



GCE Biology

S21-A400U10-1

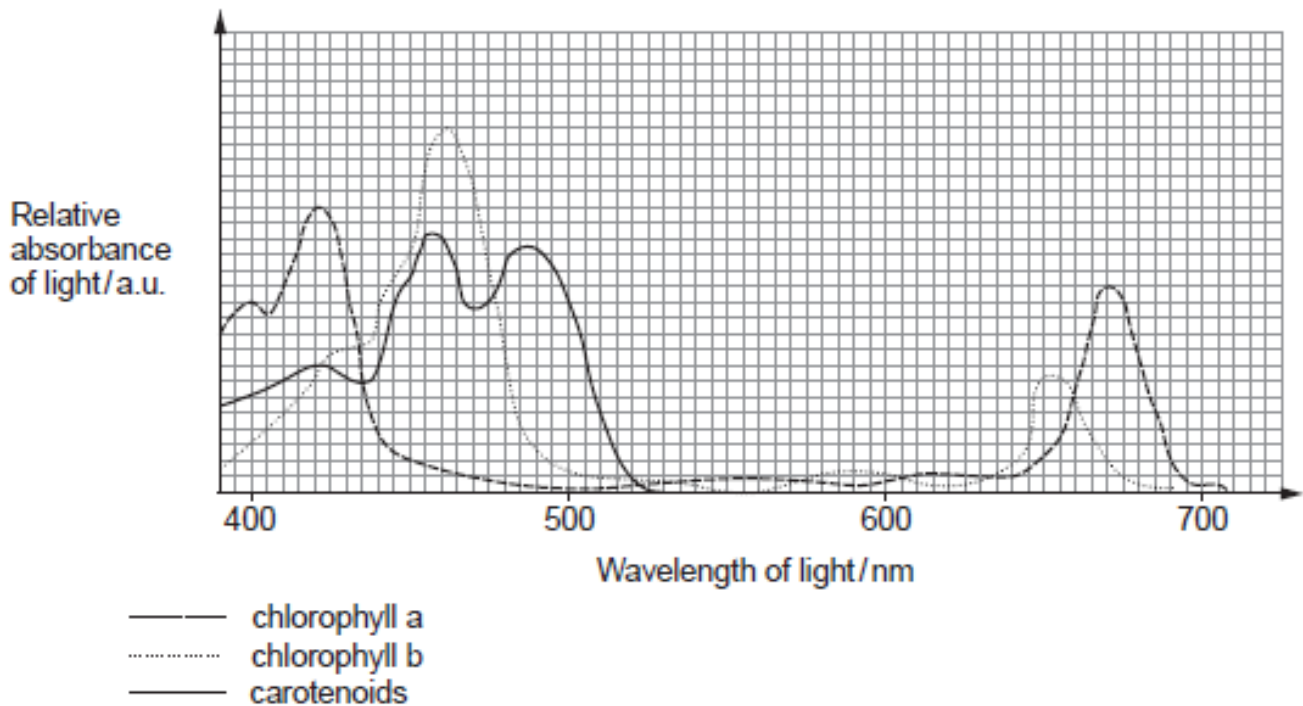
Assessment Resource 7

Energy for Life Resource G

Answer all questions.

1. Photosynthetic cells are transducers converting light energy into chemical energy. Several photosynthetic pigments are involved in the absorption of light energy. Image 1.1 is an absorption spectrum showing the relative absorbance of different wavelengths of light energy by different pigments.

Image 1.1



- (a) (i) Using information in image 1.1, describe the absorption spectrum of chlorophyll a. [2]

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- (ii) Suggest the advantage to photosynthetic cells of having several different light absorbing pigments. [1]

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Prochlorococcus is a species of cyanobacterium and is the most abundant photosynthetic organism on Earth. Cells of *Prochlorococcus* contain molecules of chlorophyll a and b embedded in photosynthetic membranes.

Image 1.2 and image 1.3 show a molecular model of a chlorophyll molecule and the arrangement of chlorophyll molecules in the photosynthetic membrane.

Image 1.2

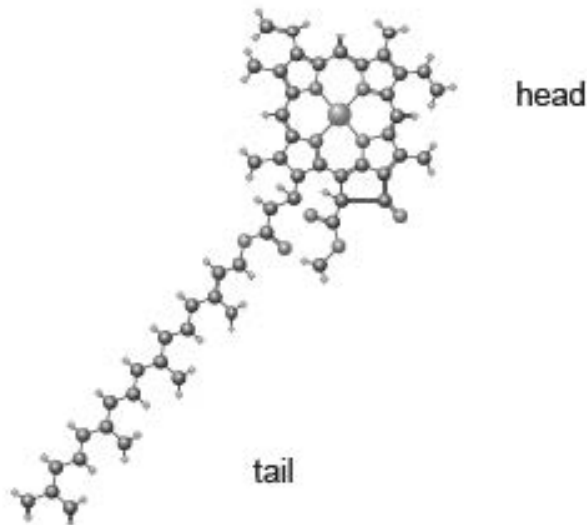
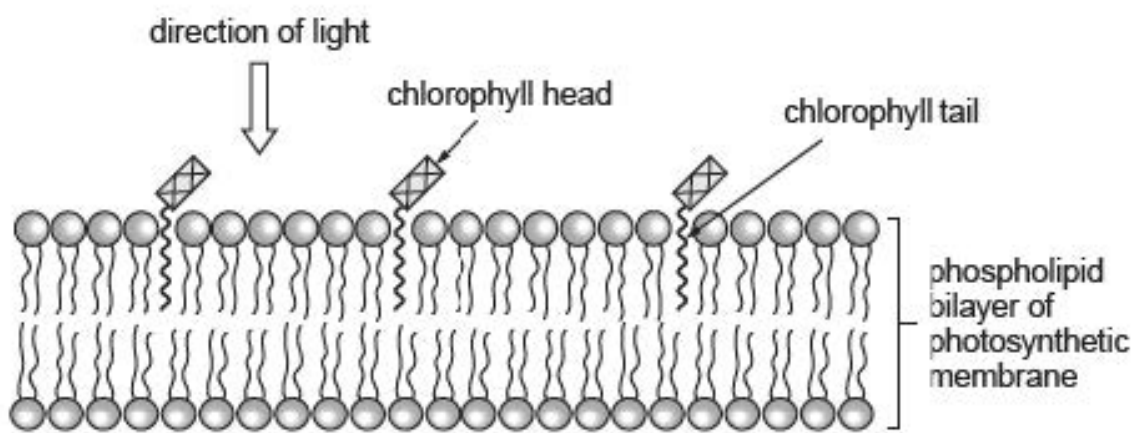


Image 1.3



(b) (i) State one element, other than carbon, hydrogen and oxygen, that is found in the chlorophyll molecule. [1]

(ii) Use image 1.2 and image 1.3 to explain how the properties of the head and tail of the chlorophyll molecule result in its position in the photosynthetic membrane. Suggest an advantage of the position of the chlorophyll molecules. [3]

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- (c) In the light dependent stage of photosynthesis, molecules of chlorophyll a emit electrons. Describe how these electrons are replaced in non-cyclic photophosphorylation. [2]

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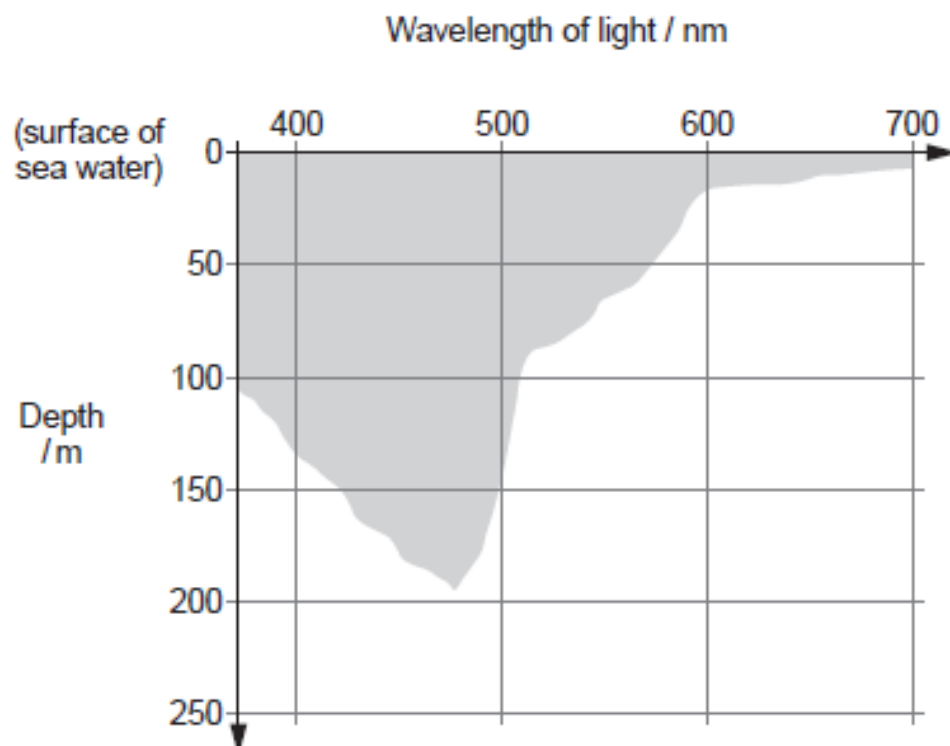
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- (d) *Prochlorococcus* is found at depths between 0 and 200m in oceans around the world. Different proportions of chlorophyll a and chlorophyll b are produced by *Prochlorococcus* at different depths. Image 1.4 shows the depth to which different wavelengths of light penetrate seawater.

Image 1.4



- Using image 1.1 and image 1.4, explain why *Prochlorococcus* cells found at depths between 150 metres – 200 metres produce chlorophyll b but not chlorophyll a. [2]

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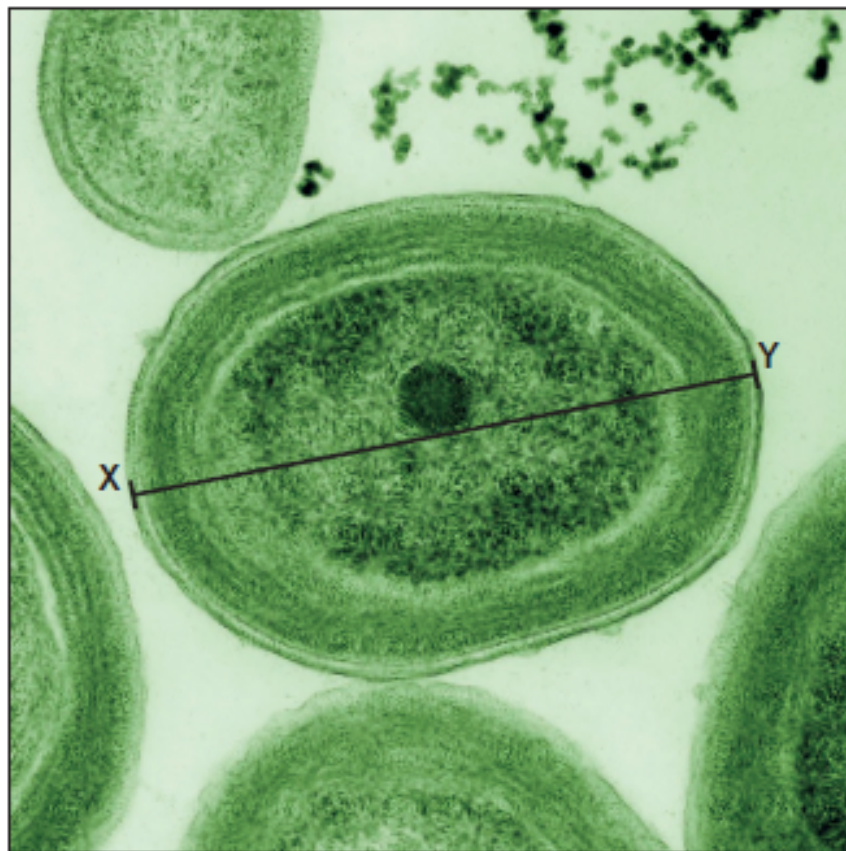
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- (e) *Prochlorococcus* is found in enormous numbers even in nutrient poor waters. Image 1.5 shows a photomicrograph of a *Prochlorococcus* cell.

Image 1.5



X-Y = 0.6 μm

- (i) Calculate the surface area : volume ratio of a *Prochlorococcus* cell which has a radius of 0.3 μm .
Express your ratio to the nearest whole numbers. [3]

Surface area of a sphere = $4\pi r^2$.

Volume of a sphere = $\frac{4}{3}\pi r^3$

$\pi = 3.14$

Surface area : volume ratio = :

- (ii) With reference to the size of the organism, explain how *Prochlorococcus* is able to gain sufficient minerals from nutrient poor waters. [3]

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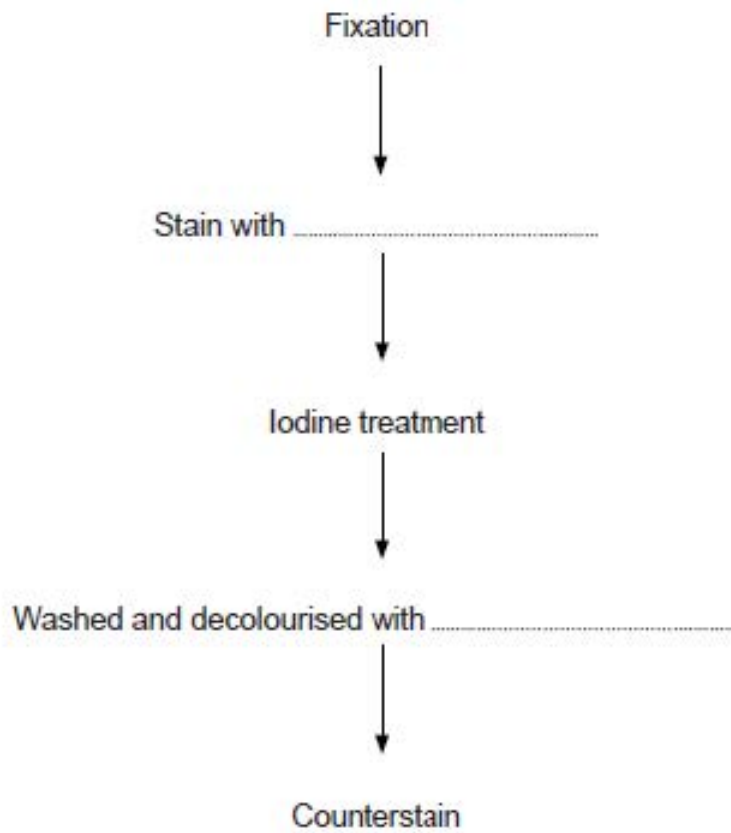
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(f) *Prochlorococcus* stains red when using the Gram staining technique.

(i) Complete the flow chart below which shows the stages in the Gram staining technique. [2]



(ii) Explain what this staining technique indicates about the structure of the cell wall of *Prochlorococcus*. [1]

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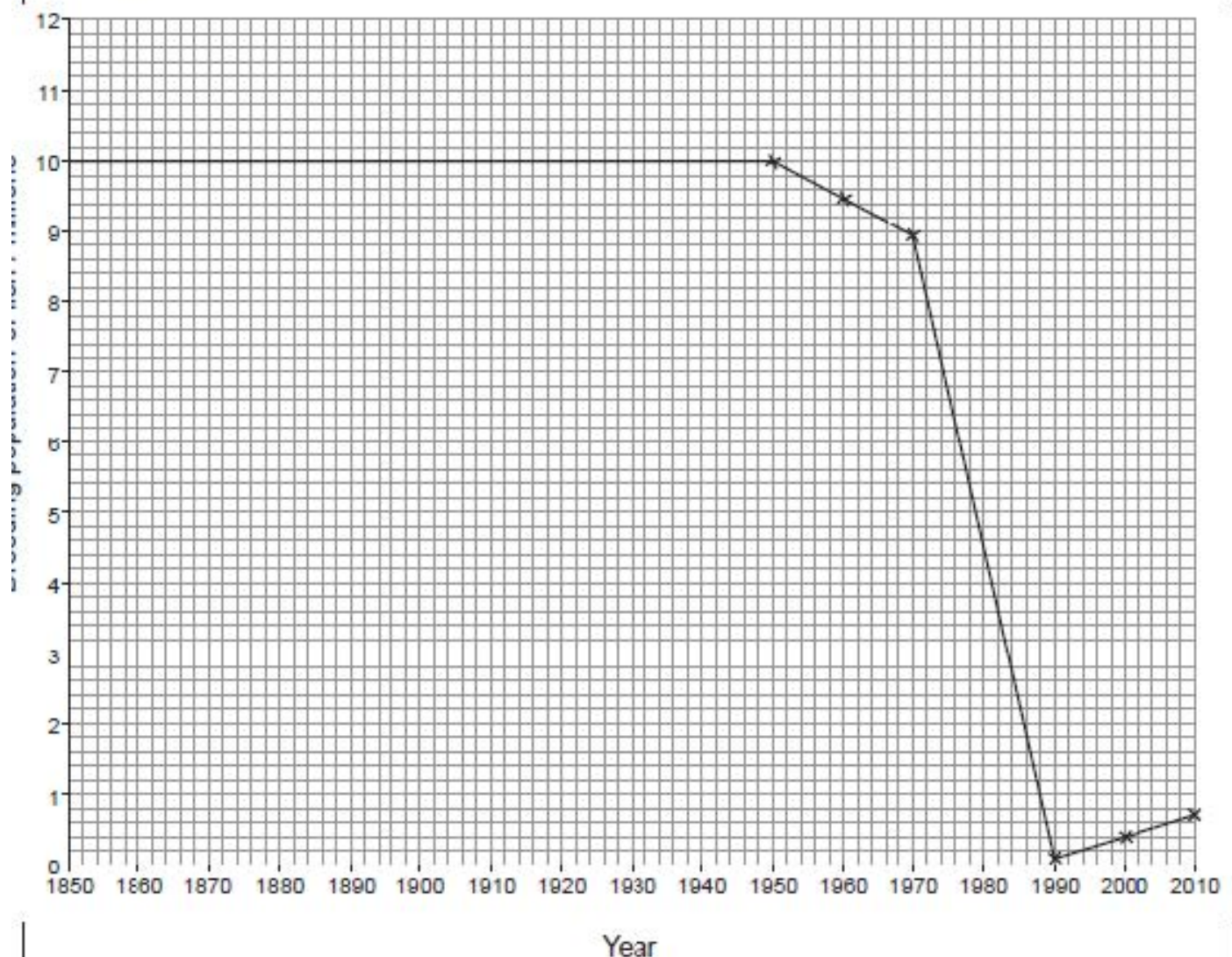
2. The Grand Banks is an area of sea off the coast of Newfoundland in Canada. Cod have been fished in the area for hundreds of years.

During the 1900s there were significant improvements in fishing techniques. By 1968, the number of cod caught had increased and 800 000 tons of cod were landed in that year alone. This represented 60% of the total cod population of reproductive age.

By 1992 the population had dropped to less than 1% of earlier levels and cod fishing was banned in the Grand Banks by the Canadian Government.

Image 4.1 shows the estimated breeding population of cod in the Grand Banks between 1850 and 2010.

Image 4.1



(a) With reference to **human activity**, explain the shape of the estimated population graph shown in image 4.1 between the following dates: [3]

1850 to 1950;

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1970 to 1990;

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1990 to 2010.

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- (b) Cod continue to grow throughout their lives. The older the cod, the larger they will be. Image 4.2 and image 4.3 show how the age of cod affects the number of eggs released and the mean percentage of fertilised eggs developing into embryos.

Image 4.2

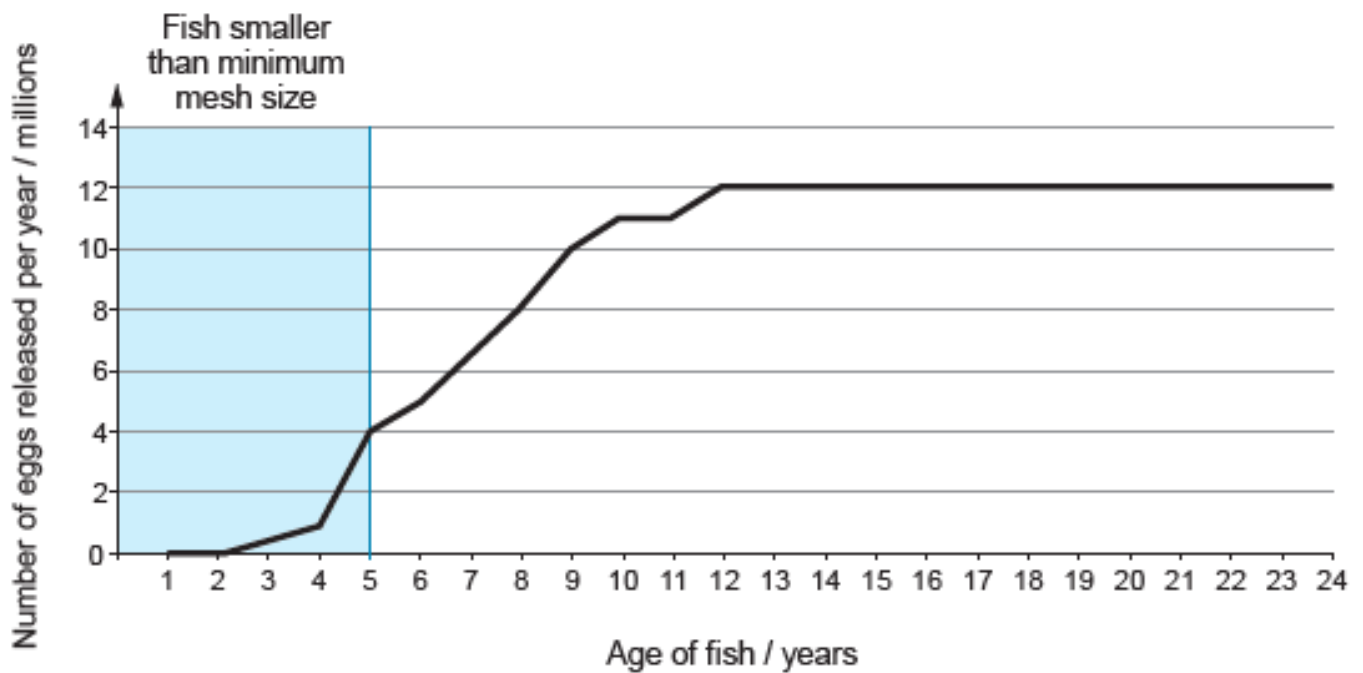
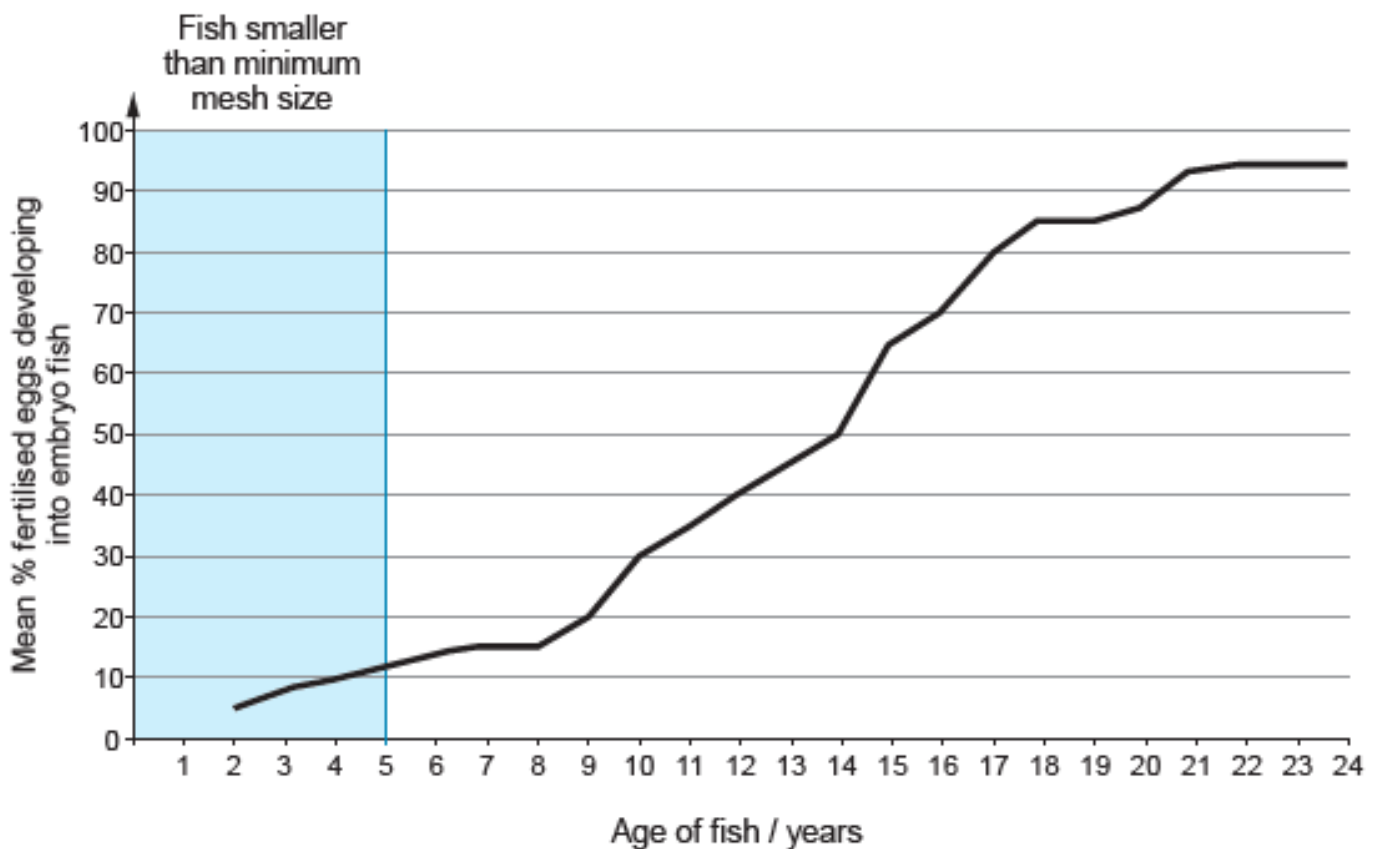


Image 4.3



There is a minimum mesh size for the nets used for trawling for cod so that only larger fish are caught.

- (i) Evaluate the effectiveness of using this minimum mesh size in allowing the recovery of the cod population. [4]

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- (ii) Other than restricting the mesh size of nets, give two methods which are used to prevent overfishing. [1]

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- (d) Bottom trawling involves dragging very large weighted nets along the sea bed. The heavy equipment used in bottom trawling destroys the seabed, as shown in image 4.5.

Image 4.5

Before bottom trawling



Same area 2 days after bottom trawling



Following bottom trawling, organisms repopulate the area. Identify the type of succession that results in the repopulation and give two reasons for your answer. [3]

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- (e) Planetary boundaries attempt to quantify and set a safe limit for the environmental impact of human activity. The boundary limit for CO₂ in the atmosphere was set at 350 ppm by volume, the current value is in excess of 400 ppm by volume. State and explain one effect that increased CO₂ has had on the marine environment. [2]

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