Instructions to candidates
• Write your session number in the boxes above.
• Do not open this examination paper until instructed to do so.
• Section A: answer all questions.
• Section B: answer one question.
• Write your answers in the boxes provided.
• A calculator is required for this paper.
• The maximum mark for this examination paper is [50 marks].
Answer all questions. Write your answers in the boxes provided.

1. Sockeye salmon (*Oncorhynchus nerka*) spend the first years of their lives in the freshwater lakes of Alaska before migrating to marine waters. Their first months in marine waters are spent foraging and growing near the shore line. They then move to offshore regions of the North Pacific Ocean for 2 to 3 years.

![Fork length of O. nerka](https://commons.wikimedia.org/wiki/File:Oncorhynchus_nerka.jpg#/media/File:Oncorhynchus_nerka.jpg)

The graph shows fork length frequency of juvenile *O. nerka* caught during their first months in marine waters in autumn 2008 and ocean age one *O. nerka* caught 15 months later during winter 2009 in the North Pacific Ocean.

![Graph showing fork length frequency of O. nerka](https://example.com/graph)

**Key:** ■ autumn 2008 (juvenile *O. nerka*)  □ winter 2009 (ocean age one *O. nerka*)


(This question continues on the following page)
(Question 1 continued)

(a) Identify the most frequent fork length for *O. nerka* caught during autumn 2008 and winter 2009. [1]

| Autumn 2008: | ....................................................... |
| Winter 2009: | ....................................................... |

(b) Distinguish between the fork lengths of *O. nerka* in autumn 2008 and winter 2009. [2]

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| ....................................................... |
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| ....................................................... |

(c) Suggest a reason for the variation in fork length of ocean age one *O. nerka*. [1]

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| ....................................................... |
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(This question continues on the following page)
(Question 1 continued)

Protein content in O. nerka was measured to evaluate possible differences during their first 15 months at sea. The graph shows the relationship between fork length and total protein content per O. nerka caught during autumn 2008 and winter 2009.

![Graph showing relationship between fork length and total protein content per O. nerka]

**Key:** ☐ autumn 2008 (juvenile O. nerka) ☑ winter 2009 (ocean age one O. nerka)


(d) (i) Compare the protein content for O. nerka caught during autumn 2008 and winter 2009. [2]

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(ii) Outline the difficulty in predicting the age of O. nerka from fork length. [1]

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(This question continues on the following page)
(Question 1 continued)

(e) Using the data, suggest one reason for the relationship between protein content and fork length. [1]

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(This question continues on the following page)
(f) Scientists measured mercury levels in different fish. The table shows the results.

<table>
<thead>
<tr>
<th></th>
<th>Mercury / µg g⁻¹</th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>Sd</td>
<td>Min</td>
<td>Max</td>
<td>Number of samples</td>
</tr>
<tr>
<td>Cod</td>
<td>0.111</td>
<td>0.066</td>
<td>0.001</td>
<td>0.989</td>
<td>115</td>
</tr>
<tr>
<td>Monkfish</td>
<td>0.181</td>
<td>0.075</td>
<td>0.056</td>
<td>0.289</td>
<td>9</td>
</tr>
<tr>
<td>Shark</td>
<td>0.979</td>
<td>0.626</td>
<td>0.001</td>
<td>4.540</td>
<td>356</td>
</tr>
<tr>
<td>Trout</td>
<td>0.071</td>
<td>0.025</td>
<td>0.001</td>
<td>0.678</td>
<td>35</td>
</tr>
</tbody>
</table>

(i) Compare the results shown in the table for monkfish and shark. [2]

(ii) Suggest additional information that would be helpful in evaluating these data. [1]

(g) State which type of fish shows the most variation. [1]
2. The diagrams show a virus and a bacterium.

(a) Calculate the magnification of the bacterium. [1]

(b) State the method that bacteria use to divide. [1]

(This question continues on the following page)
(Question 2 continued)

(c) Outline the effectiveness of antibiotics against viruses and bacteria. [1]

(d) Saprotrophic organisms, such as *Mucor* species, are abundant in soils.

(i) Define *saprotrophic organisms*. [1]

(ii) State one role of saprotrophic organisms in the ecosystem. [1]
3. The graph shows a sigmoid population growth curve.

(a) Identify the phases labelled $X$ and $Y$. [1]

X: ................................................................

Y: ................................................................

(b) Outline how fossil records can provide evidence for evolution. [2]

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(This question continues on the following page)
(Question 3 continued)

(c) The table summarizes the genome size of several organisms.

<table>
<thead>
<tr>
<th>Organism type</th>
<th>Organism</th>
<th>Genome size / base pairs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bacterium</td>
<td><em>Helicobacter pylori</em></td>
<td>1 667 867</td>
</tr>
<tr>
<td>Fruit fly</td>
<td><em>Drosophila melanogaster</em></td>
<td>130 000 000</td>
</tr>
<tr>
<td>Rice</td>
<td><em>Oryza sativa</em></td>
<td>420 000 000</td>
</tr>
<tr>
<td>Human</td>
<td><em>Homo sapiens</em></td>
<td>3 200 000 000</td>
</tr>
</tbody>
</table>

(i) Distinguish between the terms genotype and phenotype.

(ii) Outline a structural difference between the chromosomes of *Helicobacter pylori* and *Homo sapiens*.

(iii) Deduce the percentage of adenine in *Oryza sativa* if the proportion of guanine in that organism is 30%.
(Question 3 continued)

(d) The figure shows a pedigree chart for the blood groups of three generations.

(i) Deduce the possible phenotypes of individual X. [1]

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(ii) Describe ABO blood groups as an example of codominance. [1]

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4. (a) Draw a labelled diagram showing the **interconnections** between the liver, gall bladder, pancreas and small intestine. [2]

(b) Outline the role of glucagon in homeostasis of glucose. [2]

(c) List **two** examples of polysaccharides. [1]

1. .................................................................
2. .................................................................
Section B

Answer **one** question. Up to two additional marks are available for the construction of your answer. Write your answers in the boxes provided.

5.  (a) Draw a labelled diagram of a section of DNA showing four nucleotides.  
    
    (b) Outline a technique used for gene transfer.  
    
    (c) Explain how evolution may happen in response to an environmental change.

6.  (a) Outline the stages of the cell cycle.  
    
    (b) Explain the process of translation in cells.  
    
    (c) Outline the production of a dipeptide by a condensation reaction, showing the structure of a generalized dipeptide.

7.  (a) Draw a labelled diagram of a motor neuron.  
    
    (b) Explain how an impulse passes along the membrane of a neuron.  
    
    (c) Describe the process of endocytosis.