Biology 2201
Course Outline

Unit 1 – Matter and Energy for Life

"Biology" is the study of life. However, the study of the science of life is far from simple. It is complex as living things are complex and diverse. Living things are much more than a mere set of chemical reactions or a physical machine. They are composed of individual units called cells, considered to be the basic unit of structure and function and the smallest independent unit capable of displaying the characteristics of life. During this unit, the historical development of cell theory and the role of the microscope in the advancement of biological knowledge will be discussed. Students will gain an appreciation for the complexity of life at the cellular level of organization and the delicacy of interactions between components at this level as they study cell structures and their functions.

Explain the cell theory.

- Define biogenesis and abiogenesis

Describe how the contribution of scientists lead to a better understanding of biogenesis and abiogenesis.

- Include Aristotle, Redi, Needham, Spallanzani, and Pasteur.

Analyze and describe how scientific understanding was revised as a result of the invention of the microscope.

- Explain how the invention of the microscope permitted scientists to discover the existence of cells.
- Explain the contributions of Hooke and Leeuwenhoek.

Describe how the contributions of scientists lead to the progressive development of the cell theory.

- Include Brown, Schleiden, Schwann, Braun, Virchow, Pasteur.
- Understand that the development of the microscope and the development of cell theory were directly related.
- Recognize that the development of cell theory represents a paradigm shift.

Select and use apparatus and materials safely.

- Identify the microscope as an important tool for biological research.

Use instruments effectively and accurately for collecting data.

- Identify microscope parts and their functions.
- Demonstrate general care, focusing technique and safety concerns.
- Prepare, stain and observe a specimen (wet mount).
- Contrast the light microscope with the dissecting microscope.

Core Lab: Caring for and Using a Microscope
Mini Lab: Observing Stained Cells

Compile and display, using line diagrams and/or digital imagery, evidence and information collected through the use of the microscope.

- Draw a biological drawing which includes the concept of field of view and calculation of specimen size.
- Define depth of field.

Analyze why microscope technology continued to develop and improve over time.

- Examine how aspects such as magnification, resolution, imaging and preparation of specimens have improved with the driving force to view smaller and smaller objects.

Describe and evaluate the design of microscope technologies and the way they function.

- Use compound, scanning electron microscopes and transmission electron microscopes.
- Compare different microscopes in terms of illumination, magnification and specimen preparation.
- Describe the career opportunities that exists within the biological sciences.

Using different types of cells as examples, compare and contrast prokaryotic and eukaryotic cells.

- Describe the structural differences between prokaryotic and eukaryotic cells.
- Observe features of prokaryotic and eukaryotic cells using microscope technology.

Describe the appearance of cell organelles visible with the light and electron microscopes.

- Examine and compare images of cell structures generated by both the light and electron microscopes.
- Describe the role of the following cellular structures: cell membrane, cytoplasm, nucleus, nucleolus, endoplasmic reticulum, ribosome, mitochondria, chloroplast, vacuole, vesicle, golgi apparatus, microtubules/filaments, cilia, lysosome, flagella and cell wall.
- Compare plants and animal cells in terms of type of organelles present.

Describe how organelles manage various cell processes such as ingestion, digestion, transportation and excretion.

- Explain how materials are able to move into and out of cells through a selectively permeable membrane. Include passive transport (osmosis, diffusion and facilitated diffusion) and active transport (exocytosis and endocytosis, pinocytosis, phagocytosis.
- Define the term hypotonic, hypertonic and isotonic.
- Describe the effects of osmosis on cells with and without cell walls.

- Investigate the relationship between membrane surface area and cell size, summarizing findings and formulating a conclusion.

Core Lab: Osmosis in a Model Cell
Elective Lab: The Limits of Cell Size

Compare and contrast matter and energy transformations associated with the processes of photosynthesis and aerobic respiration.

- Explain the importance of photosynthesis and aerobic respiration for individual organisms.
- Demonstrate, using equations, that photosynthesis and aerobic respiration are complimentary processes.
- Explain the importance of the processes of photosynthesis and aerobic respiration on a global basis (biological basis of primary industries-agriculture, fishery).
- Define anaerobic respiration.

Elective Lab: Consumption of CO_2 By An Aquatic Plant or Production of Starch by Leaves

Unit 2 – Biodiversity

Millions of living things have been recently classified with more constantly being identified. Scientific opinion suggests that there may be anywhere between ten to thirty million of the total number of species actually in existence. Dealing with a system as large and widespread as this requires a taxonomic organizational structure to allow scientists and students to investigate the types and characteristics of these living things. This unit introduces Linnaeus' classification system as a basis for this study.

Organisms exhibit a huge range of diversity, yet maintain a number of basic things in common. All living things are therefore unique, in this, their unity and diversity. An appreciation for this paradigm is encouraged as students are given the opportunity to experience the array of organisms within a logical survey of the taxonomic categories of life and investigate their anatomy, physiology and life cycles.

Explain how scientific knowledge evolves as new evidence comes to light and as laws and theories are tested and subsequently replaced.

- Develop a list of characteristics that differentiate living and non-living things (cells, biogenesis, growth and development, metabolism, water requirement, organic compound production, reproduction with inheritance and adaptations)
- Explain how scientific classification systems have developed.

Describe and apply classification systems and nomenclatures used in the biological sciences.

- List and describe the seven major categories of Linnaeus' classification system. Include kingdom, phylum, class, order, family, genus, species.
- Recognize subcategories to this system (superclass, suborder, etc.)
- Explain the advantage of binomial nomenclature.
- Demonstrate how to use a taxonomic key to group and identify an organism.

Use organisms found in a local or regional ecosystem to demonstrate an understanding of the fundamental principles of taxonomy.

Core Lab: Creating a Dichotomous Key

Identify limitations of a biological classification system and identify alternative ways of classifying to accommodate anomalies.

- Examine the common names of some species of organisms and show the inadequacies and language problems associated with this method of identification.
- Explain why a virus does not fit neatly into the existing classification system.

Identify new questions or problems that arise from what was learned.

- Recognize the difficulties inherent in the categorization of some organisms into distinct groups and identify the limitations of a five-kingdom system that led to the six-kingdom system.

Use library and electronic research tools to collect information on modern techniques used in the classification process.

- Explain how organisms are classified using radioactive dating, biochemical information (DNA/protein comparison), structural information, comparative embryology, cellular structure and behaviour.
- *STSE: Modern Classification Techniques*

Describe how classification systems improved as a result of the development of modern techniques.

- Explain how Echinodermata are more closely related to the chordates than to any invertebrate.

Describe the anatomy and physiology of viruses and organisms from each kingdom.

- Identify the general characteristics (cell type, nutrition, body form, reproduction, locomotion) that distinguish the members of the six recognized kingdoms (Bacteria, Archaea, Protista, Fungi, Plantae, Animalia) from each other.
  Table 1: Kingdoms
- Identify examples of members of each of the Kingdoms.
- Describe the differences that exists between the major groups of plants (bryophytes, ferns, gymnosperms, angiosperms)
  Table 2: Plants
- Explain why angiosperms are the most diverse plant group.
- Describe the differences that exist between the invertebrate phyla (symmetry, body cavity, reproduction, digestion) with respect to developmental trends.
- Describe the various types of symmetry (asymmetry, radial, bilateral).
- Discuss the difference between coelomate and acoelomate organisms.
  Table 3: Invertebrates
- Explain why arthropods are the most successful phylum of animals.
- Discuss why insects are the most successful class of arthropods.
- Describe the differences that exist between vertebrate taxa (symmetry, body cavity, circulation, respiration, reproduction, endoskeleton) with respect to developmental trends.
  Table 4: Vertebrates

Analyze and explain the lifecycle of a sample organism from each kingdom, including a representative virus.

- Lifecycle of virus-"T4", Bacteria/Archaea-"*E. coli*", Protista-"Plasmodium", Fungi-"Rhizopus", Plantae-"Fern" and Animalia-"Frog".

Unit 3 – Maintaining Dynamic Equilibrium I

Cells, tissues, organs, organ systems and ultimately organisms must maintain a biological balance despite changing external conditions. Homeostasis is the state of internal balance so critical to existence. It represents a dynamic equilibrium displaying constant interactions and checks and balances both within organisms and between organisms and their environment. There are a variety of systems within living things responsible for the maintenance of this delicate balance. This unit will identify and introduce the role of those plant and animal systems, including the circulatory, respiratory, digestive, excretory and immune systems. The vital links that exist between them will be investigated.

Explain the concept of homeostasis and its critical nature to living things.

- Define homeostasis including the concept of dynamic equilibrium.

Explain the importance of temperature regulation in maintaining homeostasis.

- Define homeotherm and poikilotherm.
- Describe how homeotherms maintain a dynamic equilibrium.
- Discuss the mechanisms of temperature control, behavioral and physiological.

Explain how the human circulatory system helps maintain homeostasis.

- Explain the need for a transport system.
- Explain how the circulatory system contributes to the maintenance of dynamic equilibrium through its role in the transport of heat energy and matter.
- Describe the structure of an artery, vein and capillary and relate these structures to their function in blood circulation.
- Identify the main components of the human heart and explain the role of each. Include atria, ventricles, valves (bicuspid, tricuspid, semilunar), aorta, pulmonary vein, pulmonary artery and septum.
- Trace the flow of blood through the heart and describe the pulmonary and systemic pathways.
- Identify the main components of blood and explain the role of each. Include erythrocytes, leukocytes, platelets and plasma.
- Observe the principal features of the circulatory system utilizing models, computer simulation, dissection or drawings or photographs.
- Discuss the clotting process.

Carry out an experiment to relate blood pressure and physical activity and identify the specific variables involved.

Core Lab: The Effects of Stress on Blood Pressure

Identify the impact of circulatory diseases on the homeostasis of an organism.

- Describe disorders linked to the circulatory system and their effect on the homeostasis of the system and the organism as a whole. Include hypertension, atherosclerosis and arteriosclerosis.

Analyze why and how technology related to the treatment of circulatory disorders was developed and improved over time.

- Describe the progress from bypass surgery to modern techniques. Include shunts, angioplasty and clot-busting drugs.

Explain how the human respiratory system helps maintain homeostasis.

- Explain the need for a respiratory surface in humans.
- Identify and state the function of nasal cavity, trachea, bronchi, bronchioles, alveoli and diaphragm.
- Investigate the mechanics of inhalation/exhalation and the regulation of the breathing cycle.
- Observe the principal features of the respiratory system utilizing models, computer simulation, dissection or drawings or photographs.

Carry out an experiment to collect data on respiratory function and identify the specific variables involved.

Core Lab: Measuring Respiratory Volumes

Identify how respiratory diseases affect the homeostasis of an organism.

- Investigate the disorders lung cancer, asthma and pneumonia. Explain the disorder, technology used to diagnose and treatment.

Predict the impact of environmental factors on the respiratory system of an asthmatic.

- Include cigarette smoke, allergens (dust, mould, food), petrochemical fumes and perfumes.
- Debate the rights of the smoker versus non- smoker, smoke free school policies or tobacco companies sponsoring of sporting events.

Explain how the human digestive system helps maintain homeostasis.

- Describe the purpose and functioning of the digestive system.
- Define mechanical and chemical digestion and explain the relationship between them.
- Identify the major organs and glands of digestion and investigate their role in the digestive process. Include salivary glands, stomach, liver, pancreas, gall bladder, small intestine and large intestine.

  Table 5: Digestion
- Observe the principal features of the digestive system utilizing models, computer simulation, dissection or drawings or photographs.
- Trace the pathway of food through the human digestive tract and explain the efficiency of its structure. Include teeth, taste buds, tongue, mucous lining, sphincters, villi and peristalsis.

Identify chemical elements and compounds that are commonly found in living systems.

- Identify the six basic nutrients: carbohydrates, lipids, proteins, vitamins, minerals and water and determine the source of each of these nutrients.

Identify the role of some compounds involved in digestion.

- Discuss the role of the six basic nutrients.
- Discuss the general role of enzymes and secretions and the role of these substances pertaining to the digestive system.

Identify the structure and function of the important biochemical compounds carbohydrates, proteins and lipids.

- Explain the role of hydrolysis and dehydration reactions within the digestive process.
- Discuss the basic structural units of carbohydrates, lipids and proteins.
- Discuss the basic structure of carbohydrates, lipids and proteins.
- Describe the end products of digestion for carbohydrates, lipids and proteins.

STSE: What Fuels You?

Carry out an experiment to investigate the effect of specified variables on the effectiveness of an enzyme.

Core Lab: What's Here? Testing Macromolecules

Describe disorders and the treatment of disorders linked to organs of the digestive system and their effect on the homeostasis of the system and the organism as a whole.

- Discuss the pathology, technology to diagnosis and treatment/cure for ulcers, gallstones and ileitis/colitis.

Explain the importance of fitness and nutrition in maintaining homeostasis.

- Discuss a proactive societal approach of improvement of diet versus a reactive approach surrounding the treatment of disease.

Propose alternative solutions to a given practical problem, identify the strengths and weaknesses of each and select one as the basis for a plan.

- Evaluate how nutritional deficiencies and starvation diets such as bulimia and anorexia nervosa can adversely affect the dynamic equilibrium.
- Discuss whether the images portrayed through the media and advertising, promote positive self-image and a healthy lifestyle for men and women.

Explain how the excretory system helps maintain homeostasis.

- Explain how the following act as organs of excretion. Include lungs, skin, liver and kidney.
- Explain the role of the kidney as an excretory organ in removing metabolic wastes from the body.
- Identify and describe the main structures of the human urinary system including kidney, ureter, bladder and urethra.
- Identify and describe the internal structure and function of the kidney including the cortex, medulla and pelvis.
- Identify and describe the function of the glomerulus.

- Identify and explain the function of the parts of the nephron. Include Bowman's capsule, loop of Henle, tubules – proximal and distal and collecting duct and the processes of filtration and re-absorption.
- Observe the principal features of the excretory system utilizing models, computer simulation, dissection or drawings or photographs.

Describe disorders linked to the excretory system and their effect on the homeostasis of the system and the organism as a whole.

- Include kidney stones, kidney infections and bladder infections.

Analyze and describe examples where technologies were developed, based on scientific understanding, to treat renal failure.

- Briefly explain how the technology of dialysis works.

Analyze natural and technological systems to interpret and explain their structure and dynamics.

- Compare the human kidney system with that of kidney dialysis technology.
- Briefly explain why dialysis is a temporary measure for treating kidney disease.

STSE: Kidney and Urological Diseases

Identify multiple perspectives that influence a science-related decision or issue.

- Discuss the merits of funding kidney transplant therapy versus improvements in dialysis technology.

Predict the impact of environmental factors on homeostasis within an organism.

- Explain the meaning of antigen (allergen) and antibody and their role in an allergic reaction.
- Explain how the allergic response affects the maintenance of homeostasis within the organism.
- Recognize that a properly functioning immune system is essential for health and well being and the consequences when the immune system is not functioning properly.

Explain how the immune system helps to maintain homeostasis.

- Explain the complete immune response. Include 1st line of defense (physical and chemical barriers), 2nd line of defense (inflammatory response) and 3rd line of defense (immune response).
- Compare the role of white blood cells in the defense process including phagocytes and lymphocytes.
- Compare the mechanism of acquired immunity including passive (breast milk) and active (actual exposure, vaccines).

Identify how autoimmune disorders cause diseases such as rheumatoid arthritis.

STSE: Hodgkin's Disease

Unit 4 – Interactions Among Living Things

During a discussion of human ecology (the relationship between the human population and the environment), students will build on their understanding of the basis of ecology and ecosystems and certain principles of population dynamics. It is important that they understand the many interrelationships affecting human population growth and dynamics and the issues facing global population growth, particularly the subsequent and continuous pressure being placed on the natural resources of the globe.

Describe population growth and explain factors that influence it.

- Describe how population growth is dependent upon the difference between natality and mortality and a balance between emigration and immigration. Use regionally endangered species as an example.
- Analyze and describe the limiting factors that regulate population size within ecosystems: competition, environmental quality (availability of food, shelter, water and suitable climate), disease, parasitism, predation, stress).
- Distinguish between density independent and dependent factors.
- Explain how biotic potential, environmental resistance and carrying capacity interact in population dynamics.

Compile and organize data, using appropriate formats and data treatments, to facilitate interpretation of the data.

Core Lab: Sampling Hare Populations

Evaluate Earth's carrying capacity considering human population growth and its demands on natural resources.

- Determine the current growth rate of the human population and the projected growth rate.
- Investigate the demands that will be placed upon Earth's natural resources by future population growth.
- Explain how technological developments have raised, and continue to raise, the carrying capacity of the Earth.
- Describe the four phases of demographic transition.

Propose courses of action on the social issue of global population control, taking into account an array of perspectives, including that of sustainability.

- Debate the ethics of human population control methods (China's one child policy).
- Discuss how improved infrastructure, education of women, use of advanced technologies and changed lifestyles may lead to a sustainable human growth pattern.

Compare theoretical and empirical population values and account for discrepancies.

- Examine and label the sections of an S-shaped (logistic) and J-shaped (exponential) growth curve.

- Compare how S and J curves describe the general population growth pattern observed in animal populations.
- Explain the predator-prey cycle with respect to population growth curves.

Gather and examine information on the limiting factors that work to influence human population growth.

- Describe the limiting factors within the human population. Include space, war, disease and poverty.