Surname	Centre Number	Candidate Number
Other Names		2

GCE A LEVEL – NEW

A400U20-1

S17-A400U20-1

BIOLOGY – A level component 2
Continuity of Life

TUESDAY, 20 JUNE 2017 – MORNING

2 hours

For Examiner's use only		
Question	**Maximum Mark**	**Mark Awarded**
1.	**15**	
2.	**18**	
3.	**17**	
4.	**17**	
5.	**11**	
6.	**13**	
7.	**9**	
Total	**100**	

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01

ADDITIONAL MATERIALS

In addition to this examination paper, you will need a calculator and a ruler.

INSTRUCTIONS TO CANDIDATES

Use black ink or black ball-point pen. Do not use gel pen. Do not use correction fluid.

Write your name, centre number and candidate number in the spaces at the top of this page.

Answer **all** questions.

Write your answers in the spaces provided in this booklet. If you run out of space, use the continuation pages at the back of the booklet, taking care to number the question(s) correctly.

INFORMATION FOR CANDIDATES

The number of marks is given in brackets at the end of each question or part-question.

The assessment of the quality of extended repsonse (QER) will take place in question **7**.

The quality of written communication will affect the awarding of marks.

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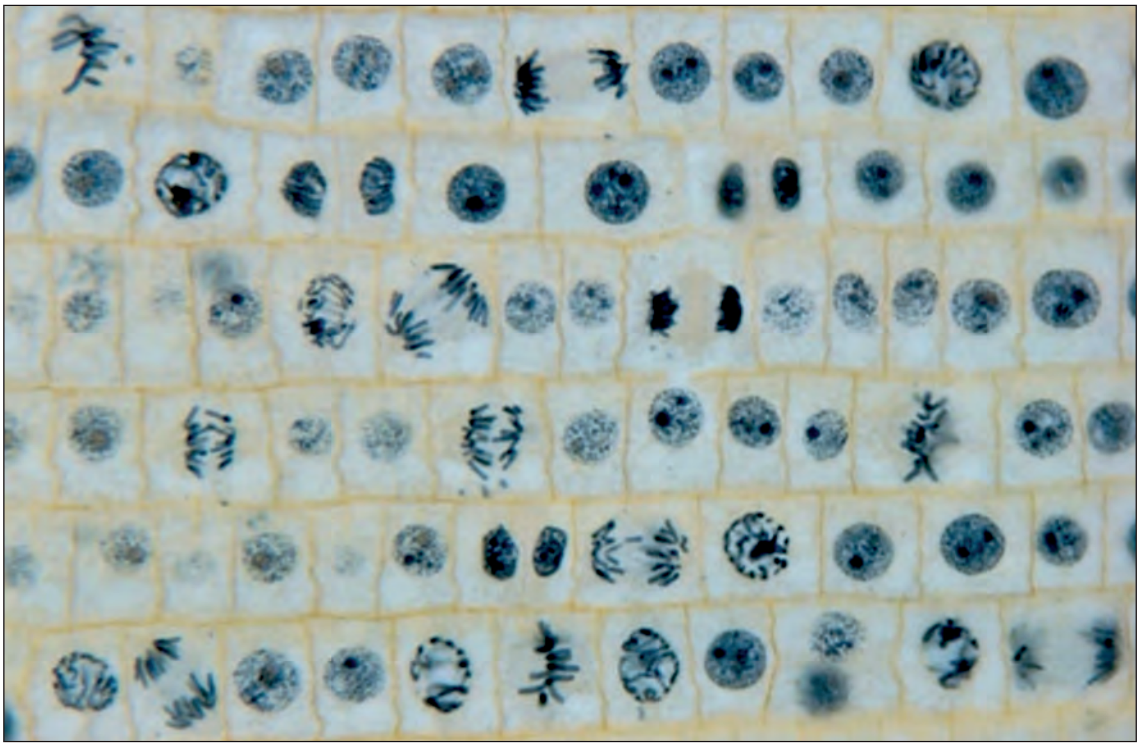
Answer **all** *questions.*

1. The photomicrograph below shows cells from a root tip undergoing cell division.



(a) (i) Name the type of cell division taking place in this tissue. [1]

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(ii) Count the number of cells in metaphase and anaphase. **Enter the values in the table below:** [2]

Phase	Number of cells	Time in minutes	% of cell cycle (by time)
Interphase	35	394	55
Prophase	9	101	14
Metaphase	....	....	....
Anaphase	....	....	....
Telophase/cytokinesis	10	112	16
Totals	64	720	100

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(iii) Calculate the time taken for the **two** phases, using the formula.

$$\text{Time for a particular phase} = \frac{\text{number of cells in the phase}}{\text{total number of cells counted}} \times \text{total time taken for cell cycle}$$

Enter the values in the table opposite. [2]

(iv) Calculate the percentage time spent in each phase.

Enter the values in the table opposite. [2]

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(b) Describe **two** ways in which the process of cell division shown differs between plant cells and animal cells. [2]

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In humans, unrestricted cell division can lead to the development of abnormal growths called tumours.

(c) (i) What term is applied to the formation of malignant growths by unrestricted cell division? [1]

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(ii) Studies have shown that the plasma membranes of cells in these growths have some transmembrane proteins with shorter carbohydrate side chains.

In the boxes below, draw diagrams of a short section of the plasma membrane from a normal and an abnormal cell. Include labels for the following structures: phospholipid bilayer, transmembrane protein and carbohydrate side chains. [3]

Normal	Abnormal

(iii) How would the difference described in (ii) affect the properties of the abnormal cells? [2]

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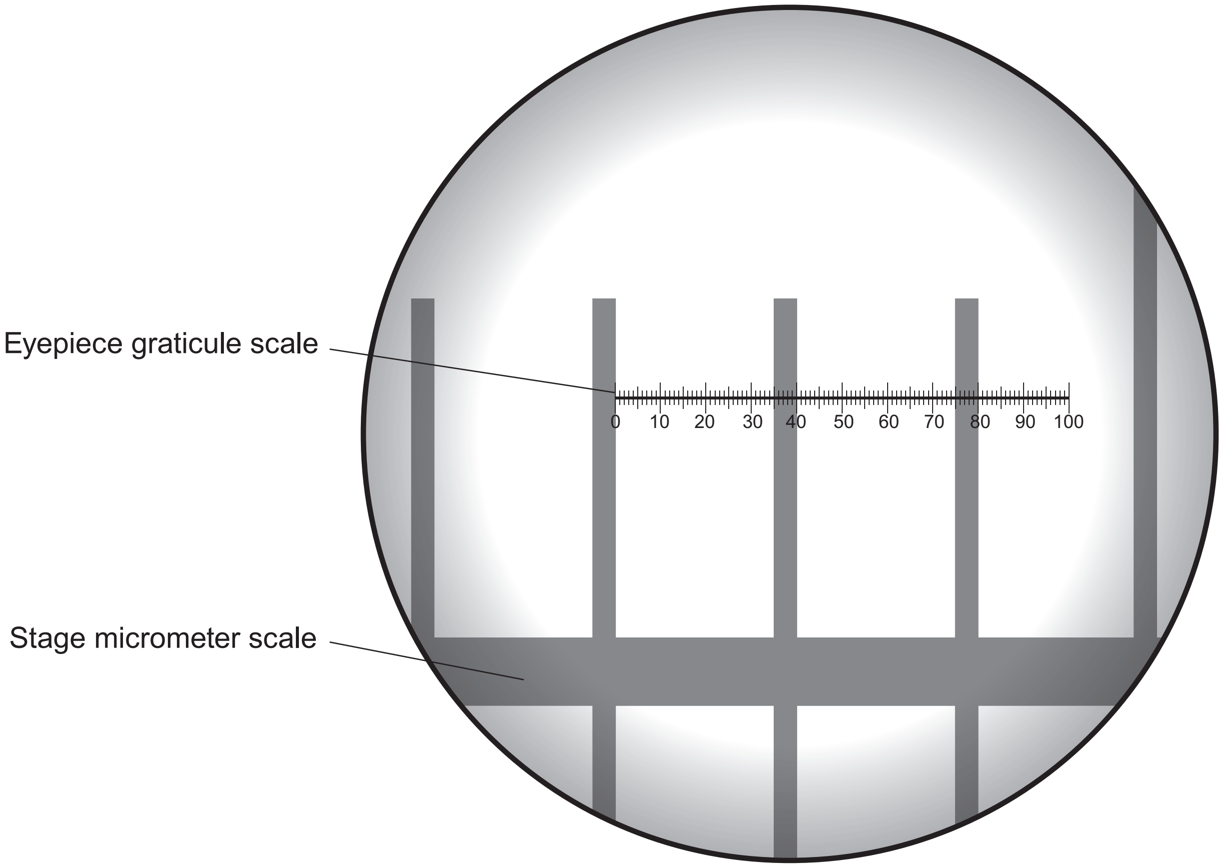
2. It is possible to germinate pollen grains *in vitro* by placing them in a suitable solution containing a mixture of mineral salts. One technique involves hanging a droplet of the mixture from the underside of a coverslip and suspending the coverslip above a microscope slide using petroleum jelly. The pollen grains may then be observed directly through a microscope.

(a) The photomicrograph below shows part of a stage micrometer and the eyepiece graticule.



The smallest divisions on the stage micrometer measure 100 µm.

(i) Calibrate the eyepiece graticule. Express your answer to one decimal place. [2]

1 eyepiece unit = ... µm

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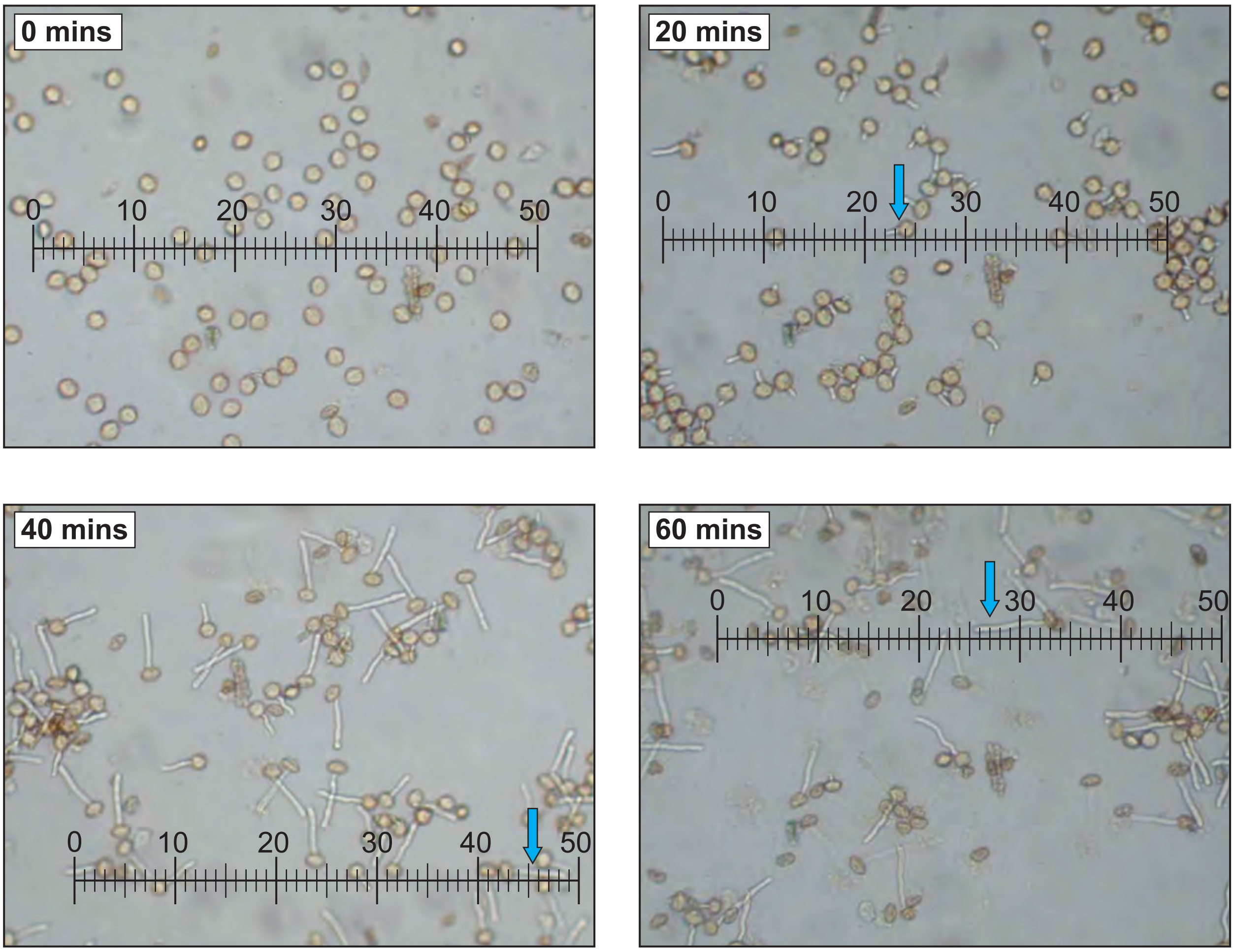
The photomicrographs below were taken at time intervals of 20 minutes from placing the pollen in the solution.



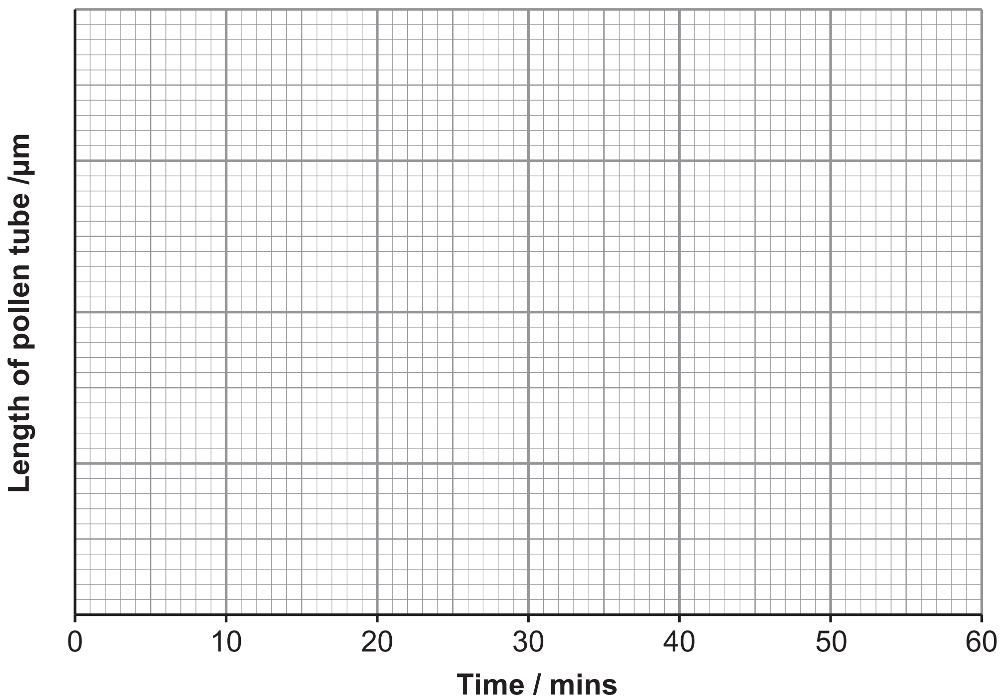
Examiner only

(ii) Use the eyepiece graticule to measure the length of the pollen tube indicated by an arrow from each photomicrograph. Measure each pollen tube to the nearest whole number. **Enter the values in the table below.** [2]

Time / mins	**Length of pollen tube / eyepiece graticule units**	**Actual length of pollen tube /μm**
0	0	0
20	....	....
40	....	....
60	....	....

(iii) Calculate the actual length of the pollen tubes in μm. **Write your answers in the table above**. [2]

(iv) Plot a graph of the results using a suitable scale for the y-axis. [3]



(v) How could you make the data more reliable? [1]

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Turn over.

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(b) Using the technique described on page 5, design an experiment to investigate the effect of pH on the growth of pollen tubes.

Give a brief description of your method. [4]

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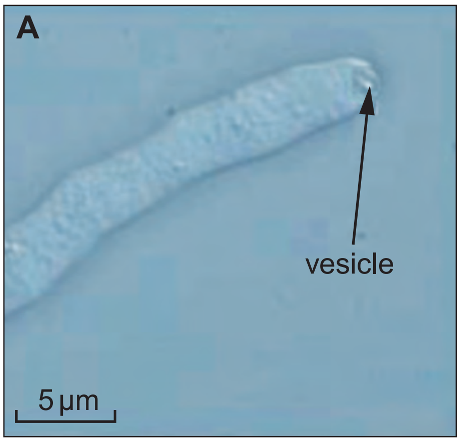
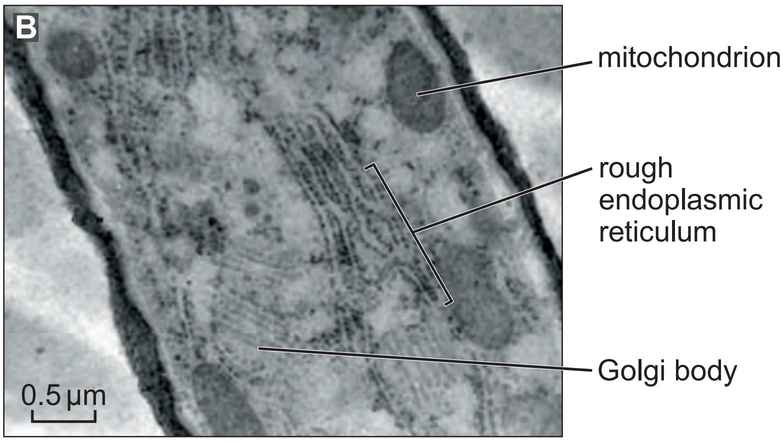
The photomicrographs below show pollen tubes. Photomicrograph **A** shows a clear zone near the tip with an arrow; this is a vesicle. Electron micrograph **B** shows organelles present in a region further back from the tip.





(c) Describe the roles of the vesicle and the labelled organelles in the passage of the pollen tubes through the style of a flower. [4]

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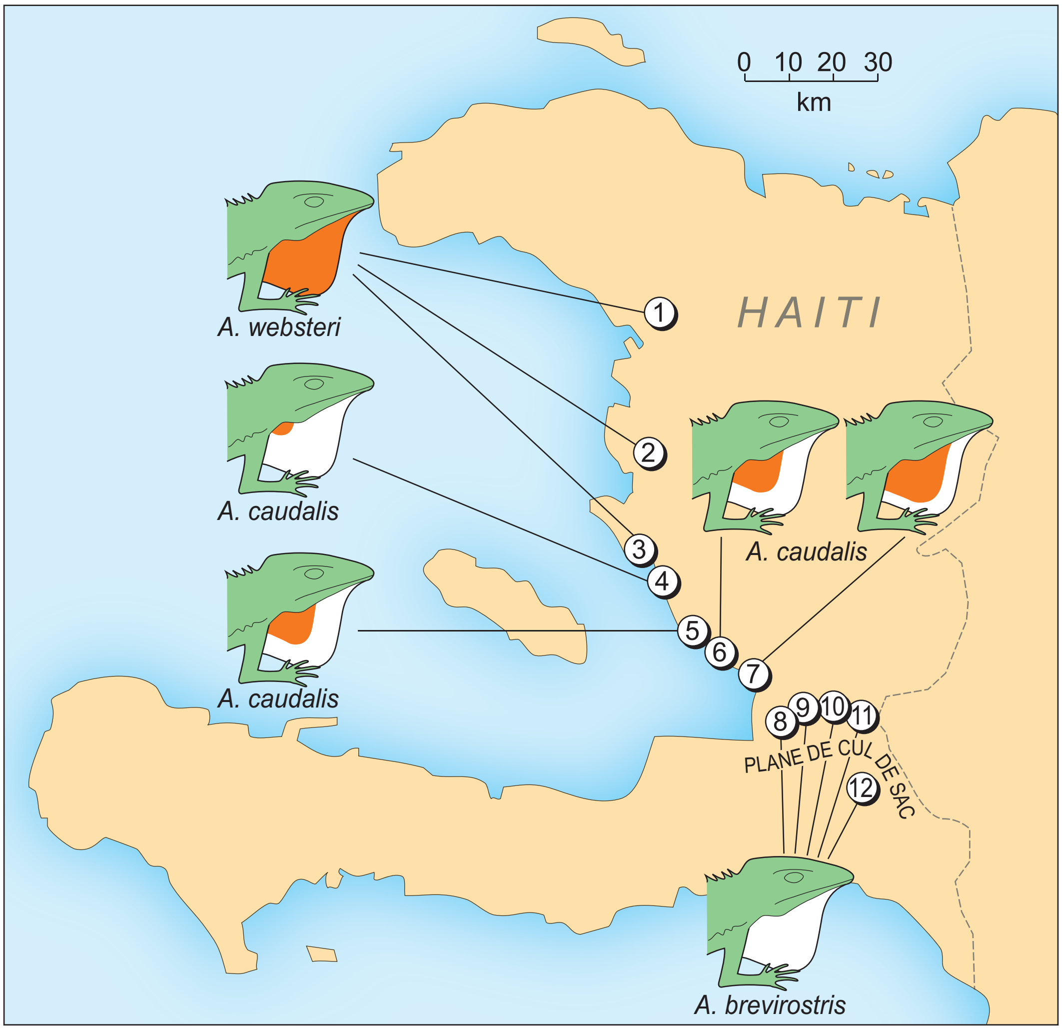
18

3. In the Caribbean there is a group of lizards called Anoles. The males possess a retractable flap of skin under the throat, termed a dewlap, which is used in courtship, aggressive interactions and even encounters with predators. The patterns of orange colouration on the dewlaps of three species of Anole lizard and their distribution in Haiti are shown below.



Zone	Sites	Habitat
North	1,2,3	Beach
Central	4,5,6,7	Beach
South	8,9,10,11,12	Forest

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(a) (i) Describe the patterns of orange and white dewlap colouration for each species. [2]

Species	Pattern of orange and white
Anolis brevirostris	....
Anolis websteri	....
Anolis caudalis	....

(ii) Describe how the three species are distributed between the three zones. [1]

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(iii) Describe how the dewlap colouration varies from north to south in the central zone. [1]

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Breeding experiments in the lab have revealed that dewlap colour-pattern is inherited as a Mendelian trait, in which orange (**D**) is dominant to white (**d**).

The gene pool of the *A.brevirostris* population contains no **D** alleles.

The Hardy-Weinberg equations may be used to calculate the frequencies of the alleles **D** and **d** in the gene pool of the population of *A.websteri*

$p + q = 1$

$p^2 + 2pq + q^2 = 1$

(b) In the north zone population of 400 lizards, four were found to have white dewlaps.

Calculate the frequencies of the two alleles in this population, and calculate how many of the lizards with orange dewlaps were heterozygous. [4]

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Examiner only

The evolution of the three species is believed to be an example of sympatric speciation, resulting from differences in the habitats.

(c) (i) Explain how the habitat in the south zone could bring about the dewlap colouration found in *A.brevirostris*. [4]

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(ii) Explain why after many generations the frequency of allele **D** is zero in the *A.brevirostris* population but the frequency of allele **d** in *A.websteri* will never be zero. [2]

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(d) The Anole lizards found at sites **3** and **4** are different species. Explain how their dewlap colouration may have resulted in this speciation. [3]

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Examiner only

4. In mice, coat colour is determined by genes at more than one locus.

Locus I.
This gene determines the colour of pigment. There are two major alleles: **B** coding for black pigment and **b** for brown.

Locus II.
This gene determines the distribution of pigment in the hair. Allele **A** produces a phenotype called agouti. The agouti phenotype is due to yellow bands on the otherwise dark hair shaft. In the non-agouti phenotype (determined by the allele **a**), the yellow bands are absent, so the hair shaft is a solid dark colour.

The table below shows the genotypes and corresponding phenotypes.

Locus I genotype	Locus II genotype	Phenotype (coat colour)
BB or Bb	**AA or Aa**	Normal agouti
BB or Bb	**aa**	Solid black
bb	**AA or Aa**	Cinnamon (brown with yellow bands)
bb	**aa**	Solid brown

(a) (i) Complete the genetic diagram below to show the expected outcome of crossing mice heterozygous at both loci. [4]

Parental phenotype .... x ....

Parental genotype .... x ....

Gametes .... x ....

(ii) Give the ratio in which the following phenotypes would appear in the offspring. [1]

Offspring phenotypes: normal agouti : solid black : cinnamon : solid brown

Phenotype ratio: .... : .... : .... : ....

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A series of crosses between mice which were heterozygous at both loci produced 32 offspring. The results are shown in the table below. A null hypothesis was proposed that there was *'no significant difference between the observed and expected numbers of offspring'*.

Phenotype	Observed O	Expected E		
Normal Agouti	22			
Solid black	4			
Cinnamon	3			
Solid brown	3			

(b) (i) Using the table provided, calculate χ^2 to test this null hypothesis. [3]

$$\chi^2 = \sum \frac{(O-E)^2}{E}$$

χ^2 = ...

(ii) Choose an appropriate probability level and circle the critical value for χ^2 in the table below: [1]

Degrees of freedom	Probability								
	0.9	0.8	0.7	0.5	0.2	0.1	0.05	0.02	0.01
1	0.016	0.064	0.15	0.46	1.64	2.71	3.84	5.41	6.64
2	0.21	0.45	0.71	1.39	3.22	4.60	5.99	7.82	9.21
3	0.58	1.00	1.42	2.37	4.64	6.25	7.82	9.84	11.34
4	1.06	1.65	2.20	3.36	5.99	7.78	9.49	11.67	13.28

(iii) State whether you accept or reject the null hypothesis, and explain why. [2]

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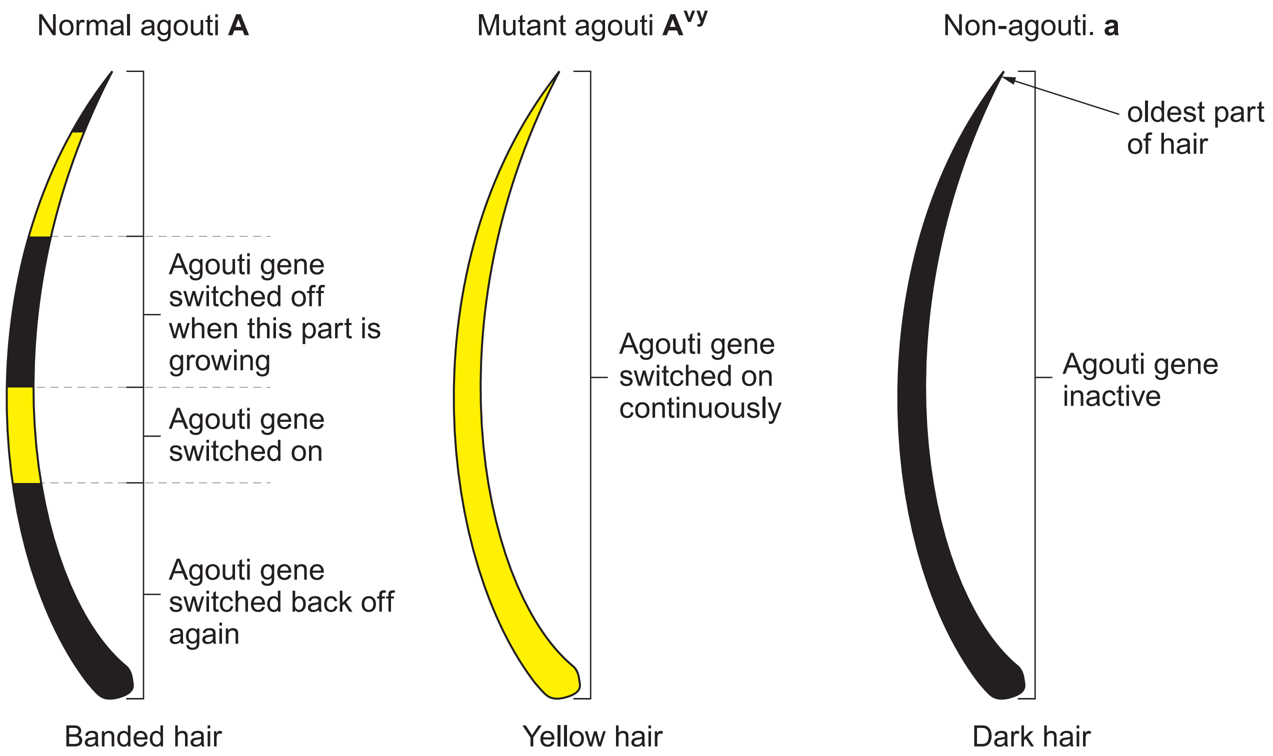
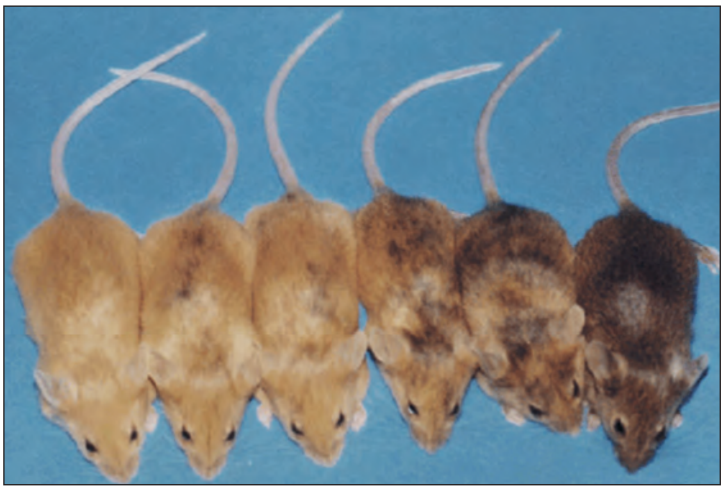
A mutant form of the gene at locus II exists, called $\mathbf{A^{vy}}$, which results in hair which is yellow along its entire length. The diagrams of hairs below explain how each of the locus II alleles works.



Scientists have bred a strain of mice with the genotype $\mathbf{A^{vy}a}$.

Since $\mathbf{A^{vy}}$ is dominant to **a**, all of the mice with genotype $\mathbf{A^{vy}a}$ could be expected to be yellow.

In fact, some are yellow, some are normal agouti and some are shades in between.



These mice have identical DNA base sequences in the agouti gene locus but the gene is being expressed differently.

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(c) (i) What name is given to the study of the control of gene expression by factors other than changes in the DNA sequence? [1]

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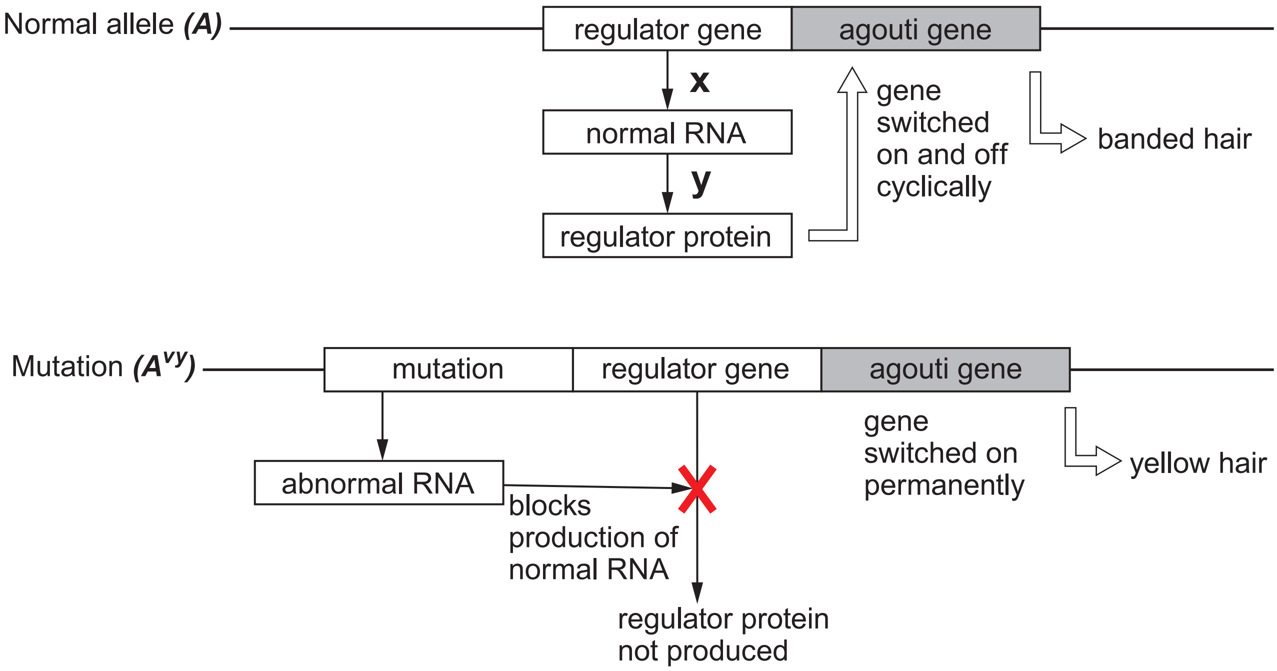

Allele ***A*** codes for the synthesis of a protein which switches off the gene in a cyclic manner.
The mutation in $\boldsymbol{A^{vy}}$ is an insertion of a sequence of bases which forms abnormal RNA molecules which block the formation of the normal RNA.

(ii) Name the processes labelled **x** and **y** on the diagram above. [2]

x ....

y ....

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The addition of methyl groups to DNA molecules (methylation) is known to interfere with the ability of the molecules to take part in the formation of mRNA.
It has been suggested that methylation of the inserted sequence of bases could be responsible for the range of colours seen in the mice with genotype $\mathbf{A^{vy}a}$.

(iii) Explain how the addition of an increasing number of methyl groups to the inserted sequence of bases results in mice with a range of coat colours. [3]

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5. Currently, a million tons of wild fish are harvested from the oceans annually. Of these, 80% are used to feed fish reared in farms.
Fish do not make their own omega-3 fatty acids, they get these by eating algae. For farmed fish to be as nutritious as wild fish, they need to be fed a diet rich in omega-3 fatty acids. Algae are hard to culture on a large scale, so wild fish provide a more convenient source.

Scientists have identified and spliced genes from algae that code for producing high levels of omega-3 fatty acids into *Camelina* plants. The genetically modified *Camelina* plants now produce seeds that contain 26% omega-3 fatty acids, so are useful for fish farm feed.

(a) Explain how named enzymes would be used to cut genes from algae and splice them into *Camelina* plants. [3]

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(b) Explain why feeding genetically modified *Camelina* seed to farmed fish could benefit biodiversity. [1]

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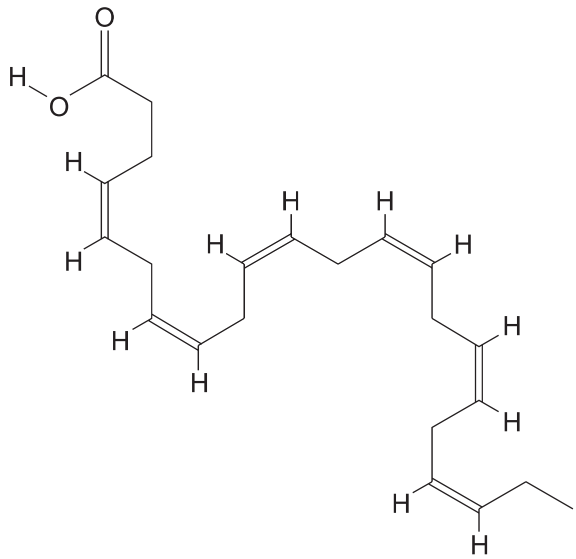
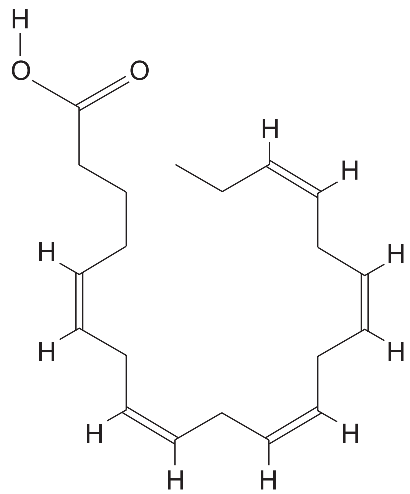
Nutritionists often recommend that fish are included in diets, due to their high omega-3 polyunsaturated fatty acid content.

The diagrams show two omega-3 polyunsaturated fatty acids.



eicosapentaenoic acid (EPA)



docosahexaenoic acid (DHA)

(c) With reference to the diagrams, explain why these compounds are described as:

(i) fatty acids; [2]

....

....

(ii) polyunsaturated. [1]

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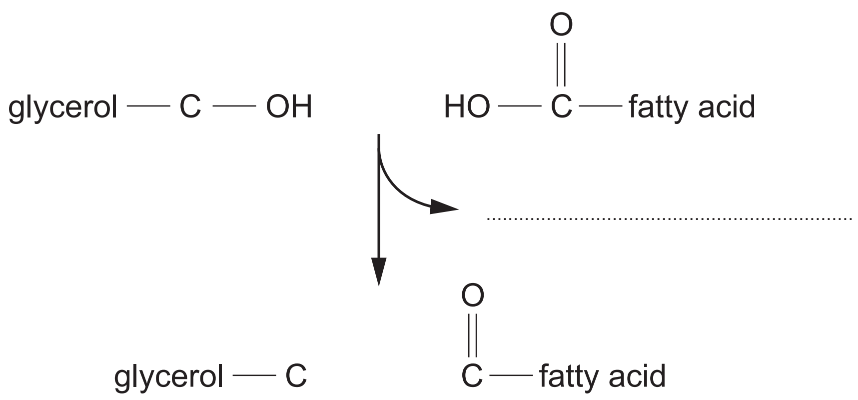
Examiner only

(d) (i) These compounds are present in fish in the form of triglygerides or phospholipids.

The diagram below shows some of the atoms of a glycerol molecule and a fatty acid molecule.

Complete the diagram to show how a bond is formed between the glycerol molecule and the fatty acid molecule, accounting for all of the atoms. [2]



(ii) Give **one** function for the following types of lipid in fish: [2]

triglyceride;

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....

phospholipids.

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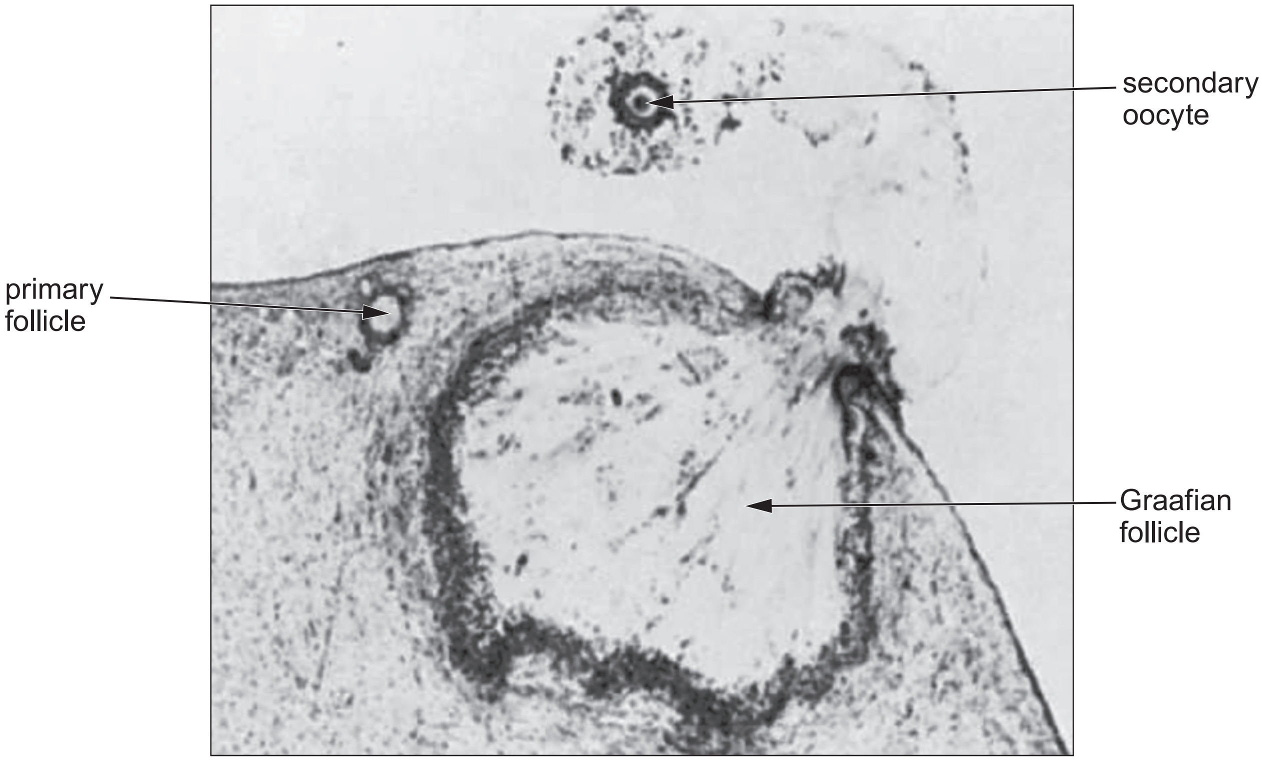
6. The photomicrograph below shows part of an ovary during ovulation.



(a) Describe what subsequently happens to the following: [2]

secondary oocyte;

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Graafian follicle.

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(b) (i) Describe how the hormones FSH and oestrogen illustrate the principle of negative feedback in controlling ovulation. [4]

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(ii) Explain why oestrogen may therefore be used as a contraceptive. [3]

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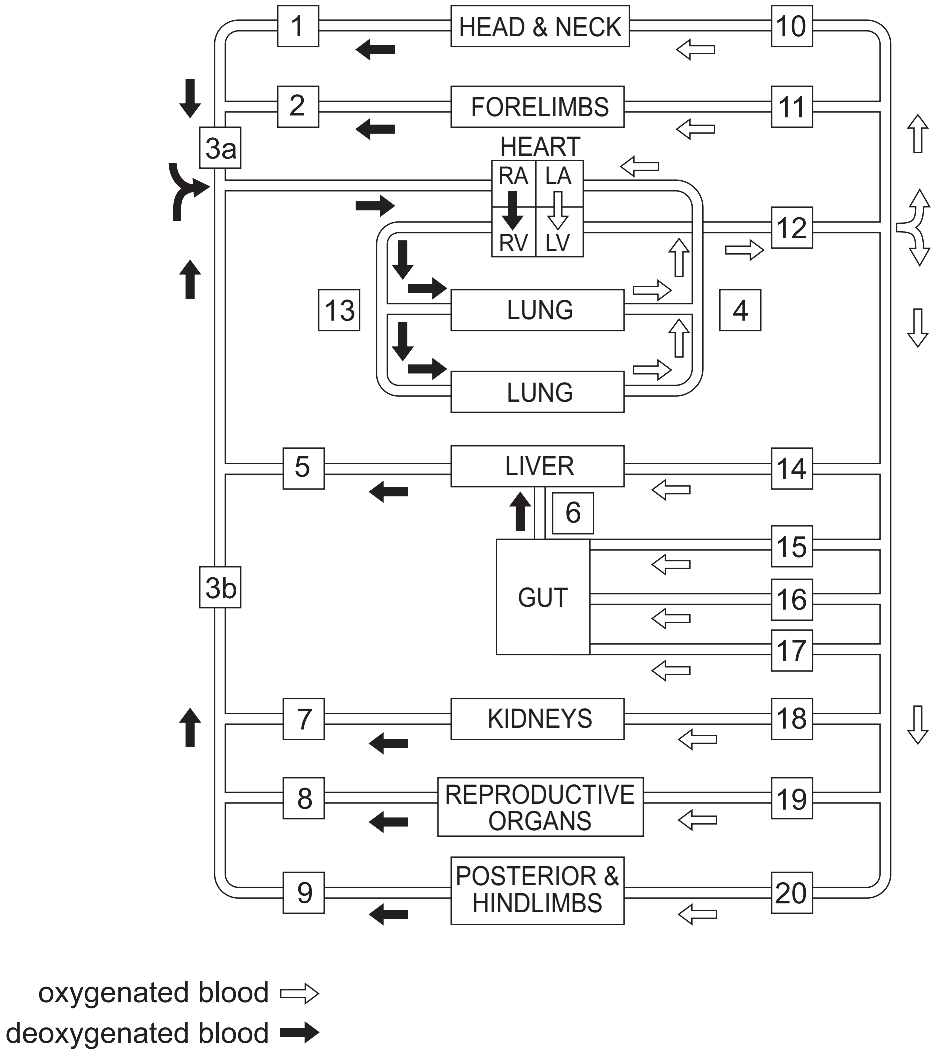
(c) For use as a contraceptive, oestrogen can be incorporated into a porous patch which may be applied to the skin on a woman's arm. The diagram below is a schematic map of the human circulatory system.



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(i) Using numbers for blood vessels and letters for the chambers of heart, describe the route that oestrogen would take from the patch to the organ where it would exert its contraceptive effect. [2]

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(ii) Apart from containing more oestrogen, describe **one** other difference in the blood leaving the patch and arriving at the target organ and state where the change would have taken place. [2]

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13

7. The deep regions of the oceans (1000 – 4000 m) are nutrient-poor habitats. In order to survive, the fish that live there have evolved remarkable morphological and life-cycle strategies. The larvae of many deep-sea species develop in the nutrient-rich surface waters (0 – 200 m). Very few specimens of these fish have been caught, which makes them difficult to classify. This illustrates the tentative nature of classification. The table below provides information on specimens of three types of deep-sea fish.

Type of Fish	Example specimen	Evidence
Tapetail		**Depth Caught:** 0 – 200 m **Number caught:** 120 **Size:** 5 – 56 mm **Age:** juvenile **Gender:** unknown **Feeding:** large numbers of animal plankton; mouth is upturned, jaws are small
Whalefish		**Depth Caught:** below 1000 m **Number caught:** 600 **Size:** 26 – 408 mm **Age:** adult **Gender:** all female **Feeding:** eat large prey; jaws are long and can open very wide to swallow prey whole
Bignose Fish		**Depth Caught:** below 1000 m **Number caught:** 65 **Size:** 34 – 68 mm **Age:** adult **Gender:** all male **Feeding:** do not feed; have a very large liver which acts as a store of energy and nutrients

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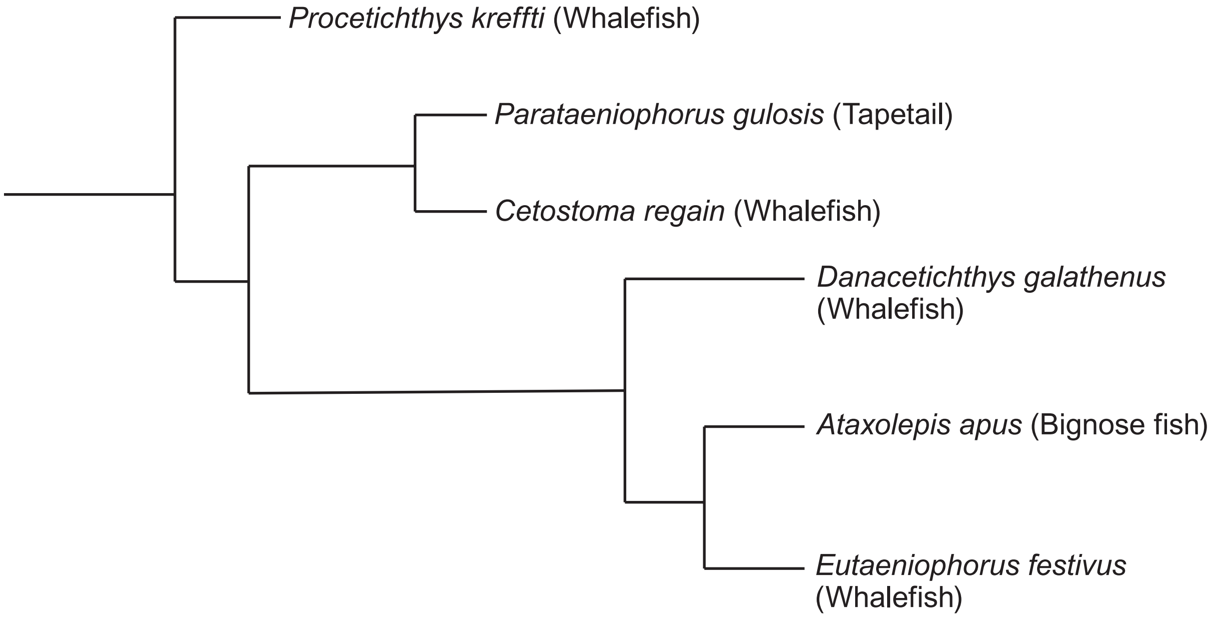
Analysis of ribosomal RNA from examples which have been caught has produced the following phylogenetic tree.

Phylogenetic evidence



Two hypotheses have been proposed to classify these deep-sea fish:

Hypothesis 1: Tapetails, Whalefish and Bignose Fish belong to **different** families of fish.

Hypothesis 2: Tapetails, Whalefish and Bignose Fish are developmental stages of different species of fish within the **same** family.

For **each type of evidence** listed opposite and above, state whether they provide support for **hypothesis 1** or **hypothesis 2** and give reasons for your answers. From this evidence, conclude which hypothesis is more likely and suggest why a different conclusion may be reached in the future. [9 QER]

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