GCE AS Level Biology

S21-B400U10-1

Assessment Resource 2

Basic Biochemistry and Cell Organisation Resource B

1. Protein synthesis involves two stages, transcription and translation. Different types of RNA are involved in each stage.

(a) The table below shows the percentages of the different types of RNA present in a rabbit body cell.

RNA	Percentage of total RNA
RNA present in nucleus	11.5
mRNA	3.5
rRNA	69.5
tRNA	15.5

(i) Name the organelle that would contain the greatest percentage of RNA. Explain your answer. [1]

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(ii) The total mass of RNA in a typical rabbit cell contains about 50 000 000 000 nucleotides.

Calculate the approximate number of nucleotides contained in the tRNA of a typical rabbit cell. Give your answer in standard form to two significant figures. [3]

Number of nucleotides in tRNA = ...

(iii) Explain why there would be large numbers of different mRNA molecules in a rabbit cell but only a maximum of 64 different tRNA molecules. [3]

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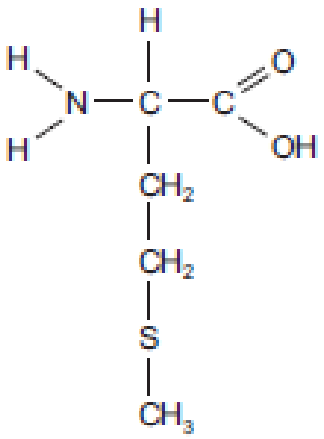
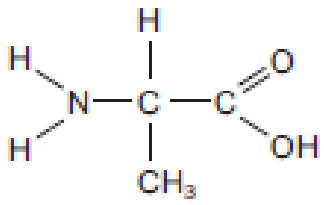
(b) During translation amino acids can be joined together in different sequences. The drawings below show the structural formulae of the amino acids methionine and glycine.

methionine



glycine



Methionine and glycine can bond together in two different ways:

methionine – glycine	or	glycine – methionine

Name the bond that would join these amino acids and with reference to the structure of the molecules, explain why two different dipeptides could be formed. [2]

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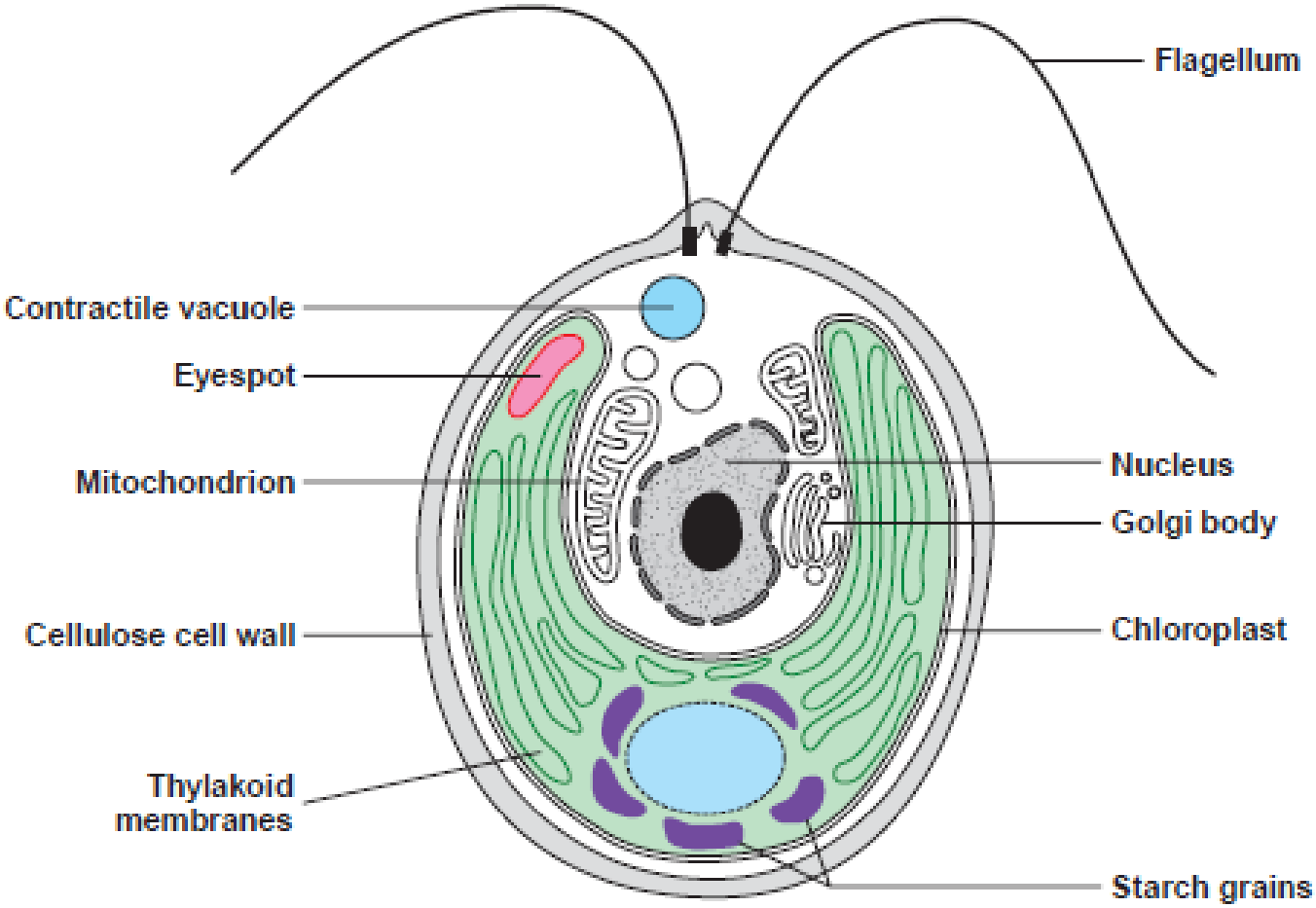
2. The classification of protoctistan eukaryotes changes frequently. *Chlamydomonas reinhardtii* is now classified as a protoctistan but has previously been classified as an animal and a plant. The diagram below shows the structure of this organism.



(a) With reference to the diagram, explain why this organism has, at different times, been classified as an animal and a plant. [2]

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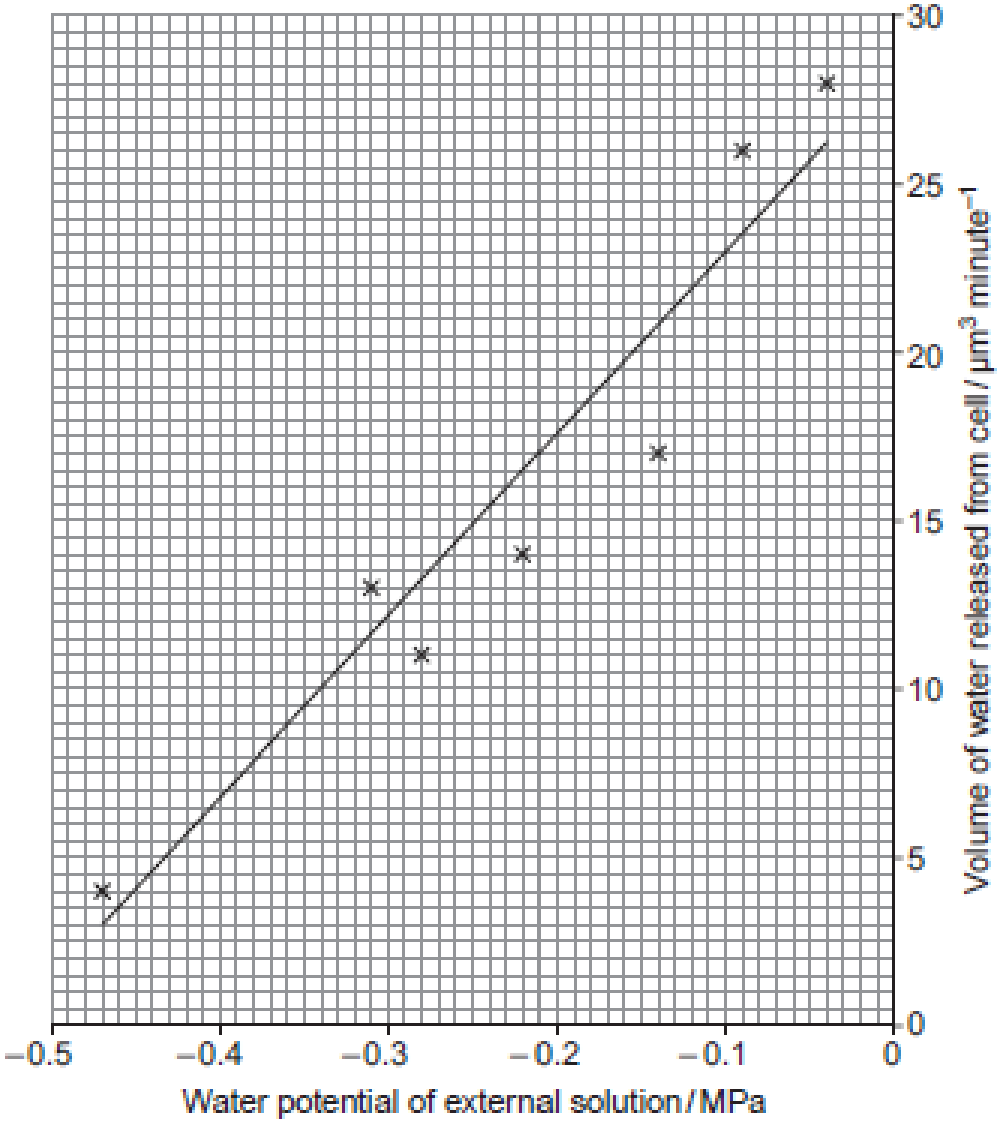
(b) *Chlamydomonas* lives in freshwater. When viewed under a light microscope, the contractile vacuoles are seen to fill and empty on a regular basis. They are involved in regulating the water content of the cell.
The graph shows the volume of water released from a cell of *Chlamydomonas* per minute at different water potentials of external solution.
A line of best fit is drawn.



(i) The diameter of a contractile vacuole reaches a maximum of 2 μm.
Calculate the volume of a contractile vacuole and use this to calculate the number of times the contractile vacuole fills and empties each minute at an external water potential of –0.24 MPa. Give your answer to one decimal place. [3]

volume of sphere = $\frac{4}{3}\pi r^3$;
π = 3.142

Volume of contractile vacuole = ...

Number of times the contractile vacuole fills and empties each minute = ...

(ii) Explain why the volume of water released from a cell of *Chlamydomonas* increases as the water potential of the external solution increases. [4]

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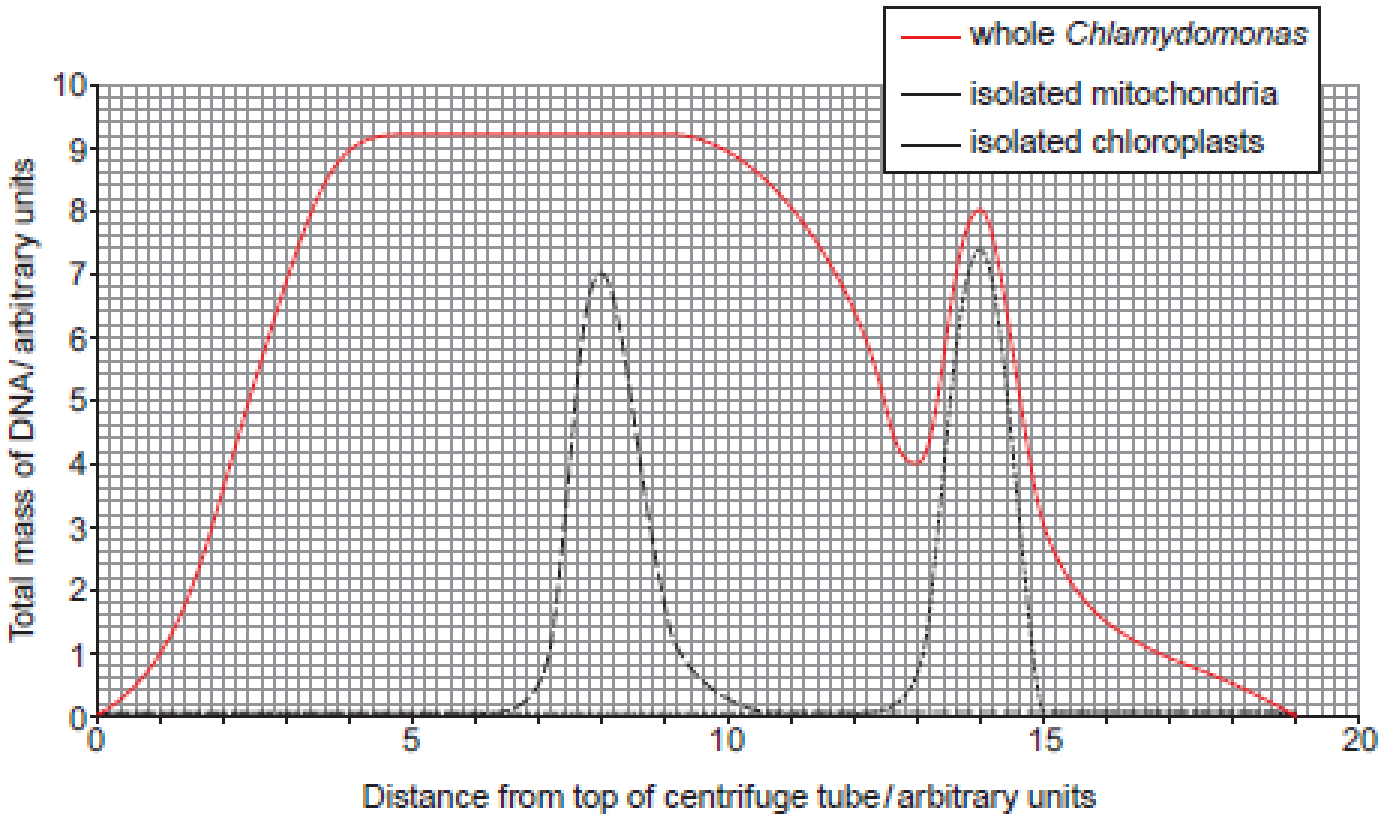
(c) The nuclear DNA of *Chlamydomonas reinhardtii* contains approximately 120 million base pairs arranged in 17 chromosomes of varying length. The mitochondrial DNA contains nearly 16 000 base pairs and the chloroplast DNA a further 203 000 base pairs.

DNA was extracted from whole *Chlamydomonas* and also from isolated mitochondria and chloroplasts. The samples were spun separately in an ultracentrifuge. The results are plotted on the graph below.



(i) The cytoplasm of *Chlamydomonas* was found to contain an enzyme that partially digests the chromosomes. Explain how the presence of this enzyme could be a reason for the results obtained for the whole *Chlamydomonas* extract. [2]

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(ii) To improve the quality of data obtained using this method, the scientists added an inhibitor of the enzyme that digests the chromosomes of *Chlamydomonas*. Suggest how this change would affect the data obtained. [3]

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(iii) Explain why keeping the whole *Chlamydomonas* extract **on ice** in a **buffer** would also improve the quality of data. [2]

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(iv) Both mitochondria and chloroplasts are believed to have evolved from prokaryotes. What evidence does the graph provide that could support this hypothesis? Explain your answer. [2]

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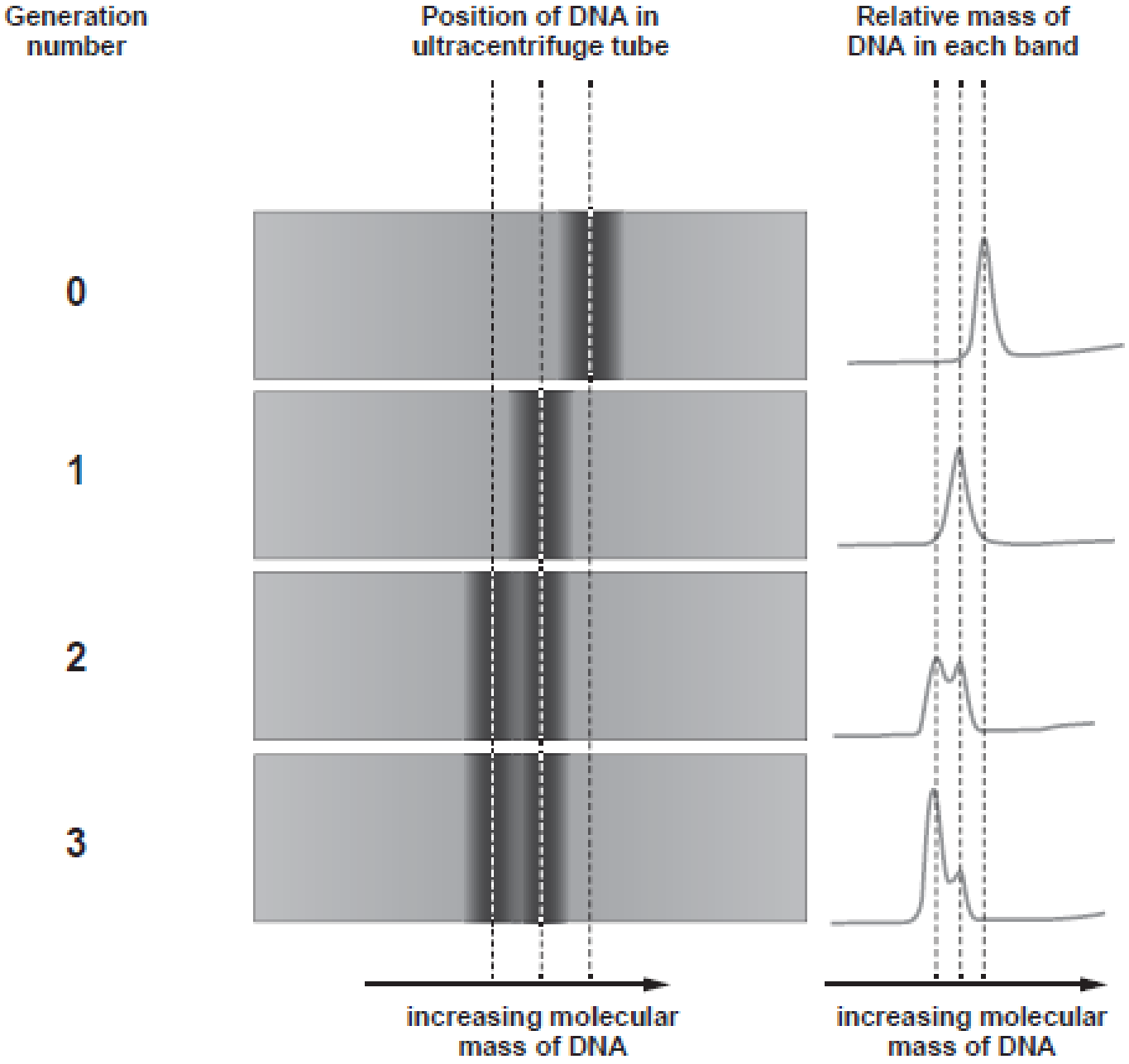
3. In 1958, Matthew Meselson and Franklin Stahl conducted a series of experiments that demonstrated that DNA replication is semi-conservative.

The images below show some of their results.



Other theories of DNA replication included:

- conservative replication, in which the original DNA is retained as a double stranded molecule; and
- dispersive replication, where the original DNA is split into many fragments which are then dispersed throughout the replicated molecules.

Using your own knowledge of Meselson and Stahl's experiments, explain how their experiment and the results shown in the image supported the theory of semi-conservative replication. Predict how the results would have differed if the other theories had been correct. Explain your answer. [9 QER]

END OF PAPER