**Stage 1 Biology – Topic 1 and Topic 4: Biology in Garden: Program 5**

**This Program articulates to LAP 5**

**Biology in the Garden**

This is a 10-credit program for students intending to study Stage 1 Biology.

The number of lessons is equivalent to approximately 60 hours over 1 semester, including 8 – 10 hours of practical activities.

It draws on **Topic1: Cells and Microorganisms** (shown in blue) and **Topic 4: Biodiversity and Ecosystem Dynamics** (shown in green)

| **Science Understanding** | **Activities/teaching strategies** | **SIS** | **SHE** |
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| **Week 1** | | | |
| Introduction to biology.  Living things are distinguishable from non-living things.  Ecosystems can be diverse, and can be defined by their biotic and abiotic components and the interactions between elements of these components.  Biodiversity is the variety of all living things and includes diversity in genetics, species and ecosystems.  Distinguish between a species, population, community, and an ecosystem. | Small group discussion then class brainstorm on what makes up a garden (or bushland area).  Review concept of living & non-living.  Categorise list from brainstorm into living/non-living – introduce terms *biotic* and *abiotic.*  Discuss diversity of living things.  What are the similarities and differences between the living organisms in a garden?  Similarities lead to cell theory. | Make and record some observations in the school garden. | Discuss why gardens are important for well-being. |
| **Week 2** | | | |
| The cell theory unifies all living things.  Living things are made up of one or more cells.  Cells:   * are the structural and functional units of life * cells come from pre-existing cells * cells contain hereditary material.   The cell is the smallest independent unit of life.  The cell membrane defines a cell; it separates the cell from its surroundings. | Use microscopes and diagrams to show that cells are the structural and functional units of life, come from pre-existing cells, and contain hereditary material.  Introduce the concepts of unicellular and multicellular. | Practical: Review the Use of a light Microscope.  Microscope skills: view cells from various organisms.  Activity: Look at photomicrographs of various organelles and draw schematic diagrams. Discuss key factors that make good representations. |  |
| **Week 3 and 4** | | | |
| The major cell types are:   * prokaryotic * eukaryotic.   Prokaryotic and eukaryotic cells have many features in common (a reflection of their common evolutionary past). These features include:   * cell membrane * nucleic acids * proteins * ribosomes. | View video clip to compare structures of prokaryotes and eukaryotes identifying features of each (Prokaryotic cells lack internal membrane-bound organelles, do not have a nucleus, are significantly smaller than eukaryotic cells, and usually have a single circular chromosome.)  Refer back to brainstorm list and classify living things as prokaryotes and eukaryotes.  Draw diagrams to compare the structure and show that Prokaryotic cells lack internal membrane-bound organelles, do not have a nucleus, are significantly smaller than eukaryotic cells, and usually have a single circular chromosome.  Identify the organelles in cells. Know that each organelle has a specific function: nucleus, ribosome, vacuole, mitochondrion, chloroplast, endoplasmic reticulum, Golgi body. | Review concept of representation. | Consider changes of understanding of cell structure with new technology.  10 minute debate: Will other new structures be discovered with further new technology? |
| **Week 5** | | | |
| In order to reproduce, cells need to copy their genetic material, and then divide to form two new (daughter) cells.   * Describe and represent binary fission in prokaryotic cells. * Describe and represent mitosis.   Compare binary fission in prokaryotic cells with mitotic cell division in eukaryotic cells. | Use video clips to compare mitosis with binary fission.  Prepare a summary table to show the similarities and differences.  View microscope slides of different stage of mitosis. |  |  |
| **Week 6 and 7** | | | |
| Biological classification is hierarchical and indicates the relationship between organisms based on their physical structures and the similarities in shared molecular sequences.  There is an internationally agreed system of nomenclature of species which undergoes revision.   * Distinguish between scientific names and common names for species. * Recognise that very closely related species have similar scientific names. * Discuss the advantages of an internationally agreed system of nomenclature. | Discuss difference between plants (or animals).  How are plants (and animals) identified?  How alike do organisms have to be to be given the same scientific name (belong to the same species)?  **Summative SAT:**  Prepare a ‘How to…….’ guide to enable a person to identify a blob of orange, jelly–like material as biotic/abiotic, prokaryote/eukaryote, autotroph/heterotroph, plant/animal with clear justification at each step. | Use keys to identify examples of plants and animals. | Discuss how the internationally agreed nomenclature was agreed on.  Check out examples of change based on new ideas and understanding. (Acacia)  How do plant nurseries make use of scientific nomenclature?  Look at plant labels. Visit nursery? |
| **Week 8** | | | |
| The biotic and abiotic components of ecosystems interact with each other to capture, transform, and transfer energy. | What is the relationship between biotic factors and abiotic factors?  Are there differences between plants in the garden and in pots? | Test soils for pH, water content.  Measure light intensity in different parts of the garden.  Small groups discussion for problem deconstruction:  *How would you go about working out the best growing conditions for a new plant species?* |  |
| **Week 9, 10, 11** | | | |
| Cells require materials.   * Compare the sources of materials for autotrophs and heterotrophs.   Material requirements move in and wastes and some cell products move out of cells.  The cell membrane separates cellular activity from the external environment.   * Describe the structure of the semi-permeable cell membrane.   The selectively permeable nature of the cell membrane maintains relatively constant internal conditions.   * Explain how the cell membrane controls the exchange of materials between the cell and its environment. * Describe how some substances move passively across the cell membrane with the concentration gradient (i.e. by diffusion and osmosis). * Compare active and passive transport with regard to: * concentration gradient * energy requirement.   The surface area-to-volume ratio of cells is critical to their survival. | Key abiotic factors in a garden?  How do nutrients/water get into cells?  Draw labelled diagrams of the semi-permeable cell membrane. Consider the phospholipid bilayer and the role of the embedded proteins.  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://youtube/QQgXfuFyKM4>  Use 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 rhubarb epidermis. Discuss the idea of design, altering the independent variable.  Practical: Observe the effect of salt concentration on osmosis in potato cubes (can combine the later with SA:Vol ratio.)  Small group discussion for problem deconstruction:  *How could you compare the SA:Vol for cells of different (irregular) shapes?*  Record and graph data. Use to discuss graphing and sources of uncertainty.  Practical: The effect of size on diffusion using agar cubes.  Observe and discuss the role of root hairs and the impact of damaging these during transplantation.  **Summative practical investigation:**  Design an investigation to test the effect of a factor on the germination or growth of a seed/plant.  Undertake data interpretation exercises to develop skills in data analysis, discussing trends and patterns, interpolation, and extrapolation. | 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.  10-minute small group discussion:  Why can salt be used as a snail killer? Should it be used for this purpose? |
| **Week 12 and 13** | | | |
| Nutrients within an ecosystem are involved in biogeochemical cycles.  Microorganisms act as decomposers, which enables recycling of essential nutrients.  In ideal conditions bacteria grow exponentially. Bacteria reproduce by binary fission (asexual).  Different bacteria require specific conditions for growth.   * Discuss the effects of factors such as: * temperature * nutrient availability * moisture * pH * the removal of wastes. * Represent the water cycle and biogeochemical cycles, for elements such as nitrogen, phosphorous, and carbon.   Humans can interfere with natural cycles. | Microorganisms are important living things.  Why are microorganisms important in a garden? | Practical: Grow bacteria under different conditions.  Discuss best way of representing data.  Revisit ‘representation’. | How do gardens make use of knowledge of biochemical cycles (discuss compost bins)  Explore human activities that can interrupt cycles:  - excess use of fertilisers  - soil sterilisation  - use of insecticides and other pesticides |
| **Week 14** | | | |
| Cells require energy.  The source(s) of energy are light (most autotrophs) and chemical (heterotrophs).  Photosynthesis, respiration, and fermentation are important energy processes for cells.  Write word equations for photosynthesis, respiration, and fermentation (in plant and animal cells). | Categorise original list as autotrophs and heterotrophs.  Discuss factors affecting the rate of photosynthesis.  How does that impact on a garden? |  |  |
| **Week 15** | | | |
| Organisms have adaptations that help them survive and reproduce.  Discuss examples of adaptations (behavioural, structural, and physiological) in plants and animals. | Why do some plants thrive in some conditions but not in others?  **Summative SAT:**  Design a garden to suit a particular niche, clearly identifying the plants, animals, microorganisms that are significant, the role they play, and the adaptations each has for the niche. | Practical: Simulations of characteristics to demonstrate survival, e.g. bird beaks or different food types or Pepper Moth simulations using white paper and newspaper. | Discuss advantages and disadvantages of using native or exotic plants in gardens |
| **Week 16** | | | |
| Ecosystems can change over time.  Ecological succession involves changes in biotic and abiotic components and their dynamic influence on each other.   * Describe examples of succession. | Consider how gardens change over time.  Consider other examples of succession. |  | Discuss the role of Botanic Gardens, National Parks.  **Summative SHE:**  EITHER  Prepare a submission for funding for a new botanical garden. Explain the type of ecosystem/s to be included and the social, economic, and environmental implications.  OR  A rare and endangered native orchid has been found in an area that is due to be cleared for a new housing development.  Plan a strategy for its preservation. |
| **Week 17 and 18** | | | |
| Humans have significant impacts on ecosystems.   * Explain how the destruction of habitats as a result of human activity speeds changes in ecosystems and impacts on biodiversity. | To create gardens, natural ecosystems may be destroyed. Discuss the impact. |  |  |