



**2023 specification**  
first exams in 2025

# Topic Tests for IB Biology

## D. Continuity and Change

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# Teacher's Introduction

These topic tests have been designed to help you and your students assess their knowledge of a topic after you have taught each part of **Theme D – Continuity and Change** for the **IB Biology Diploma Programme (standard level (SL) and higher level (HL))**. This section of the course includes the topics: **DNA replication; Protein synthesis; Mutation and gene editing; Cell and nuclear division; Gene expression (HL only); Water potential; Reproduction; Inheritance; Homeostasis; Natural selection; Stability and change; and Climate change.**

## Remember!

Always check the exam board website for new information, including changes to the specification and sample assessment material.

Each topic test closely follows the content of the specification and includes:

- **Multiple-choice questions:** These are not in exam style, and the purpose of these is to test different elements, knowledge and skills from the specification in a variety of styles. Question types include general recall and explanation of key concepts.
- **Structured-answer section:**
  - o Some simpler, factual questions are included to ensure that all the content and basics are covered, and to allow less-able biologists access to some marks. Question types include filling in missing words in paragraphs, completing tables and labelling diagrams.
  - o Where appropriate, topics may contain one or more extended-response questions, to prepare students for what they might meet in the exam, and to test exam skills. Question types include method evaluations, ethical discussions and comparisons.

Mathematical and practical skills are also covered in these topic tests. Additional higher level only content is clearly marked in a separate section.

The table below shows the content, specification reference and number of marks allocated to each test.

Topic	Test Title	Topics Covered	Total Marks (SL)	Total Marks (HL)
1. Molecules	DNA replication	D1.1.1–9	20	32
	Protein synthesis	D1.2.1–19	24	51
	Mutation and gene editing	D1.3.1–10	20	33
2. Cells	Cell and nuclear division	D2.1.1–17	26	50
	Gene expression ( <b>HL only</b> )	D2.2.1–11	-	33
	Water potential	D2.3.1–11	17	29
3. Organisms	Reproduction	D3.1.1–20	47	59
	Inheritance	D3.2.1–21	42	62
	Homeostasis	D3.3.1–11	27	40
4. Ecosystems	Natural selection	D4.1.1–15	23	42
	Stability and change	D4.2.1–15	27	44
	Climate change	D4.3.1–12	24	35

Tests have been designed to take approximately 40–50 minutes to complete, although some are shorter than others. Students are able to see the number of marks awarded for each question, allowing them to gauge the level of detail they will require for the answers. Full answers with marks are included at the end of each test. Additionally, it makes the resource a suitable tool for students to use independently.

The topic tests are suitable for a classroom assessment, revision aid or homework task and are, therefore, suitable for use immediately after a topic is completed in class or at the end of teaching the course.

The HL content for tests D1.1 and D3.3 are duplicated on the page to halve the photocopying cost – simply cut on the dotted line before handing out to students.

It is recommended that students have access to a calculator to complete the questions. It is intended that students answer on a separate paper or in their books to save on photocopying costs.

We hope you find these tests useful during your teaching.

December 2024

## D1.1 DNA replication

### Multiple-choice questions

- What is the underlying function of DNA replication?
  - To repair damaged DNA
  - To transcribe RNA from DNA
  - To generate two identical copies of the original DNA
  - To produce proteins
- What principle **defines** the semi-conservative model of DNA replication?
  - DNA replication occurs only in the presence of enzymes
  - Each new DNA molecule consists of one parental and one newly synthesised strand
  - The process involves the synthesis of RNA templates for DNA replication
  - DNA replication produces completely identical copies of the original DNA
- Polymerase chain reaction (PCR) is a technique used to:
  - Analyse protein structure
  - Amplify specific DNA sequences
  - Convert RNA into DNA
  - Sequence entire genomes
- In gel electrophoresis, separation of DNA fragments is a result of what?
  - Size and shape
  - Density and charge
  - Charge and size
  - Hydrophobicity and charge

### Structured-answer section

- If a template DNA strand showed the sequence 5'-ACG TAC ACT GAC GTT ACC-3', the newly synthesised complementary strand display?
- State **two** important biological uses of DNA replication.
- Describe the roles of helicase and DNA polymerase in DNA replication.
- Match the following keywords to their respective uses in the polymerase chain reaction (PCR).

1. Primers
2. Temperature changes
3. <i>Taq</i> polymerase

a. Facilitates amplification of target DNA by repeated cycles of denaturation, annealing and extension
b. Initiates DNA synthesis at specific sites on the single-stranded DNA template
c. Allows separation of DNA strands to expose single-stranded DNA template
- Choose **one** application each for polymerase chain reaction (PCR) and gel electrophoresis, and state their significance in biological research or diagnostics.

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## Additional higher level content (HL)

### Multiple-choice questions

5. Which **two** proofreading mechanisms are involved in the process of mismatch repair?
- Helicase and ligase
  - DNA polymerase proofreading and exonuclease activity
  - Primase and topoisomerase
  - Single-strand binding proteins and telomerase

### Structured-answer section

6. State the words or phrases which complete the gaps below:

In DNA, adenine pairs with **(a)** \_\_\_\_, while cytosine pairs with **(b)** \_\_\_\_\_. DNA structure, where one strand runs in a 3' to 5' direction, while the other runs in a 5' to 3' direction. The sugar-phosphate backbone of DNA possesses directionality, with the 5' end having a (c) \_\_\_\_\_ group.

7. Summarise the steps involved in DNA replication, emphasising distinctions between leading and lagging strands, and identify the specific enzymes involved in the process.



## Additional higher level content (HL)

### Multiple-choice questions

5. Which **two** proofreading mechanisms are involved in the process of mismatch repair?
- Helicase and ligase
  - DNA polymerase proofreading and exonuclease activity
  - Primase and topoisomerase
  - Single-strand binding proteins and telomerase

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## D1.2 Protein synthesis

### Multiple-choice questions

- Which enzyme is primarily responsible for synthesising RNA using a DNA template?  
A. DNA polymerase      B. RNA polymerase      C. Helicase
- What is the complementary base pairing of adenine (A) on the DNA template strand during transcription?  
A. Van der Waals forces      C. Ionic interaction  
B. Hydrogen bonding      D. Covalent bonding
- Given a DNA sequence 'TACGCTA', which mRNA sequence would be transcribed?  
A. AUGCGAU      B. ATGCCAT      C. UACGCUA
- During protein synthesis, which stage involves the stepwise addition of amino acids to a growing polypeptide chain?  
A. Termination      B. Initiation      C. Termination
- What is the function of the anticodon in tRNA?  
A. Initiates transcription      C. Carries the amino acid  
B. Binds to the ribosome      D. Recognises the codon
- Which type of mutation is caused by a deletion or an insertion of one or more nucleotides?  
A. Frame-shift mutation      C. Missense mutation  
B. Silent mutation      D. Nonsense mutation

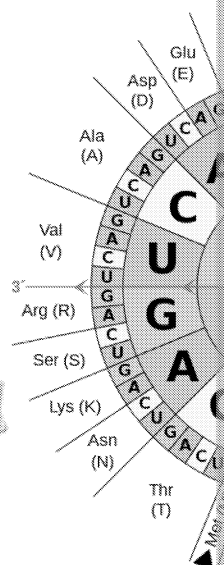
### Structured-answer section

- State the words or phrases which complete the gaps below: [2]

The stability of the DNA template ensures (a) \_\_\_\_\_ during the process of transcription, which serves as the (b) \_\_\_\_\_ of genetic information into mRNA.

- Describe the process of translation in protein synthesis, detailing the roles of mRNA, ribosomes, and tRNA. [3]

- What is a point mutation? [1]
  - What are the impacts of point mutations on protein structure and function? [2]
  - Translate the mRNA sequence AUG-UCG-CAA-UGG-UUA-CGU into a sequence of amino acids using the provided codon table. [3]



- Match the feature of the genetic code with its definition:

- |               |
|---------------|
| 1. Degenerate |
| 2. Triplet    |
| 3. Universal  |

- |  |
|--|
| a. Describes the structure of the codons consisting of three nucleotides                           |
| b. Indicates that the genetic code is consistent across all organisms                              |
| c. Refers to the redundancy in the genetic code where multiple codons code for the same amino acid |

- Describe the steps involved in the movement of the ribosome during translation.

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### Multiple-choice questions

7. Which of the following statements accurately describes the directionality of translation in molecular biology?
  - A. Transcription occurs in the 3' to 5' direction while translation occurs in the 5' to 3' direction
  - B. Both transcription and translation occur in the 5' to 3' direction
  - C. Transcription occurs in the 5' to 3' direction while translation occurs in the 3' to 5' direction
  - D. Transcription occurs randomly, while translation occurs in the 5' to 3' direction
8. What is the function of a promoter in gene expression?
  - A. Initiates translation
  - B. Marks the end of the coding region
  - C. Signals the start of transcription
  - D. Removes introns
9. Which of the following accurately describes introns and exons?
  - A. Introns are coding regions, while exons are non-coding regions
  - B. Introns are removed during splicing, while exons are retained in mature mRNA
  - C. Introns are translated into proteins, while exons are untranslated
  - D. Introns contain regulatory elements, while exons contain the genetic code
10. Which process is essential for the conversion of pre-proinsulin into insulin?
  - A. Translation
  - B. Transcription
  - C. Post-translational modification
  - D. Translocation
11. Proteasomes play a crucial role in maintaining a functional proteome by:
  - A. Facilitating protein synthesis
  - B. Degrading misfolded or damaged proteins
  - C. Initiating protein synthesis
  - D. Secreting peptides

### Structured-answer section

4. Explain how cells recycle amino acids during protein synthesis.
5. Explain the roles of 5' caps and 3' polyA tails in eukaryotic cells during post-transcriptional modification.
6.
  - a) Describe the functions of the three binding sites for tRNA on the ribosome during elongation.
  - b) Explain the steps involved in the initiation of translation.
7. Explain the process of alternative splicing of exons in eukaryotic cells, highlighting its significance in generating multiple variants of proteins from a single gene.
8. State the words or phrases which complete the gaps below:

Non-coding sequences play crucial roles in gene regulation and expression. They are (a) \_\_\_\_\_ and are transcribed but not translated into proteins. Examples of these include (b) \_\_\_\_\_, which are intervening sequences found within genes and are removed during the process of splicing to produce mature mRNA. Another example is (c) \_\_\_\_\_, which are located at the ends of chromosomes and are important for maintaining chromosomal stability. Additionally, genes for (d) \_\_\_\_\_ and (e) \_\_\_\_\_, which are involved in protein synthesis, are often found within non-coding sequences in eukaryotic DNA.

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### D4.3 Climate change

#### Key for mark schemes:

OWTTE = or words to that effect

AVP = any valid point

Question	Answer
<b>Multiple-choice questions</b>	
1	<p><b>Correct answer: B. Volcanic eruptions</b></p> <p>A. <i>Deforestation</i>: Incorrect – Deforestation is an anthropogenic cause driven by agriculture, logging, and urban development, which contribute to a rise in greenhouse gas emissions by reducing carbon dioxide absorption through photosynthesis and releasing stored carbon as trees are burned or decomposed.</p> <p>C. <i>Burning of fossil fuels</i>: Incorrect – Burning of fossil fuels is a significant anthropogenic cause of climate change due to the release of greenhouse gases.</p> <p>D. <i>Industrial agriculture</i>: Incorrect – Industrial agriculture contributes to climate change through means such as methane emissions from livestock and land-use change.</p>
2	<p><b>Correct answer: C. Carbon dioxide</b></p> <p>A. <i>Methane</i>: Incorrect – While methane is a potent greenhouse gas, carbon dioxide is the primary greenhouse gas responsible for anthropogenic global warming.</p> <p>B. <i>Nitrous oxide</i>: Incorrect – Nitrous oxide is also a potent greenhouse gas, but its contribution to global warming is lower compared to carbon dioxide.</p> <p>D. <i>Ozone</i>: Incorrect – Ozone is not a primary greenhouse gas responsible for global warming.</p>
3	<p><b>Correct answer: B. Melting polar ice caps</b></p> <p>A. <i>Increased forest cover</i>: Incorrect – Increased forest cover can act as a negative feedback mechanism by absorbing carbon dioxide, thus mitigating global warming.</p> <p>C. <i>Reduced emissions from cars</i>: Incorrect – Reduced emissions from cars would decrease greenhouse gas emissions, acting as a negative feedback mechanism.</p> <p>D. <i>Enhanced volcanic activity</i>: Incorrect – Enhanced volcanic activity can release greenhouse gases but is not considered a primary example of positive feedback in global warming.</p>
4	<p><b>Correct answer: B. Increased water temperature</b></p> <p>A. <i>Ocean acidification</i>: Incorrect – Ocean acidification is primarily caused by carbon dioxide dissolving in seawater.</p> <p>C. <i>Pollution run-off</i>: Incorrect – Pollution run-off can harm coral reefs, but the primary cause of coral bleaching is increased water temperature.</p> <p>D. <i>Overfishing</i>: Incorrect – Overfishing can contribute to the decline of coral reefs but is not the primary cause of coral bleaching.</p>
5	<p><b>Correct answer: B. Warmer temperatures and decreased winter snowfall</b></p> <p>A. <i>Decreased temperature and increased winter snowfall</i>: Incorrect – Decreased temperature and increased winter snowfall would likely contribute to enhanced carbon sequestration, not net loss.</p> <p>C. <i>Increased precipitation and reduced forest fires</i>: Incorrect – Increased precipitation and reduced forest fires would generally promote forest health and carbon accumulation.</p> <p>D. <i>Enhanced primary production and forest greening</i>: Incorrect – Enhanced primary production and forest greening would typically lead to increased carbon sequestration.</p>
6	<p><b>Correct answer: C. Loss of breeding grounds for emperor penguins</b></p> <p>A. <i>Expansion of breeding grounds for emperor penguins</i>: Incorrect – Melting sea ice would likely reduce breeding grounds for emperor penguins due to habitat loss.</p> <p>B. <i>Increased food availability for walruses</i>: Incorrect – Melting of sea ice would likely reduce food availability for walruses rather than increasing it.</p> <p>D. <i>Enhanced biodiversity in Arctic ecosystems</i>: Incorrect – While melting ice might lead to some changes, it would not necessarily result in enhanced biodiversity in Arctic ecosystems.</p>
7	<p><b>Correct answer: B. Decrease it</b></p> <p>A. <i>Increase it</i>: Incorrect – Warmer surface water inhibits nutrient upwelling, which would likely decrease primary production.</p> <p>C. <i>Have no effect on it</i>: Incorrect – Changes in nutrient availability due to warming would likely impact primary production, so this option is incorrect.</p> <p>D. <i>Vary unpredictably</i>: Incorrect – While ocean systems are complex and changes can be unpredictable, the general trend is for decreased primary production due to decreased nutrient availability, so this option is incorrect.</p>

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Question	Answer
8 (HL only)	<p><b>Correct answer: B. Hibernation of bears</b></p> <p>A. <i>Flowering of deciduous trees</i>: Incorrect – The flowering of deciduous trees is influenced by photoperiod and temperature patterns. As daylight hours decrease and temperatures drop, trees sense these environmental cues and adjust their growth and flowering patterns.</p> <p>C. <i>Bird migration</i>: Incorrect – Bird migration is strongly influenced by photoperiod and temperature patterns. Changes in day length and temperature trigger migratory behaviour, prompting them to undertake long-distance journeys in search of suitable breeding grounds.</p> <p>D. <i>Nesting behaviour</i>: Incorrect – Nesting behaviour in various animal species, including mammals, is also influenced by photoperiod and temperature patterns. These cues play a crucial role in determining the timing of nesting activities, ensuring that offspring are born or hatched at a favourable time for survival.</p>
9 (HL only)	<p><b>Correct answer: C. Photoperiod and temperature cues</b></p> <p>A. <i>Atmospheric pressure</i>: Incorrect – Atmospheric pressure may influence weather patterns but is not directly related to phenological events.</p> <p>B. <i>Humidity levels</i>: Incorrect – While humidity levels may affect plant growth, they are not primary cues for phenological events.</p> <p>D. <i>Soil pH</i>: Incorrect – Soil pH can affect plant nutrient uptake but is not a primary cue for phenological events.</p>
10 (HL only)	<p><b>Correct answer: C. Spruce bark beetles</b></p> <p>A. <i>Monarch butterflies</i>: Incorrect – Monarch butterflies may be affected by climate change, but they do not typically experience increases in life cycles within a year.</p> <p>B. <i>Honeybees</i>: Incorrect – Honeybees may be affected by climate change, but they do not typically experience increases in life cycles within a year.</p> <p>D. <i>Ladybugs</i>: Incorrect – Ladybugs may be affected by climate change, but they do not typically experience increases in life cycles within a year.</p>
11 (HL only)	<p><b>Correct answer: A. By accelerating spring growth and delaying migration</b></p> <p>B. <i>By delaying spring growth and accelerating migration</i>: Incorrect – Climate change typically accelerates spring growth and may also advance migration.</p> <p>C. <i>By synchronising temperature cues across ecosystems</i>: Incorrect – Climate change typically causes divergent temperature cues across ecosystems rather than synchronisation.</p> <p>D. <i>By enhancing the coordination of photoperiod cues</i>: Incorrect – Climate change typically affects temperature cues more significantly than photoperiod cues in phenological events.</p>
<b>Structured-answer section</b>	
1 a)	Carbon dioxide levels increasing alongside rising global temperatures. (1)
1 b)	<p>Human activities such as burning of fossil fuels / deforestation / industrial processes are the main causes for the observed trend. AVP (1)</p> <p>These activities release greenhouse gases, particularly carbon dioxide, into the atmosphere, contributing to the greenhouse effect and subsequent warming of Earth's surface. (1)</p>
2	<p>a) <del>negative</del>/positive (1)</p> <p>b) acidic/alkaline (1)</p> <p>c) <del>Decreases</del>/Increases (1)</p> <p>d) carbon/oxygen (1)</p>
3	<p>Burning of fossil fuels releases carbon dioxide into the atmosphere, contributing to the greenhouse effect. (1)</p> <p>Deforestation reduces the number of trees available to absorb carbon dioxide, exacerbating the effect. (1)</p> <p>Increased carbon dioxide levels lead to ocean acidification, harming marine life. (1)</p> <p>Rising temperatures disrupt ecosystems, causing habitat loss and species extinction. (1)</p>
4	<p>1c) <b>Deforestation</b> – The process of establishing forests on land that was previously cleared. (1)</p> <p>2b) <b>Causation</b> – The relationship where one factor directly influences the occurrence of another. (1)</p> <p>3f) <b>Correlation</b> – The statistical relationship between two variables where changes in one are associated with changes in another, without implying causation (1)</p> <p>4e) <b>Forest browning</b> – The phenomenon characterised by the decline in health of forest vegetation, often due to stressors like drought or pollution (1)</p> <p>5c) <b>Peat</b> – Partially decomposed organic matter accumulated in waterlogged conditions, forming a unique type of soil (1)</p> <p>6a) <b>Upslope range shifts</b> – Movement of species to higher elevations due to climate change. (1)</p>

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Question	Answer
5 (HL only)	With reduced snow cover, brown owls may have better camouflage and hunt higher fitness compared to white owls. (1) This could result in a shift in the population towards brown owls over time. (1)
6 (HL only)	Mismatches in timing between species interactions can lead to: <ul style="list-style-type: none"> <li>Asynchronous flowering and pollination, leading to reduced seed production in plant populations. (1)</li> <li>Mismatch between predator and prey emergence, affecting population dynamics leading to declines in predator populations or outbreaks of pest species. (1)</li> <li>Alterations in migration patterns of birds and insects, impacting food webs. (1)</li> <li>Changes in timing of plant leaf emergence and herbivore feeding, affecting survival rates. (1)</li> </ul>



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