A-Level Biology Summer Preparation Work

Bridging the Gap: GCSE to A-Level Biology

Target Time: 10-15 hours total **Purpose:** To reinforce and deepen understanding of key GCSE Biology concepts essential for A-Level success

IMPORTANT: All tasks must be completed over the summer holidays. This work will be uploaded to Google Classroom in the first few days of your start at Oakes. Handwritten tasks can be photographed and uploaded to the platform.

Task 1: Cell Structure and Function Deep Dive (1 hour)

Create a detailed comparison table of prokaryotic and eukaryotic cells, then answer the following questions:

Questions:

1. Explain why mitochondria are often called the "powerhouses" of the cell. Include details of the main process that occurs within them and how their structure helps with this function.
2. A student observes cells under a microscope and notices some have a cell wall while others don't. What conclusions can they draw about the types of cells they're observing? Justify your reasoning with reference to specific cell structures.
3. Describe how a protein moves from where it's made in the cell to outside the cell, naming the organelles involved in this process.
4. Calculate the magnification needed to observe a mitochondrion (typical length 2 μm) if you want it to appear 4 cm long in your field of view. Show your working.

Task 2: Biological Molecules - Structure and Function (1.5 hours)

Part A: Carbohydrates Draw the structural formulae for glucose. Explain how glucose molecules join together to make starch and cellulose.

Part B: Proteins Describe how amino acids join together to make proteins, including the role of enzymes in this process.

Questions:

1. A diabetic patient's blood glucose level is 15 mmol/L (normal range: 4-7 mmol/L). Explain the processes that should occur to return this to normal, including the roles of insulin and glucagon.
2. Explain why cooking an egg white causes it to change from transparent to white and solid. What does this tell us about the importance of protein shape for enzyme function?
3. Compare and contrast the structure and function of starch and cellulose, explaining why humans can digest one but not the other despite both being made of glucose.

Task 3: Enzymes - The Biological Catalysts (1 hour)

Design and describe three experiments to investigate different factors affecting enzyme activity (temperature, pH, and substrate concentration).

Questions:

1. An enzyme has an optimum temperature of 37°C. Sketch a graph showing the effect of temperature on enzyme activity from 0°C to 80°C, and explain the shape of your curve.
2. Pepsin works optimally at pH 2, while other digestive enzymes work optimally at pH 8. Explain why these enzymes have such different optimal pH values and relate this to where they work in the digestive system.
3. A student measures the rate of an enzyme-catalyzed reaction at different substrate concentrations and finds that increasing substrate concentration beyond a certain point has no effect on the rate. Explain this observation using the lock and key model of enzyme action.
4. Explain how competitive inhibitors affect enzyme action and why increasing substrate concentration can overcome competitive inhibition.

Task 4: DNA and Protein Synthesis (1.5 hours)

Create a flow chart showing how genetic information in DNA leads to protein production in cells.

Questions:

1. A section of DNA has the sequence: TACGCAATGGCT. Write out the complementary DNA strand and explain how this information would be used to make a protein.
2. Explain what is meant by the "genetic code" and why it's important that it's the same in all living organisms.
3. A mutation changes one DNA base from A to T. Explain what effect this might have on the protein produced, considering that some changes might have no effect while others could be harmful.

4. Describe the roles of DNA, mRNA, and ribosomes in protein synthesis, including where in the cell each process occurs.

Task 5: Cell Division - Mitosis and Meiosis (1 hour)

Create detailed diagrams showing the key stages of mitosis and meiosis, highlighting the main differences between them.

Questions:

1. Explain why it's essential that DNA replication occurs before cell division begins, and describe what would happen if cells divided without replicating their DNA first.
2. A diploid organism has 24 chromosomes. How many chromosomes would be found in: (a) each daughter cell after mitosis, (b) each gamete after meiosis? Explain your reasoning for each answer.
3. Explain the importance of meiosis in sexual reproduction and how it contributes to genetic variation in offspring.
4. Describe what happens when cell division goes wrong and relate this to cancer development.

Task 6: Inheritance and Genetics (1.5 hours)

Work through genetic crosses involving single characteristics (monohybrid inheritance), including examples with dominant and recessive alleles.

Questions:

1. In humans, brown eyes (B) are dominant to blue eyes (b). A brown-eyed woman whose father had blue eyes marries a blue-eyed man. What are the possible genotypes and phenotypes of their children, and in what ratios? Show your working using a genetic diagram.
2. In garden peas, tall plants (T) are dominant to dwarf plants (t). If two heterozygous tall plants are crossed, what proportion of their offspring would you expect to be: (a) tall, (b) dwarf? Explain your answer with a genetic diagram.
3. Explain what is meant by dominant and recessive alleles, using examples to illustrate your answer.
4. Explain why the actual ratios obtained in genetic crosses often differ slightly from the theoretical ratios predicted, giving specific examples of factors that can cause these differences.

Task 7: Evolution and Natural Selection (1 hour)

Research and create a timeline showing key evidence for evolution, including fossil evidence and observations of species.

Questions:

1. The peppered moth (Biston betularia) exists in light and dark forms. Before industrial pollution, 95% were light-colored. After pollution darkened tree trunks, 95% became dark-colored. Explain this change using Darwin's theory of natural selection.
2. Antibiotic resistance in bacteria is a major medical problem. Explain how antibiotic resistance develops in bacterial populations and why this supports the theory of evolution.
3. Explain what is meant by "survival of the fittest" in the context of natural selection, and give an example of how environmental change can affect which organisms survive and reproduce.
4. Describe the types of evidence that support the theory of evolution, including fossils and observations of living organisms.

Task 8: Photosynthesis - Capturing Light Energy (1 hour)

Draw a detailed diagram of a leaf showing the structures involved in photosynthesis.

Questions:

1. Write the word equation and balanced symbol equation for photosynthesis and explain why this process is essential for most life on Earth.
2. Explain how the structure of a leaf is adapted for photosynthesis, including the roles of different cell types and tissues.
3. A student investigates the effect of light intensity on the rate of photosynthesis using pondweed. Describe how they could carry out this investigation, including the variables they would control and how they would measure the rate of photosynthesis.
4. Explain what limiting factors are and how light intensity, carbon dioxide concentration, and temperature can limit the rate of photosynthesis.

Task 9: Respiration - Releasing Chemical Energy (1 hour)

Compare and contrast aerobic and anaerobic respiration, including their uses in different organisms and situations.

Questions:

1. Write word equations and balanced symbol equations for aerobic respiration and for anaerobic respiration in both yeast and muscle cells.
2. Explain why aerobic respiration releases much more energy than anaerobic respiration.

3. During intense exercise, muscle cells may switch from aerobic to anaerobic respiration. Explain why this happens and describe the consequences for the athlete.
4. Yeast is used in bread making and brewing. Explain how anaerobic respiration in yeast is utilized in each of these applications.

Task 10: Homeostasis and Control Systems (1.5 hours)

Create a detailed diagram showing how body temperature is regulated in humans, including the role of the brain and effector organs.

Questions:

1. Explain what is meant by homeostasis and why it's important for proper cell function. Give three examples of conditions that are controlled by homeostasis.
2. Describe how blood glucose levels are controlled in healthy individuals, including the roles of insulin and glucagon. Explain what happens in Type 1 diabetes and how this condition can be managed.
3. Explain how the human body responds to being too hot and too cold, including the role of the thermoregulatory center in the brain.
4. Describe how the kidneys help maintain water balance in the body and explain what happens when someone is dehydrated.

Task 11: Disease and Immunity (1 hour)

Research how the human body defends itself against pathogens, including both physical barriers and the immune system.

Questions:

1. Explain the difference between active and passive immunity, giving examples of each and discussing the advantages and disadvantages of each type.
2. Describe how vaccination works and explain why it's such an effective public health measure.
3. Explain why some people with damaged immune systems are extremely vulnerable to infections that wouldn't normally be dangerous.
4. Explain why antibiotics are effective against bacterial infections but not viral infections, and discuss why this is important when treating different types of disease.

Task 12: Ecology and Ecosystems (1 hour)

Draw a food web for a woodland ecosystem and use it to explain energy flow through the ecosystem.

Questions:

1. Explain why food chains rarely have more than four or five levels (trophic levels), including what happens to energy as it passes from one level to the next.
2. Describe the role of decomposers in ecosystems and explain what would happen to an ecosystem if all decomposers were removed.
3. Red squirrels in Britain have declined since grey squirrels were introduced. Explain this in terms of competition between species and discuss what factors might determine the outcome of such competition.
4. Explain the importance of the carbon cycle for life on Earth, including the role of different processes like photosynthesis, respiration, and combustion.

Task 13: Plant Biology - Structure and Function (1 hour)

Create detailed diagrams of root hair cells, palisade cells, and guard cells, explaining how each is adapted for its specific function.

Questions:

1. Explain how water moves from the soil through a plant to the atmosphere, including the processes of absorption, transport, and transpiration.
2. Describe how plants respond to light (phototropism) and gravity (gravitropism), including examples of where you might observe these responses.
3. A student notices that a plant's leaves wilt on a hot, sunny day but recover in the evening. Explain this observation in terms of water loss and water transport.
4. Compare the structure and function of xylem and phloem tissue in plants, explaining why plants need these transport systems.

Task 14: Human Body Systems Integration (1 hour)

Create a concept map showing how the circulatory, respiratory, and digestive systems work together to supply cells with nutrients and oxygen.

Questions:

1. Trace the journey of oxygen from the lungs to a muscle cell, naming all the structures involved and explaining the processes that occur at each stage.
2. Explain why the human heart is described as a "double pump" and discuss the advantages of having separate circuits for the lungs and the rest of the body.
3. Describe the process of digestion and absorption of food, including the roles of different digestive enzymes and where absorption occurs.
4. Explain how the body's systems adapt to meet increased demands during exercise, including changes in heart rate, breathing rate, and blood flow.

Task 15: Synthesis and Application (1 hour)

Write a comprehensive essay (800-1000 words) on ONE of the following topics, demonstrating your understanding of multiple biological concepts:

Option A: "The importance of enzymes in living organisms" **Option B:** "How the human body maintains stable internal conditions" **Option C:** "The role of DNA in inheritance and variation"

Your essay should:

- Include specific examples from different areas of biology
- Use appropriate biological terminology correctly
- Show clear understanding of underlying scientific principles
- Demonstrate links between different biological concepts
- Include relevant diagrams where appropriate

Completion Checklist

Before starting your A-Level course, ensure you can:

[ ] Explain the relationship between structure and function in cells and biological molecules

[ ] Describe the processes of cell division and their importance in growth and reproduction

[ ] Understand and apply principles of inheritance using genetic diagrams

[ ] Explain how organisms obtain and use energy through photosynthesis and respiration

[ ] Describe how organisms respond to changes in their environment

[ ] Understand the basic principles of classification and evolution

[ ] Explain the importance of maintaining stable internal conditions (homeostasis)

[ ] Describe the interactions between organisms and their environment

Assessment: Your biology teacher may ask you to discuss your work from selected tasks during the first week of term. Focus on understanding the underlying principles rather than memorizing facts.

Good luck with your A-Level Biology studies!