IB Biology Y1 Unit 1: Cells

Teacher(s)	IB Biology PLC	**Subject group and course**	Group 4/IB Biology Y1 SL		
Course part and topic	Unit 1: Cells Topic 1 - 6 subtopics	**SL or HL/Year 1 or 2**	SL Y1	**Dates**	August 2022 - TBD
Unit description and texts		**DP assessment(s) for unit**			
Cytology is the study of all aspects of a cell (structure and function). As our understanding of the cell increases, our ability to understand all forms of life, from the smallest to the largest organisms, will also increase. (Subtopics 1.1-1.6, Pearson IB Biology Textbook)		• Unit Summative assessment • Practical 1: Calculation of magnification of drawings, actual size of structures from drawings or micrographs • Practical 2: Estimation of osmolarity in tissues • Formative assessment quizzes per subtopic to check for understanding			

INQUIRY: Establishing the purpose of the unit

ACTION: teaching and learning through inquiry

Content/skills/concepts—essential understandings **U = Understandings** **NOS = Nature of Science** **A = Applications** **S = Skills**	**Learning process** *Check the boxes for any pedagogical approaches used during the unit. Aim for a variety of approaches to help facilitate learning.*
Students will know the following content/Students will grasp the following concepts: **1.1 The evolution of multicellular organisms allowed cell specialization and cell replacement.** **1.1.U1 According to cell theory, living organisms are composed of cells.** ● State the three parts of the cell theory. ● Outline evidence that supports the cell theory. ● Compare the use of the word theory in daily language and scientific language. **1.1.U2 Unicellular organisms carry out all functions of life.** ● Outline the functional characteristics of life. **1.1.U3 Cell Surface to volume is an important limitation to cell size.** ● Outline the activities occurring in the volume and at the surface of the cell. ● Calculate the surface area, volume and SA:V ratio of a cube. ● Explain the benefits and limitations of using cubes to model the surface area and volume of a cell. ● Describe the relationship between cell size and the SA:V ratio of the cell. ● Explain why cells are often limited in size by the SA:V ratio. ● List three adaptations of cells that maximize the SA: volume ratio. **1.1.U4 Multicellular organisms have properties that emerge due to the interaction of their cellular components.** ● Define and provide an example of a multicellular organism. ● Define and provide an example of a unicellular organism. ● Define “emergent property. ● ”Provide an example of emergent properties at different hierarchical levels of life. **1.1.U5 Specialized tissues can develop by cell differentiation in multicellular organisms.**	Learning experiences and strategies/planning for self-supporting learning: Lecture Socratic Seminar Small Group/Pair Work PowerPoint Lecture Notes Individual Presentations Group Presentations Student Lecture/Leading the class Interdisciplinary Learning Guided and Student Designed Labs and Explorations Details: Practicals 1 and 2 will be completed in this unit Other/s: Modeling, Think/Pair/Share, CER, Writing Prompts, Videos, etc. Accommodations: ● *SWD/504 – Accommodations Provided* ● *ELL – Reading & Vocabulary Support* ● *Intervention Support* ● *Extensions – Enrichment Tasks and Project*

- Define tissue.
- Outline the benefits of cell specialization in a multicellular organism.
- Define differentiation.

1.1.U6 Differentiation involves the expressions of some genes and not others in a cell's genome.

- Describe the relationship between cell differentiation and gene expression.

1.1.U7 The capacity of stem cells to divide and differentiate along different pathways is necessary in embryonic development and also makes stem cells suitable for therapeutic uses.

- Define zygote and embryo.
- List 2 key properties of stem cells that have made them on the active areas of research in biology and medicine today.
- Explain why stem cells are most prevalent in the early embryonic development of a multicellular organism.
- Contrast the characteristics of embryonic, umbilical cord and adult somatic stem cells.
- Define totipotent, multipotent and pluripotent.

1.2 Eukaryotes have a much more complex cell structure than prokaryotes.

1.2.U1 Prokaryotes have a simple cell structure without compartmentalization.

- Outline the major differences between prokaryotic and eukaryotic cells.
- List the functions of the following structures of a prokaryotic cell: cell membrane, nucleoid, plasmids, cytoplasm, ribosomes, cell wall, pili, capsule, and flagella.
- Contrast the size of eukaryotic and prokaryotic ribosomes.

1.2.U2 Eukaryotes have a compartmentalized cell structure.

- State the meaning and advantages of eukaryotic cells being "compartmentalized."
- State structural differences between plant and animal cells.

1.2.U3 Prokaryotes divide by binary fission.

- Define asexual reproduction.
- Outline the steps of binary fission.

1.2.U4 Electron microscopes have a much higher resolution than light microscopes.

- Define resolution.
- Compare the functionality of light and electron microscopes.

1.3 The structure of biological membranes makes them fluid and dynamic

1.3.U1 Phospholipids form bilayers in water due to the amphipathic properties of phospholipid molecules.

- Draw a simplified diagram of the structure of the phospholipid, including a phosphate-glycerol head and two fatty acid tails.
- Define hydrophilic and hydrophobic.
- Define amphipathic and outline the amphipathic properties of phospholipids.
- Explain why phospholipids form bilayers in water, with reference to hydrophilic phosphate heads and two hydrophobic hydrocarbon tails.

1.3.U2 Membrane proteins are diverse in terms of structure, position in the membranes and function.

- State the primary function of the cell membrane.
- Contrast the structure of integral and peripheral proteins.
- List at least four functions (with example) of membrane bound proteins.
- Contrast the two types of transport proteins: pumps and channels.

1.3.U3 Cholesterol is a component of animal cell membranes.

- Identify the structure of cholesterol in molecular diagrams.
- Describe the structural placement of cholesterol within the cell membrane.

1.4 Membranes control the composition of cells by active and passive transport.

1.4.U1 Particles move across membranes by simple diffusion, facilitated diffusion, osmosis and active transport.

- Describe simple diffusion.
- Explain two examples of simple diffusion of molecules into and out of cells.
- Outline factors that regulate the rate of diffusion.
- Describe facilitated diffusion.
- Describe one example of facilitated diffusion through a protein channel.
- Define osmosis.
- Predict the direction of water movement based upon differences in solute concentration.
- Compare active transport and passive transport.
- Explain one example of active transport of molecules into and out of cells through protein pumps.

1.4.U2 The fluidity of membranes allows materials to be taken into cells by endocytosis or released by exocytosis. Vesicles move materials within cells.

- Describe the fluid properties of the cell membrane and vesicles.
- Explain vesicle formation via endocytosis.

- Outline two examples of materials brought into the cell via endocytosis.
- Explain release of materials from cells via exocytosis.
- Outline two examples of materials released from a cell via exocytosis.

1.4.U3 Vesicles move materials within cells.

- List two reasons for vesicle movement.
- Describe how organelles of the endomembrane system function together to produce and secrete proteins (rough ER, smooth ER, Golgi and vesicles).
- Outline how phospholipids and membrane bound proteins are synthesized and transported to the cell membrane.

1.5 There is an unbroken chain of life from the first cells on Earth to all cells in organisms alive today.

1.5.U1 Cells can only be formed by division of preexisting cells.

- Discuss implications of all cells being formed from preexisting cells.

1.5.U2 The first cells must have arisen from non-living material.

- Outline the four processes needed for the spontaneous origin of cells on Earth.
- Outline the experiments of Miller and Urey into the origin of organic compounds.
- Define polymerization, monomer and polymer.
- Outline two properties of RNA that would have allowed it to play a role in the origin of life.
- Outline why fatty acids were likely the primary component of the membrane of early cells.

1.5.U3 The origin of eukaryotic cells can be explained by the endosymbiotic theory.

- State the endosymbiosis theory.
- Outline the major events in the origin of eukaryotic cells.
- Describe the evidence for the endosymbiotic theory.

1.6 Cell division is essential but must be controlled.

1.6.U1 Mitosis is the division of the nucleus into two genetically identical daughter nuclei.

- State the function of mitosis.
- List four processes which involve mitosis.
- State the names of the four phases of mitosis.
- Draw typical eukaryotic cells as they would appear during the interphase and the four phases of mitosis.

- Outline four events that occur during prophase.
- Outline the process of metaphase, inclusive of the role of microtubules and the kinetochore.
- Outline the process of anaphase.
- Outline four events that occur during telophase.

1.6.U2 Chromosomes condense by supercoiling during mitosis.

- Describe the structure of a replicated chromosome, include the centromere and sister chromatids.
- Explain why chromosomes must condense during mitosis.

1.6.U3 Cytokinesis occurs after mitosis and is different in plants and animal cells.

- Define cytokinesis.
- State the difference between mitosis and cytokinesis.
- Contrast cytokinesis in plant and animal cells.
- Describe the formation of the cleavage furrow in animal cell cytokinesis.
- Describe the formation of the middle lamella and cell wall in plant cell cytokinesis.

1.6.U4 Interphase is a very active phase of the cell cycle with many processes occurring in the nucleus and cytoplasm.

- List example metabolic reactions occurring during cell interphase.
- Outline events of G1, S, G2 and G0 phases of interphase.

1.6.U5 Cyclins are involved in the control of the cell cycle.

- Explain the role of cyclin and cyclin-CDK complexes in controlling the cell cycle.
- State the role of cyclins D, B, A and E in the cell cycle.

1.6.U6 Mutagens, oncogenes and metastasis are involved in the development of primary and secondary tumors.

- Define tumor, benign, malignant, metastasis, cancer, mutagen and carcinogen.
- Describe why mutagens are not necessarily carcinogens.
- Describe how cancer arises, referring to accumulation of mutations over time.
- Explain the relationship between oncogenes, tumor suppressor genes and cancer.

Students will develop the following skills:

1.1.A1 Questioning the cell theory using atypical examples, including striated muscle, giant algae and aseptate fungal hyphae.

- Describe features of striated muscle fibers that make them a discrepancy from an atypical cell.

- Describe features of red blood cells that make them a discrepancy from an atypical cell.
- Describe features of aseptate fungal hyphae that make them a discrepancy from an atypical cell.
- Describe features of giant algae that make them a discrepancy from an atypical cell.

1.1.A2 Investigation of functions of life in Paramecium and one named photosynthetic unicellular organism.

- Describe characteristics of *Paramecium* that enable it to perform the functions of life.
- Describe characteristics of *Chlamydomonas* that enable it to perform the functions of life.

1.1.A3 Use of stem cells to treat Stargardt's disease and one other named condition.

- Outline why stem cells are used in medical research and treatment.
- Outline the cause and symptoms of Stargardt's disease.
- Explain how stem cells are used in the treatment of Stargardt's disease.
- Outline the cause of leukemia.
- Explain how stem cells are used in the treatment of leukemia.

1.1.A4 Ethics of the therapeutic use of stem cells from specially created embryos, from the umbilical cord blood of a newborn baby and from an adult's own tissues.

- Discuss the benefits and drawbacks in using adult stem cells.
- Discuss the benefits and drawbacks in using embryonic stem cells.
- Discuss the benefits and drawbacks in using cord blood stem cells.

1.1.S1 Use of a light microscope to investigate the structure of cells and tissues.

- Label the names of parts of the microscope.
- Define magnification.
- Given the magnification of the ocular and objective lenses, calculate the total microscope magnification.
- Define "field of view."
- Outline how to determine the diameter of a field of view using low power magnification.
- Calculate the field of view diameter of a microscope under medium or high power.
- Outline how to estimate the size of a sample in the microscope field of view.
- Demonstrate how to focus the microscope on a sample.

1.1.S2 Drawing of cell structures as seen with the light microscope. (Practical 1)

- Demonstrate how to draw cell structures seen with a microscope using sharp, carefully joined lines and straight edge lines for labels.

1.1.NOS1 Looking for trends and discrepancies- although most organisms conform to cell theory, there are exceptions.

- Define "trend" and explain why trends are useful in scientific study.
- Define "discrepancy" and explain why discrepancies are useful in scientific study.

- List features that would be considered a “trend” related to the cell theory.

1.1.NOS2 Ethical implications of research- research involving stem cells is growing in importance and raises ethical issues.

- Explain why biological research must take ethical issues into consideration.

1.2.A1 Structure and function of organelles within exocrine gland cells of the pancreas.

- State the function of an exocrine gland cell.
- Describe the function of the following structures in an exocrine gland cell: plasma membrane, nucleus, mitochondria, Golgi apparatus, lysosomes, vesicles and endoplasmic reticulum.

1.2.A2 Structure and function of organelles within palisade mesophyll cells of the leaf.

- State the function of a palisade mesophyll cell.
- Describe the function of the following structures in a palisade mesophyll cell: cell wall, plasma membrane, chloroplasts, vacuole, nucleus, and mitochondria.

1.2.S1 Drawings of the ultrastructure of prokaryotic cells based on electron micrographs.

- Explain why the ultrastructure of prokaryotic cells must be based on electron micrographs.
- Draw the ultrastructure of E.coli as seen in an electron micrograph.

1.2.S2 Drawings of the ultrastructure of eukaryotic cells based on electron micrographs.

- Draw and label a diagram of the ultrastructure of a generic animal cell.
- Draw and label a diagram of the ultrastructure of a generic plant cell.

1.2.S3 Interpretations of electron micrographs to identify organelles and deduce the function of specialized cells.

- Explain why cells with different functions will have different structures.
- Identify ultrastructures visible in a micrograph of a eukaryotic cell.
- Given a micrograph of a cell, deduce the function of the cell based on the structures present.

1.2.NOS Developments in scientific research follows improvements in apparatus- the invention of the electron microscopes led to greater understanding of cell structure.

- With reference to a specific example, explain how an improvement in apparatus allowed for greater understanding of cell structure.

1.3.A1 Cholesterol in mammalian membranes reduces membrane fluidity and permeability to some solutes.

- Describe the function of cholesterol molecules in the cell membrane.

1.3.S1 Drawing of the fluid mosaic model.

- Draw and label the structure of membranes. Include:
  - Phospholipid bilayer
  - Integral proteins shown spanning the membrane
  - Peripheral proteins on membrane surface
  - Protein channels with a pore
  - Glycoproteins with a carbohydrate side chain
  - Cholesterol between phospholipids in the hydrophobic region
  - An indication of thickness (10nm)

1.3.S2 Analysis of evidence from electron microscopy that led to the proposal of the Davson-Danielli model.

- Describe the observations and conclusions drawn by Davson and Danielli in discovering the structure of cell membranes.

1.3.S3 Analysis of the falsification of the Davson-Danielli model that led to the Singer-Nicolson model.

- Describe conclusions about cell membrane structure drawn from freeze-etched electron micrograph images of the cell membrane.
- Describe conclusions about cell membrane structure drawn from cell fusion experiments.
- Describe conclusions about cell membrane structure drawn from improvements in techniques for determining the structure of membrane proteins.
- Compare the Davson-Danielli model of membrane structure with the Singer-Nicolson model.

1.3.NOS1 Using models as representations of the real world-there are alternative models of membrane structures.

- Explain what models are and their purposes in science.
- Describe the observations and conclusions drawn by Gorter and Grendel in discovering the structure of cell membranes.

1.3.NOS2 Falsification of theories with one theory being superseded by another-evidence falsified the Davson-Danielli model.

- Describe why the understanding of cell membrane structure has changed over time.

1.4.A1 Structure and function of the sodium-potassium pumps for active transport and potassium channels for facilitated diffusion in axons.

- Describe the structure of the sodium-potassium pump.
- Describe the role of the sodium-potassium pump in maintaining neuronal resting potential.
- Outline the six steps of sodium-potassium pump action.

- Describe the structure of the potassium channel.
- Describe the mechanism of potassium movement through the potassium channel.
- Explain the specificity of the potassium channel.
- Describe the action of the “voltage gate” of the potassium channel.

1.4.A2 Tissues or organs to be used in medical procedures must be bathed in a solution with the same osmolarity as the cytoplasm to prevent osmosis.

- Explain what happens to cells when placed in solutions of the same osmolarity, higher osmolarity and lower osmolarity.
- Outline the use of normal saline in medical procedures.

1.4.S1 Estimation of osmolarity in tissues by bathing samples in hypotonic and hypertonic solutions. (Practical 2)

- Define osmolarity, isotonic, hypotonic and hypertonic.
- Calculate the percentage change between measurement values.
- Calculate the mean value of a data set.
- Calculate the standard deviation value of a data set.
- State that the term standard deviation is used to summarize the spread of values around the mean, and that 68% of the values fall within one standard deviation of the mean.
- Explain how the standard deviation is useful for comparing the means and the spread of data between two or more samples.
- Determine the correct type of graph to represent experimental results.
- State that error bars are a graphical representation of the variability of data.
- Accurately graph mean and standard deviation of data sets.
- Determine osmolarity of a sample given changes in mass when placed in solutions of various tonicities.

1.4.NOS Experimental design- accurate quantitative measurements in osmosis experiments are essential.

- Define quantitative and qualitative.
- Determine measurement uncertainty of a measurement tool.
- Explain the need for repeated measurements (multiple trials) in experimental design.
- Explain the need to controlled variables in experimental design.

1.5.A1 Evidence from Pastuer’s experiments that spontaneous generation of cells and organisms does not now occur on Earth.

- Define spontaneous generation.
- Describe Pasteur’s experiments about spontaneous generation.

• Explain why Pasteur's experiments did not support the idea of spontaneous generation. **1.5.NOS Testing the general principles that underlie the natural world- the principles that cells only come from pre-existing cells needs to be verified.** • Outline historical thinking about spontaneous generation. • Summarize the Redi experiment. • Summarize the Spallanzani experiment. • List reasons why biologists now universally accept that cells only come from preexisting cells. **1.6.A1 The correlation between smoking and incidence of cancers.** • Explain the use of correlations to determine the relationship between two variables (inclusive of positive and negative correlations). • Explain why the existence of a correlation does not necessitate a causal relationship between two variables. • Calculate a correlation coefficient using Pearson's R. • Determine if a correlation coefficient value is significant. • Define significant as related to the relationship between two variables. • Use epidemiological case study information to outline the relationships between smoking and cancer. **1.6.S1 Identification of phases of mitosis in cells viewed with a microscope or in a micrograph.** • Determine the phase of mitosis of a cell viewed in a micrograph or with a microscope. **1.6.S2 Determination of a mitotic index from a micrograph** • State the formula for calculation of a mitotic index. • Calculate the mitotic index of a tissue as seen in a micrograph. • Outline the use of mitotic index calculations in diagnosis and treatment of cancer. **1.6.NOS Serendipity and scientific discoveries- the discoveries of cyclins was accidental.** • Outline the discovery of cyclins including the role of serendipity.	
Students will be assessed daily with classwork, discussions, group work, and reflections using a variety of formats with a focus on the applications and skills provided in the syllabus.	**Formative assessment:** Quiz/Test Project/Model CER/Reflection

	Essay/Writing Assignment

Students will be assessed per subtopic and then at the end of the unit (Topic) to ensure understanding using IB exam style questions, modeling, reflection, lab reports, and writing prompts	**Summative assessment:** Quiz/Test Project/Model CER/Reflection Essay/Writing Assignment
Students may be aware of many of the concepts within this unit, so building on prior knowledge using scaffolding techniques to aid students in a deeper understanding and extending learning to ensure that students can meet the goals set by the unit.	Differentiation: Affirm Identity - build self-esteem Value Prior Knowledge Scaffold Learning Extend Learning Details: Many concepts may be familiar to the students and others will need more scaffolding and extension.

Approaches to learning (ATL)

Check the boxes for any explicit approaches to learning connections made during the unit. For more information on ATL, please see the guide.

Thinking
Social Communication
Self-management
Research

***Each one will be focused on individually (~2 weeks per ATL)**

Details: This unit will provide students an overview of cellular biology and allow them to explore new horizons within the expanding world of cytology.
Students will need to be able to make connections between structure and function, differentiate between the cell types, and explain how all of these components help us understand living things.
Students will learn at the beginning of this course to keep organized notebooks, complete assignments in a timely manner, and learn to use time management to aid them in being successful in the course (self-management).
Since this is the beginning of a new course, the students will have opportunities to get to know each other, me, and the classroom via individual and group assignments.

There will be research components embedded into the content to allow students to dig deeper into the content.

Language and learning	TOK connections	CAS connections
Check the boxes for any explicit language and learning connections made during the unit. For more information on the IB's approach to language and learning, please see the guide.	*Check the boxes for any explicit TOK connections made during the unit*	*Check the boxes for any explicit CAS connections. If you checked any of the boxes, provide a brief note in the "details" section explaining how students engaged in CAS for this unit.*

Activating Background Knowledge Scaffolding for new learning Acquisition of new learning through practice Demonstrating proficiency Details: Students may be proficient in many of the concepts within this unit so the focus will be on activating background knowledge and providing students opportunities to learn and practice new applications and skills.	Personal and Shared Knowledge Ways of Knowing Areas of Knowledge The Knowledge Framework Details: Biology is one of the natural sciences, an area of knowledge. The natural sciences can sometimes be placed in false conflict with the arts or religious and indigenous knowledge systems. The *natural sciences* tend to rely on the ways of knowing sense perception, reason, language, memory. There are many examples of discoveries made or inspired by imagination, intuition and emotion – however these are then rigorously tested and explained using the scientific method (falsification). Students will have a writing prompt covering the following items: 1.1 There is a difference between the living and the non-living environment. How are we able to know the difference? 1.2 The world that we inhabit is limited by the world that we see. Is there any distinction to be drawn between knowledge claims dependent upon observations made by sense perception and knowledge claims dependent upon observations assisted by technology? 1.3 The explanation of the structure of the plasma membrane has changed over the years as new evidence and ways of analysis have come to light. Under what circumstances is it important to learn about theories that were later discredited? 1.5 Biology is the study of life, yet life is an emergent property. Under what circumstances is a systems approach productive in biology and under what circumstances is a reductionist approach more appropriate? How do scientists decide between competing approaches?	Creativity Activity Service Details: Modeling and active participation in the learning process. Creating materials to aid their fellow classmates in understanding a particular concept through peer interaction and team/group activities.

International Mindedness/Aims:

International Mindedness: (Research/Reflections/Writing)

1.1 Stem cell research has depended on the work of teams of scientists in many countries who share results thereby speeding up the rate of progress. However, national governments are influenced by local, cultural and religious traditions that impact on the work of scientists and the use of stem cells in therapy.

1.2 Microscopes were invented simultaneously in different parts of the world at a time when information traveled slowly. Modern-day communications have allowed for improvements in the ability to collaborate, enriching scientific endeavors.

1.6 Biologists in laboratories throughout the world are researching the causes and treatment of cancer.

Aims: (Practicals/Activities/Student Reflections/CER Activities)

- **Aim 6: Develop experimental and investigative scientific skills including the use of current technologies.**
- **Aim 8: Become critically aware, as global citizens, of the ethical implications of using science and technology.**

1.1/1.2 Aim 8: There are ethical issues involved in stem cell research, whether humans or other animals are used. Use of embryonic stem cells involves the death of early-stage embryos, but if therapeutic cloning is successfully developed the suffering of patients with a wide variety of conditions could be reduced.

1.4 Aim 8: Organ donation raises some interesting ethical issues, including the altruistic nature of organ donation and concerns about the sale of human organs.

1.4 Aim 6: Dialysis tubing experiments can act as a model of membrane action. Experiments with potato, beetroot or single-celled algae can be used to investigate real membranes.

1.5 Aim 6: Pasteur's experiment can be repeated using modern apparatus.

1.6 Aim 8: The tobacco industry could be discussed. Suppression of the results of research by tobacco companies into the health effects of smoking tobacco was unethical. Smoking causes considerable social harm, but, with the exception of laws on production and supply in Bhutan, has never been made illegal.

Resources
Damon, A.; McGonegal, R.; Tosto, P.; Ward, W. *Standard level biology*; Pearson Education Limited: Harlow, Essex, 2014. Greenwood, T.; Pryor, K.; Bainbridge-Smith, L.; Allan, R. Environmental science: student workbook; Biozone International: Hamilton, New Zealand, 2013. Van de Lagemaat, R. www.inthinking.net: Andorra la Vella, Andorra, 2019. IB Biology Schoology Course and Group

Stage 3: Reflection—considering the planning, process and impact of the inquiry

What worked well *List the portions of the unit (content, assessment, planning) that were successful*	**What didn't work well** *List the portions of the unit (content, assessment, planning) that were not as successful as hoped*	**Notes/changes/suggestions:** *List any notes, suggestions, or considerations for the future teaching of this unit*