Stage 1 Semester 1 Program 3: This program articulates with LAP 3.

10 credit, Human Biology (students who may be interested in nursing)

Cells and Microorganisms, Infectious Disease and Multicellular Organisms- with a human focus.

Number of lessons equivalent to 60hrs per semester, including 8-10 hrs of practical activities.

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| **Science Understandings** | **Activities/teaching strategies** | **SIS** | **SHE** |
| Term 1  Week 1:  Introduction to biology  What is human biology?  Living things are made up of one or more cells. | Class discussion on what defines “Biology” and the many aspects of “Human Biology”  Brainstorm the scope of biology and how it relates to humans  Review the concept of living compared to non-living  List the characteristics of living things e.g. REMRING or MRS GREN  Introduce the concepts of unicellular and multicellular- what are the challenges for each type of organism? |  | Consider how STEM has impacted humans- relating to the brainstorm list generated |
| Week 2-3  Cells- structure and function  The structure of the cell membrane  The cell membrane separates cellular activity from the external environment  The role of the cell membrane in controlling substances entry and exit | Draw and label a typical animal cell  Identify the organelles in animal cells. Know that each organelle has a specific function: nucleus, ribosome, vacuole, mitochondrion, chloroplast, endoplasmic reticulum, Golgi body  Draw labelled diagrams of the semi-permeable cell membrane. Consider the phospholipid bilayer and the role of the embedded proteins, especially in transport and recognition.  Describe the structure of the membrane in terms of the Fluid Mosaic Model – students to write an extended response on the structural arrangement of the cell membrane.  Activity: Watch a simulation of the cell membrane (and transport  <http://phet.colorado.edu/en/simulation/membrane-channels>)  and/or YouTube video on Cell membrane structure.  <https://youtu.be/QQgXfuFyKM4>  Discuss how accurate these types of simulations and models are- how are they designed? Limitations? Can they be considered as “fact”? | Practical: Review the Use of a light Microscope.  Microscope skills- view different types of human cells. Consider scale and details that can be seen.  Activity: Look at photomicrographs of various organelles and draw schematic diagrams. Discuss the difference to the light microscope images observed. | Consider risks and ethical considerations of using human cells  Students provided with the following URL (<http://www.timetoast.com/timelines/history-of-the-theoretical-models-of-the-cell-membrane>) to investigate the changes in understanding of the structure of the cell membrane over time. |
| Week 4-5:  Material requirements move in and wastes and cell products move out of cells.  The selectively permeable nature of the cell membrane maintains relatively constant internal conditions.  The surface area-to-volume ratio of cells is critical to their survival. | Using diagrams of the cell membrane to explain how the exchange of materials between the cell and its environment is controlled: size, charge and composition of the material being transported.  Consider also the processes of endocytosis and exocytosis and how the membrane is arranged to enable transport of materials.  Activity: Watch a short video showing the process of endocytosis and exocytosis. <https://youtu.be/qpw2p1x9Cic>  Students draw schematic diagrams to show endocytosis and exocytosis.  Describe how some substances move passively by diffusion and osmosis across the cell membrane with the concentration gradient.  Draw a table to compare active and passive transport with regard to:   * concentration gradient * energy requirement * type of materials transported | Practical: Investigate the effect of diffusion using cellulose tubing, starch, and iodine solutions. Introduce the idea of design, altering the independent variable, justified conclusions and limitations of the design. |  |
| Week 6  Hierarchical Structure of Multicellular Organisms- use the human body as the example | Use examples from humans to explain organisation of cells into tissues, tissues into organs, organs into systems.  Illustrate the relationship between the structure and function of cells, tissues, organs and/or systems.  Organ systems in a multicellular organism are interdependent and function together to ensure the survival of the organism. | Practical: Look at specimens of cells from different human/animal tissues using the microscope.  Practical: Use virtual or actual organ dissections e.g. virtual frog dissection or hands-on practical activity using goat/sheep heart or kidneys. Consider the risks associated.  View videos to show the functions of cells, tissue and organs. |  |
| Week 7-9  Exchange Surfaces in Humans  Respiratory System  Excretory System  .  Digestive System  Circulatory System | Consider examples of materials taken in and released by the human body.  Discuss the features of exchange surfaces that enable them to function efficiently:   * thin * moist * large surface area * blood supply in close vicinity   Consider the structure of alveoli in Human lungs  Describe the process of diffusion as a passive process that does not require additional input of energy.  Recognise that the respiratory and circulatory systems are interconnected and function together.  Describe the structure and function of nephrons in the kidney in the human excretory system.  Explain the importance of filtration and reabsorption  Relate the structure of organs of the digestive system to their function.  Describe the structure and function of villi in the human digestive system.  Construct a table to summarise the major macromolecules (e.g. proteins), their monomers (e.g. amino acids) and their specific digestive enzymes (e.g. proteases)  Describe how different nutrients are absorbed through the villi by various transport processes including diffusion, active transport and endocytosis.  Compare the role of blood capillaries and lymph capillaries in the exchange of materials  Examine the structural differences between arteries, veins and capillaries.  Formative SAT: Quiz on the Systems of the Human Body (Oral, group exercise) | Practical: Use organs from sheep (or similar) to:   * show the connection of the circulatory and respiratory systems * inflate the lungs * perform a lung dissection * examine the blood vessels connecting the heart to the lungs.   Practical: Use the Balloon Lung investigation to model the respiratory system. Consider tidal volume, residual volume and vital capacity.  Consider controlled variables, sources of uncertainty and appropriate conclusions that can be made and justified.  Practical Investigation: Investigate digestive enzymes and factors that may affect their function (e.g. amylase and pH or lipase and temperature).  Practical: Dissect a mammalian heart (e.g. pig, cow, sheep or goat).  Summative Practical Design Investigation and Deconstruct of Problem: Investigate the effect of exercise on heart rate and deconstruct a problem and then design a method to test if exercise can improve underlying medical conditions. | Debate/Consider the use of live or deceased donors for organ transplants.  Debate/Discuss the ethical considerations of live organ donations.  Explore innovative technologies, such as 3D bio-printers to produce kidneys that are genetically matched to the recipient.  Research how pacemakers and other devices have saved the lives of many waiting for a heart transplant. |
| Week 10  Lifestyle Choices impacts on the functioning of organs and systems. | Discuss the effects of different lifestyle choices have on the functioning of different organs e.g. smoking and lungs or in pregnancy or energy drinks and the digestive system etc.  Consider some of the scientific issues related to lifestyle choices e.g. Should everyone have access to free health if they choose to smoke? Or do energy drinks do more harm than good?  Investigate the consequence of uncontrolled cell division that may result from lifestyle factors such as exposure to carcinogens (e.g. lung cancer and its link with smoking). |  | Investigate lifestyle diseases related to the respiratory system (emphysema, lung cancer, pneumonia, asthma).  Consider questions such as:  Is there a difference between the lung capacities of non-athletes to athletes? (formative design or deconstruct problem opportunity)  What are the benefits of exercise for the individual/society? How has this been measured? |
| Term 2  Week 1-2  What is an infectious disease?  What is a pathogen?  How do we become infected by a pathogen?  How do pathogens cause disease? | Discussion on what distinguishes infectious disease from non-infectious diseases including genetic and lifestyle diseases (discussed last term)  Use examples of pathogens to describe how pathogens may be transmitted between hosts e.g. air = common cold (through droplets) or faeces = Salmonella or worms.  Describe how pathogens and host cells recognise each other.  Explain that some pathogens enter cells to survive and reproduce.  Describe the basic concept of molecular recognition e.g. pathogens binding to cellular receptors.  Explain that some pathogens must enter cells to ensure their survival, replication and to evade the immune system. | Look at diagrams or photographs of the different types of pathogens e.g. bacteria, viruses etc.  Use animations to model the entry of viruses and other pathogens into cells. E.g. (<http://highered.mheducation.com/sites/0072556781/student_view0/chapter18/animation_quiz_1.html>) |  |
| Week 3  Disease outbreaks | Describe the interrelated factors that can determine the spread of infectious disease including:   * persistence of the pathogen within hosts * the transmission mechanism * the proportion of the population that are immune or have been immunised * mobility of individuals of the affected population. |  | Simulate the spread of disease using a simple model or practical  **Summative SHE Task**: Teacher selected or Student selected of a disease outbreak.  Risk, Spread and Control  e.g. Ebola, SARS, bubonic plague, cholera etc. |
| Week 4-6  Investigating disease outbreaks. | Discuss the ethics of controlling the spread of disease   * quarantine * access to medications/vaccine * location of outbreak * resources available   Evaluate strategies to control the spread of diseases   * site planning * water supply * sanitation * food supply * education * resources available |  |  |
| Week 7-9  The Human Immune System: Physical Barriers, Innate and Adaptive (Acquired) | Distinguish between self vs non-self (foreign) antigens, after defining the concept of an antigen.  Importance of physical barriers to prevent entry of pathogens, the role of the innate or non-specific immune system and the need for specific immune responses with the adaptive immune system.  The immune system has many interdependent parts, that work together to ensure pathogens do not cause disease.  Use a disease example or organ transplantation or vaccination to:  Describe the function of the components of the innate (non-specific) immune system include:   * complement system * inflammatory response * phagocytes * natural Killer Cells.   Describe the function of the components of the adaptive (acquired) immune response include:   * B-lymphocytes * T-lymphocytes * antibodies * memory cells * secondary lymphoid organs.   Compare the difference between the innate (non-specific) and adaptive immune systems can be explained by the role of memory cells  Compare passive and active immunity and the science behind vaccinations.  Discuss the reason why vaccinations are critical for disease control and extinction.  Look at the data for those opposing vaccination and show the links have been misinterpreted, and highlight how this has serious consequences. | **Summative Practical Investigation**: Investigate the use of antiseptics to enhance the effectiveness of physical barriers  Useful website: http://www.nuffieldfoundation.org/practical-biology/how-good-your-toilet-paper systems in Humans  Use graphs to analyse how the immune system responds to pathogens after vaccination using the memory cells of the adaptive immune system. |  |
| Week 10  Microorganisms are important to humans- they do not all cause disease | Discuss the benefits to humans e.g. production of growth hormones or insulin in the treatment of disease  Discuss the ethics of access to treatments.  **Skills and Application Task: Case Study: Vaccination** |  | Research Task: Investigate innovations that have been beneficial to humans in medicine |