SKJ Education

LC HL BIOLOGY

FOUNDATION PROGRAM: WEEK 1

INTRODUCTION TO BIOLOGY

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LC HL BIOLOGY – FOUNDATION PROGRAM

Week 1: Introduction to Biology

Learning Objectives

- **1.1:** State the characteristics and kingdoms of life.
- **1.2:** Identify the structure and state the function of key animal and plant cell organelles.
- **1.3:** Describe the stages of mitosis and state its importance for growth and repair.
- **1.4:** Describe the stages of meiosis and state its importance for gamete formation.
- **1.5:** Define cancer and explain how it results from uncontrolled cell division.

Key Terms - Week 1

- **Biology:** The scientific study of life.
- **Organism:** A living thing that displays all the characteristics of life.
- **Cell:** The basic structural and functional unit of all living organisms.
- **Organelle:** A specialised structure within a cell that performs a specific function.
- **Mitosis:** A type of cell division that results in two daughter cells, each with the same number and kind of chromosomes as the parent nucleus. It is essential for growth and repair.
- **Meiosis:** A type of cell division that reduces the chromosome number by half, resulting in four gamete cells. It is essential for sexual reproduction.
- **Chromosome:** A thread-like structure of nucleic acids and protein found in the nucleus, carrying genetic information in the form of genes.
- **Cancer:** A disease caused by uncontrolled cell division, leading to the formation of tumours that can invade surrounding tissues.

Weekly Challenge: As you study this week, find **3 examples of living processes** around you (e.g., a plant growing towards light (response), a pet seeking food (metabolism), mould growing on bread (reproduction)). Share your observations in our Google Classroom!

WEEK 1 STUDY PLAN

Day	Activities & Time Commitment	✓	Rating (1-10)
Monday	- Review Learning Objectives (5 min) - Rank your current ability (5 min) - Review Key Terms (10 min) - Complete Exercise A1 (15 min) *Focus: PREPARATION*		
Tuesday	- Complete Exercise B (50 min) *Focus: EXPERIMENTAL THINKING*		
Wednesday	- Reflect on content so far (what has been challenging?) (10 min) - Plan remaining study sessions (10 min) *Focus: PROCESSING*		
Thursday	- Complete Exercises A2 & A3 (60 min) - 1-hour online lesson (60 min) *Focus: QUESTIONING*		
Friday	- Complete Exercise C (40 min) *Focus: ERROR ANALYSIS*		
Saturday	- Complete Exam Question Assessment (D) (60 min) *Focus: EXECUTION*		
Sunday	- Correct assessment (30 min) - Complete self-reflection (15 min) - Plan next week (15 min) *Focus: REFLECTION & RECHARGING*		

Study Tips for Success

- **Active Recall:** After studying, close your notes and write down **everything you remember**. Force your brain to grow.
- **Spaced Repetition:** Review concepts **multiple times** over several days.
- **Biology in Action:** Look for **real-world examples** of the concepts you're learning.
- **Ask Questions:** Don't hesitate to ask for help when concepts are unclear. Reach out via *Google Classroom* or email; *steven@skjeducation.com*.
- **Celebrate Progress:** **Acknowledge your improvements**, no matter how small.

A1. Proficiency Drills

Learning Focus: Foundational concepts of what defines life, cell structure, and the purposes of cell division.

Part 1: What is Life? - The Characteristics of Living Things

Key Concepts

Living organisms share a set of common features that distinguish them from non-living things. A common acronym to remember them is **MRS GREN**.

Task #1: Complete the MRS GREN table below.

Characteristic	Description	Example
Movement		A cheetah chasing its prey.
Respiration	The chemical reactions that release energy in cells.	
Sensitivity	The ability to detect and respond to changes in the environment.	
Growth		A seed germinating into a tree.
Reproduction		
Excretion	Getting rid of waste products from metabolism.	
Nutrition		A Venus flytrap digesting a fly.

Part 2: The Building Blocks of Life - Cell Organelles

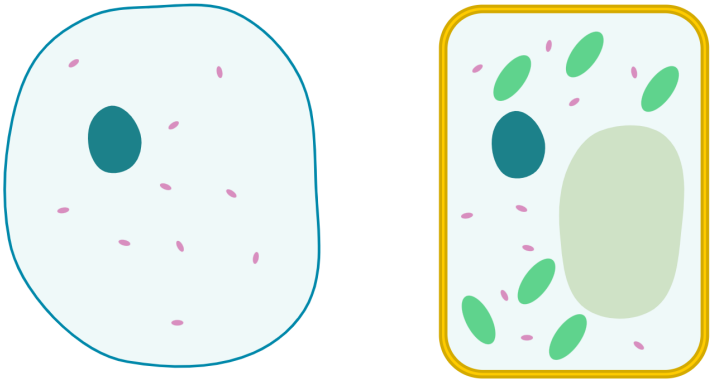
Essential Knowledge

Plant vs. Animal Cells:

- **Plant Cells:** Have chloroplasts, a large central vacuole, and a rigid cellulose cell wall.
- **Animal Cells:** Have centrioles and can have lysosomes. No cell wall or chloroplasts.
- **Both Have:** Nucleus, mitochondria, cell membrane, ribosomes, cytoplasm.

Task #2: Label the diagrams of the animal and plant cell below and complete the function table.

ANIMAL VS. PLANT CELL



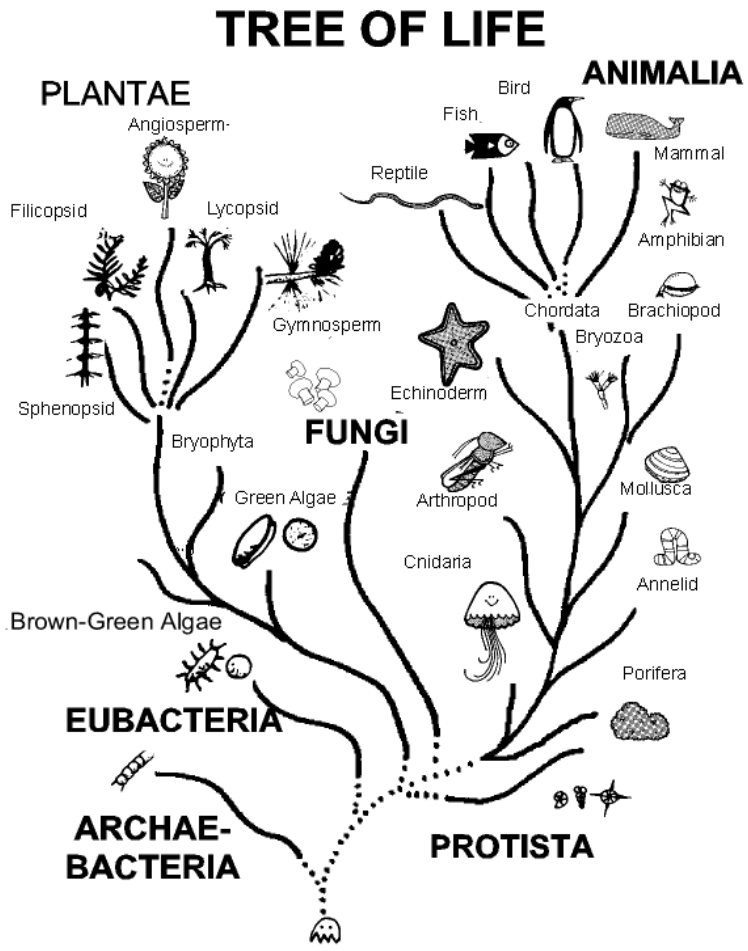
Organelle	Animal Cell?	Plant Cell?	Function
Nucleus			
			Site of aerobic respiration, where energy (ATP) is released.
Chloroplast			
			Controls the passage of substances into and out of the cell.
Cell Wall			
Ribosome			
Vacuole			

Part 3: Classifying Life - An Introduction to Kingdoms

Biology Vocabulary

- **Autotroph:** An organism that makes its own food (e.g., plants via photosynthesis).
- **Heterotroph:** An organism that gets food by consuming other organisms (e.g., animals, fungi).
- **Unicellular:** Made of a single cell (e.g., bacteria, amoeba).
- **Multicellular:** Made of many cells (e.g., animals, plants).
- **Prokaryotic:** Does not have a nucleus or membrane-bound organelles (e.g., bacteria).
- **Eukaryotic:** Does have a nucleus and membrane-bound organelles (e.g., fungi).

Task #3: Classify the following organisms based on the MRS GREN characteristics and your knowledge of cell types. You should Google any organisms that you are unfamiliar with (take a guess beforehand, see if you can *make an educated guess*).



Organism	Autotroph or Heterotroph?	Uni- or Multi-cellular?	Pro- or Eu-karyote?	Key MRS GREN Feature Observed
E. coli				
Poaceae				
Mushroom				
SARS CoV 2				
Human				
Oak Tree				
Amoeba proteus				

Further Question: Based on your table, which organism is the most difficult to classify using *only* the MRS GREN criteria? Why?

A2. Worked Example & Questions

Learning Focus: Applying knowledge of **cell division** to explain its role in **growth, repair, and disease**.

Scenario

A patient has a cut on their skin. Over the following weeks, the cut heals and new skin forms. **Question:** Explain the specific **type of cell division** responsible for this healing process and describe what happens during its **main stages**.

Solution Framework:

1. **Decode & Define:** "Healing and new growth implies the production of new, identical body cells. This is the process of mitosis."
2. **Plan:** 1) Name the process (Mitosis). 2) State its purpose in this context (repair). 3) Briefly describe the key stages involved (IPMAT).
3. **Execute:** The healing process is due to **mitosis**.
   - **Interphase:** The cell prepares for division; DNA is replicated.
   - **Prophase:** Chromosomes condense and become visible; the nuclear membrane breaks down.
   - **Metaphase:** Chromosomes line up along the equator of the cell.
   - **Anaphase:** Sister chromatids are pulled apart to opposite poles of the cell.
   - **Telophase:** Two new nuclei form; the cell begins to divide (cytokinesis).

   This results in two identical daughter cells that replace the damaged ones.
4. **Evaluate:** "The answer correctly identifies mitosis, links it to repair, and outlines the stages simply and accurately, focusing on the key events."

Test Yourself

1. **(Knowledge)** State two functions of mitosis in a multicellular organism.
2. **(Application)** A random cell has 40 chromosomes. How many chromosomes will each of its daughter cells have after mitosis?
3. **(Analysis)** Explain why meiosis is necessary for sexual reproduction but mitosis is not.
4. **(Synthesis)** A student says, "Cancer is just cells dividing." Why is this description incomplete? Use the term *mitosis* in your answer.

A3. Thinking Like a Biologist – Challenging Assumptions

Learning Focus: Developing critical thinking skills about the nature of life, cellular complexity, and the implications of cell division.

1. **The Edge of Life:** Viruses are not classified as living organisms according to MRS GREN. They cannot reproduce on their own and do not carry out respiration. *So what are they?* Does this mean we need to rethink our definition of life, or should they remain in a category of their own? Can you think of another entity that challenges the traditional definition of life?

   Task 1

   Research the **characteristics of a prion** (a misfolded protein that causes diseases like Mad Cow Disease). Create a simple table comparing it to a virus and a bacterium based on the MRS GREN criteria. Which is the **most "non-living" pathogen and why?**

2. **The Ultimate Sacrifice:** During meiosis, genetic material is "shuffled" through crossing over and independent assortment, creating massive genetic variation. *But why is variation so important?* Imagine a world where meiosis did not exist and gametes were produced by mitosis instead. What would be the long-term consequence for a species facing a new, deadly disease?

   Task 2

   Brainstorm the **pros and cons of asexual reproduction** (using mitosis) vs. sexual reproduction (using meiosis) for a species. *If you could design a super-organism, which method would you give it and why?*

3. **A Double-Edged Sword:** Mitosis is essential for life—it allows us to grow and heal. But when it goes wrong, it can cause cancer. The same process is both vital and potentially deadly. *How does the body normally keep mitosis under control?* (Hint: think about tumour suppressor genes). If you were designing a new anti-cancer drug, what stage of the cell cycle would you target to stop mitosis, and what is a potential downside of this?

   Task 3

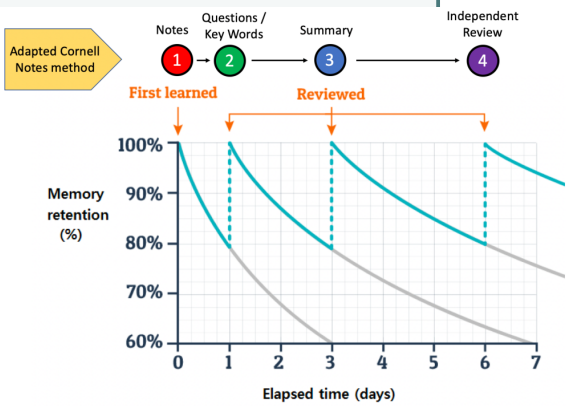
   Come up with three real-life scenarios where an **understanding of cell biology is crucial** (e.g., in choosing a chemotherapy drug that targets rapidly dividing cells, in using stem cells for medical treatments, in creating plant hybrids in agriculture).

B. Memory Retention & Learning Experiment

Learning Focus: Understanding **how memory works** and **applying the scientific method** to understand memory retention.

The Forgetting Curve Experiment

In week 1, we are not reviewing any formal LC Biology experiments. Instead, we will conduct an interesting experiment of our own. This will explore how well your brain can remember key Biology definitions and formulae over time.



Watch the following video, then attempt the quiz below. [**CLICK HERE FOR VIDEO**]

Do not look at the quiz before starting the YouTube video. DO NOT CHECK your score. For the **next 5 days**, attempt this quiz, but **DO NOT check your score**. **Do not do *any more Biology*** during this experiment. Fill in your scores after finishing the experiment below.

Day	Time to complete quiz (minutes and seconds)	Score (%)
Day 0 (Start)		
Day 1		
Day 2		
Day 3		
Day 4		
Day 5		

This experiment explores something very interesting about our brains, known as the forgetting curve. Check out this video: [**CLICK HERE FOR VIDEO**]

Quiz: 4 parts - Take quiz via Google Classroom

Quiz Components

Definitions: 4-5 important Biology definitions
Formulae: 4-5 important Biology formulae/equations
Random: 1-2 completely random questions about the video
Calculations: 1-2 experimental calculations

C. Calculation Error Analysis: Forensic Biology

Learning Focus: Developing critical analysis skills by identifying and correcting common biology misconceptions.

Analysis Tips

1. **Locate the Error:** Is there anything wrong with this statement/calculation?
2. **Diagnose the Error:** Is this a **Procedural Error** (miscalculation), a **Conceptual Error** (misunderstanding), or an **Omission Error** (incomplete answer)?
3. **Explain the Misconception:** What does the answer reveal about their understanding of how to *communicate* this idea?
4. **Correct the Solution:** Provide the complete, textbook-quality answer.
5. **Metacognitive Reflection:** "This error is subtle because the number is right. What is one personal strategy I can adopt to ensure I never overlook a crucial detail like this under exam pressure? (e.g., making sure you can reverse your calculations and they still work)."

Forensic Biology Task

Your job is to find the **flaw in the thinking**. Explain why each statement is wrong and correct it.

Statement: "Respiration and breathing are the same thing. Both happen in the lungs."

Flawed Thinking

Error Analysis:

Correct Approach

Correction:

Statement: "The nucleus is the most important organelle because it controls the cell. Therefore, red blood cells must be dead because they don't have a nucleus."

Flawed Thinking

Error Analysis:

Correct Approach

Correction:

Statement: "Mitosis and meiosis are basically the same process; they both just make new cells."

Flawed Thinking

Error Analysis:

Correct Approach

Correction:

Statement: "Cancer is a virus that you can catch from someone else."

Flawed Thinking

Error Analysis:

Correct Approach

Correction:

Statement: "A tumour is always cancerous (malignant)."

Flawed Thinking

Error Analysis:

Correct Approach

Correction:

Statement: A student is describing the stages of mitosis. They say: "In prophase, the chromosomes line up. In metaphase, they get pulled apart."

Flawed Thinking

Error Analysis:

Correct Approach

Correction:

Statement: "The main purpose of photosynthesis is for plants to create oxygen for animals to breathe."

Flawed Thinking

Error Analysis:

Correct Approach

Correction:

Statement: "Enzymes are used up in the reactions they catalyse, which is why we need to constantly eat food to get more of them."

Flawed Thinking

Error Analysis:

Correct Approach

Correction:

Statement: "The DNA in a cell is only found in the nucleus. The mitochondria and chloroplasts don't have their own DNA."

Flawed Thinking

Error Analysis:

Correct Approach

Correction:

Statement: "Diffusion is the movement of water molecules from a high concentration to a low concentration across a membrane."

Flawed Thinking

Error Analysis:

Correct Approach

Correction:

Statement: "Homeostasis means keeping the internal body conditions exactly the same at all times, like a constant temperature."

Flawed Thinking	Correct Approach
Error Analysis:	**Correction:**

Statement: "An organism's DNA changes to help it adapt to its environment. A giraffe's neck got longer over generations because it needed to reach higher leaves."

Flawed Thinking	Correct Approach
Error Analysis:	**Correction:**

Statement: "All bacteria are harmful pathogens that cause disease."

Flawed Thinking	Correct Approach
Error Analysis:	**Correction:**

Reflection Time
You have seen some of the common errors and misconceptions that come up in this topic. Here are some important questions to **ask yourself**:

- **What surprised you? *Why*?**
- **What did you find difficult to grasp? *Why*?**
- **Did you recognise any of *your own mistakes* during the exercise?**
- **What is the most important thing *you have learned* this week?**

D. Weekend Assessment – Past Exam Questions

Learning Focus: Answering exam questions under **timed conditions**.

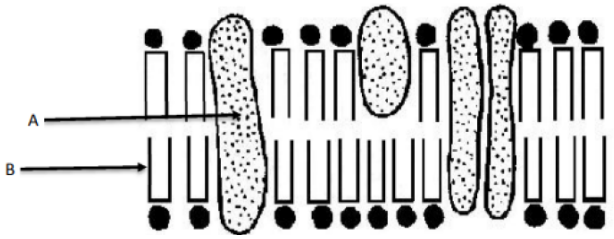
Assessment Instructions

Answer as many as you can in 60 minutes. The answers are provided in the right column in white font - highlight the cell to reveal them. Try to solve them first before checking! Complete these 10 warm up questions first, then as many exam questions as you can in the remaining time.

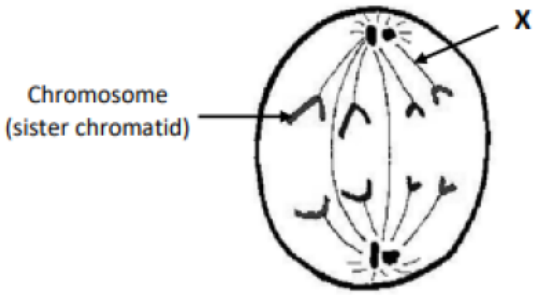
Question	Answer
1. State two characteristics of living organisms.	
2. Name an organelle, other than the nucleus, that contains DNA.	
3. What is the function of the ribosome?	
4. Describe what happens to the chromosomes during the anaphase stage of mitosis.	
5. Give one way in which the process of meiosis differs from mitosis.	
6. Explain the term cancer.	
7. Name a substance that is present in the cell wall of a plant cell.	
8. State one function of mitosis.	
9. Where in the cell does photosynthesis occur?	
10. What is a gamete?	

Past Exam Questions - Week 1

Answer the following questions in your answer book.



1. The diagram above shows part of the ultrastructure of a cell membrane.
   (a) Name the molecules labelled A and B.
   (b) Name two processes by which molecules can move through cell membranes.
   (c) Suggest a reason why the organelle involved in aerobic respiration is found in different amounts in different cells.
   (d) What term is used to describe organisms whose cells contain a nucleus?
   (e) What term is used to describe organisms that do not have nuclei?
   (f) Name an organelle other than the nucleus which contains genetic material.



2. The diagram shows a nucleus of a diploid cell undergoing one stage of mitosis.
   (a) Name the stage of mitosis shown in the diagram.
   (b) Justify your answer to part (a).
   (c) Identify the part labelled X in the diagram.
   (d) Explain the term *diploid*.
   (e) What is the diploid number of this cell?
   (f) Outline one function of mitosis in humans.
   (g) Give one example of a human cell not produced by mitosis.

3. (a) Give two features of eukaryotic cells which distinguish them from prokaryotic cells.
   (b) Give one function of one named tissue found in plants.
   (c) Give one function of one named tissue found in animals.
   (d) For each of the tissues you named, state one way in which the tissue is adapted to carry out its function.
   (e) How does an organ differ from a tissue?
   (f) What is meant by the term *tissue culture*?
   (g) State two requirements for successful tissue culture.

4. (a) What term is used to describe the long stage of the cell cycle when cell division is not occurring?
   (b) Name two types of biomolecule that are produced in the cell during this stage.
   (c) Name one organelle that is replicated at this stage.
   (d) Give any two other changes which will have occurred in the cell by the end of this stage.
   (e) Suggest why mature human red blood cells do not undergo cell division.

5. In relation to the principles of experimentation:
   (a) What is meant by the term *hypothesis*?
   (b) Explain what is meant by *double-blind testing*.
   (c) Explain the necessity for random selection.
   (d) Give two other features of good experimental design.
   (e) Where are the results of scientific research usually first published?
   (f) Why is it important that scientists publish the results of their research?

6. A horticulturist was carrying out scientific research into germination. They proposed the following hypothesis: "If soil pH is changed, then germination of grass seeds is affected."
   (a) Based on a graph provided, indicate the pH most suitable for germination.
   (b) Explain the term *hypothesis*.
   (c) State one variable from the investigation described.
   (d) What is the function of a control?
   (e) Where might the horticulturist first publish the results?
   (f) Give two limitations of the scientific method.

7. A scientist carried out a trial to investigate the effect of a herbal extract on the rate of recovery from the common cold.
   (a) What is the purpose of carrying out an experiment?
   (b) Why is a control normally used?
   (c) Identify which group was the control group.
   (d) Give two reasons why the method of selecting the participants reduces the reliability of the results.
   (e) Give two ways the experimental design could be improved.

Self-Assessment

After completing the assessment:

- Grade your work honestly
- Identify any areas for improvement
- Scan and submit via Google Classroom
- Reflect on your performance in your weekly reflection

More Exam Questions Available Here!

- **Cell Structure:** StudyStrivers - Cell Structure
- **Cell Division:** StudyStrivers - Cell Division

Self-Assessment

After completing the assessment:

- Grade your work honestly
- Identify areas needing improvement
- Scan and submit via Google Classroom
- Reflect on your performance in your weekly reflection

Another excellent week of work completed - ***well done!*** You are another step closer to *smashing your exams*, and another week closer to your summer holdiays!

Weekly Reflection Zone

What worked well this week?

What challenges did I face?

What surprised me the most this week?

Key biology concepts I want to review:

Goals for next week: