gametes.
- Describe spermatogenesis and oogenesis and the differences between the two processes.

Lecture 16 Mutations

- Define the meaning of the term mutation and describe examples of mutagens.
- Distinguish between point mutations and frame shift mutations with examples and analyse the possible effects of these mutations on a protein/ cell/whole organism.
- Describe whole chromosome mutations using translocations and aneuploidy as examples.
- Describe Down syndrome and sex chromosome aneuploidies.
- Explain why most mutations are either harmful or neutral.
- Discuss how some mutations may be advantageous.
- Discuss the importance of mutation as a source of genetic variation.

Lecture 17 Molecular biology- Biotechnology techniques 1

- Define the terms: genetic engineering, biotechnology and genome.
- Recognise that molecular biology is a continually developing field of science.
- Explain the technique used to produce recombinant DNA
- Explain the role of restriction enzymes, DNA ligase and bacterial plasmids in producing recombinant DNA.
- Distinguish between sticky ends and blunt ends
- Discuss the production of human insulin and growth hormone as specific examples of recombinant DNA.

Lecture 18 Molecular biology- Biotechnology Techniques 2

- Define the term cloning
- Give examples of naturally occurring cloning.
- Explain the 3 types of artificial cloning: gene, reproductive and therapeutic.
- Describe the different ways stem cells can be produced.
- Discuss possible uses of each type of cloning.

Lecture 19 Molecular biology- Biotechnology Techniques 3

- Explain the purpose of the polymerase chain reaction process.
- Describe the polymerase chain reaction process.
- Describe how DNA fingerprints are produced using gel electrophoresis and interpret DNA fingerprints.
- Describe the uses of DNA fingerprints.
- Describe the whole genome shotgun processes of genome analysis.

Lecture 20- Organisms Interaction: Energy Relationships within Ecosystems

- Discuss the aspects of biology studied by ecologists.
- Explain the meaning of these ecological terms: ecosystem, community, population, environment (abiotic and biotic), habitat and ecological niche.
- Describe how energy flows through the components of an ecosystem and how matter is recycled within an ecosystem.
- Explain the meaning of these ecological terms: trophic level, producer, consumer (first order, second order, third order etc.), and decomposer.
- Analyse food chains and food webs illustrating energy flow.
- Construct food webs and food chains from data.
- Construct and analyse biomass (energy) pyramids.
- Describe bioaccumulation and bio magnification using selected examples.

Lecture 21 – Organism interactions: Population and Interspecific Relationships

- Define the terms: population, natality, mortality, age structure, life expectancy, life span and survivorship.
- Describe the following techniques for counting populations and analysing their distribution: quadrats, transects, mark and recapture.
- Discuss the problems involved with counting and analysing the distribution of rare species, nocturnal species, wide spread species.
- Describe, using selected examples, the following relationships between organisms: symbiosis (mutualism, commensalism and parasitism), competition, ammensalism, and predator/prey.

2.3 Subject Content

2.4 Teaching Method/Strategies

Lectures with lecture slides available on blackboard after lectures, small class tutorials where students can work independently, or in pairs and small groups to tackle practise questions and develop their knowledge and understanding of the course content. This is a time where individuals can seek individual help from the tutor. Consultations provide an additional time for individual help. The laboratory sessions reinforce the material covered in lectures and tutorials and give students the opportunity to experience practical work.

2.5 Assessment

Assessment Type	When	Weighting	Learning Outcomes Assessed
Internal Labs	Every third week – 3 labs	10%	
Mid semester test	Week 7	20%	Covers first 11 lectures
Final Examination	Week 13 onwards	70%	Covers all lectures

2.5.1 Assessment Strategy

2.5.2 Hurdle Requirement

In order to pass this paper, students must obtain an overall mark of 50% (C-) or better.

2.5.3 Assessment Details

Assessment	Content/ Format	Time	Details
Internal Assessment Task 1	Lab 1 exit test	15 minutes at end of lab 1	**Outcomes:** After completing this laboratory session you should be able to: a) identify, name and give the functions of the parts of a stage microscope. b) set up a stage microscope and use it on a range of power magnifications. c) make a wet mount and draw diagrams of specimens observed under a microscope. d) determine the size of objects using an eyepiece micrometer (eyepiece scale units).
Internal Assessment Task 2	Lab2 exit test	15 minutes at end of lab 2	Outcomes: After the completion of this laboratory session you should be able to: a) Observe and recognise different stages in mitosis cell division b) Describe and explain the results of experiments on diffusion of water into and out of cells.

			c) Explain the importance of surface area to volume ratio on diffusion in cells.
Internal Assessment Task 3	Lab 3 exit test	15 minutes at end of lab 3	**Outcomes:** After completing this laboratory session you should be able to: Study an enzyme, peroxidise, and interpret the results of an experiment using the enzyme.
Internal assessment	Mid semester test	45 minutes	Learning objectives from lectures 1-11
Final Examination		2 hours	Learning objectives from lectures 1-22

2.6 Prescribed and Recommended Reading

Prescribed Text:
Produced Foundation Year Biology lecture book

Recommended Reading: Optional extension
Campbell Biology

3. Subject Details

3.1 Weekly Schedule

Lecture	Topic	Labs
1	Introduction lecture: Life processes and basic plant and animal cell structure.	Lab 1: Use of the light microscope
2	Prokaryotic and eukaryotic cells.	
3	Cell division-Mitosis	
4	Cell processes.	
5	Inorganic molecules.	Lab 2: Cell division and cell processes
6	Organic molecules.	
7	Enzymes	
8	Microscopes and cell ultrastructure 1	
9	Cell ultrastructure 2	Lab 3: Enzymes
10	Photosynthesis	
11	Respiration	
12	DNA structure and replication	
13	RNA and ribosomes	
14	Genetic code and protein synthesis	
15	Cell division: Meiosis	
16	Mutations	
17	Molecular biology: Biotechnology techniques 1	
18	Molecular biology: Biotechnology techniques 2	
19	Molecular biology: Biotechnology techniques 3	
20	Organism interactions1: Energy Relationships	
21	Organism interactions 2: Populations and interspecific relationships.	
22	Consolidation	
23	Consolidation	