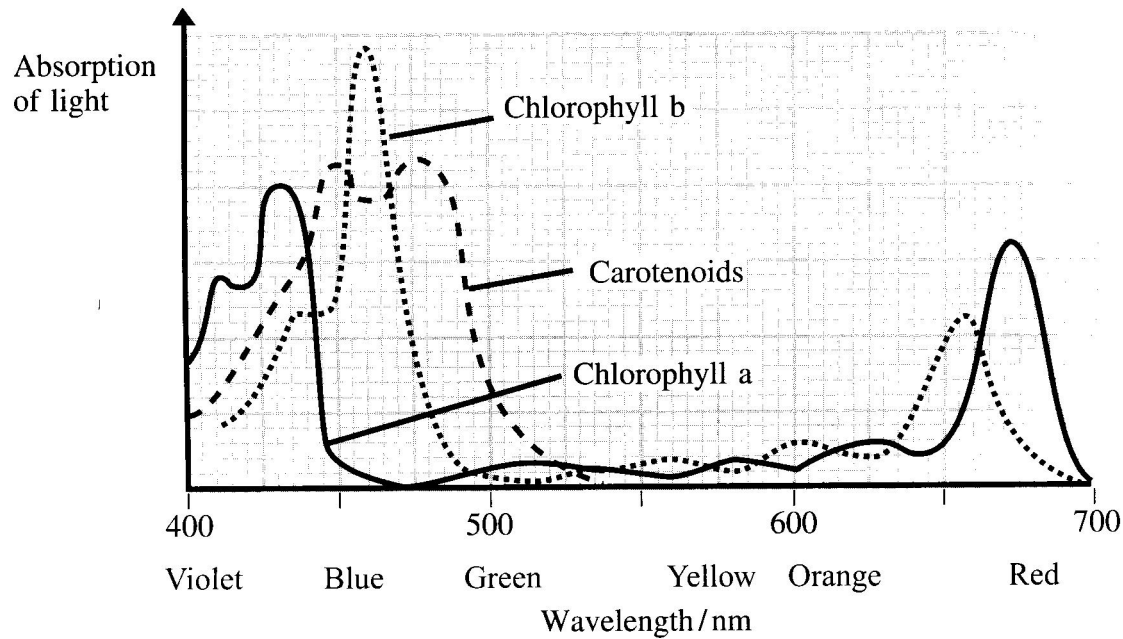




Answer ALL questions in the spaces provided.

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1. The graph below shows the absorption spectra for three photosynthetic pigments found in a leaf.



- (a) Describe the absorption spectrum of chlorophyll a.

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(2)

- (b) Using the information in the graph, explain why it is advantageous for plants to have more than one type of photosynthetic pigment.

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(2)

(c) Describe a technique that you would use to separate the photosynthetic pigments found in chloroplasts.

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(4)

Q1

**(Total 8 marks)**

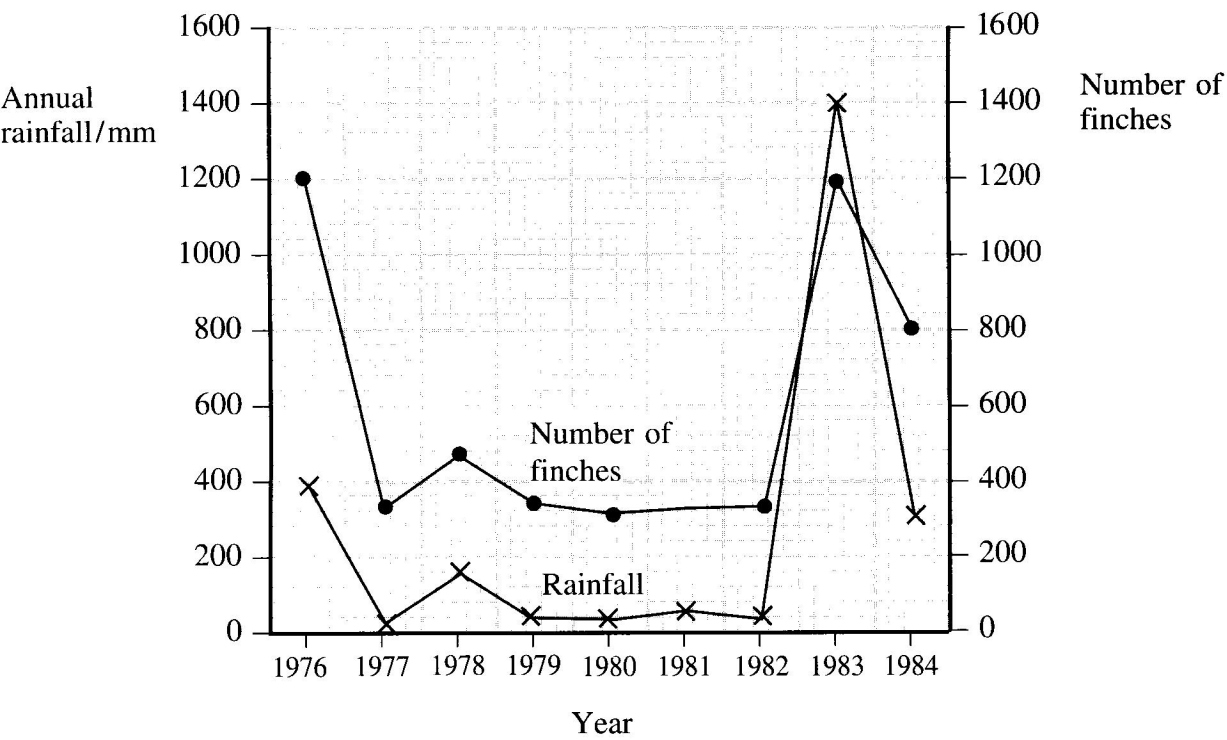
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2. Long term studies have been made of the various species of finch (a type of bird) that live on the Galapagos Islands. The annual rainfall is highly variable and this affects the plants that grow on the islands.

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The graph below shows the annual rainfall and the number of finches on one island between 1976 and 1984.



(a) Compare the changes in rainfall with the changes in the number of finches between 1976 and 1984.

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(3)

- (b) State whether you consider that the rainfall is acting as a density-dependent or a density-independent factor. With reference to the information provided, explain your answer.

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(3)

Q2

(Total 6 marks)

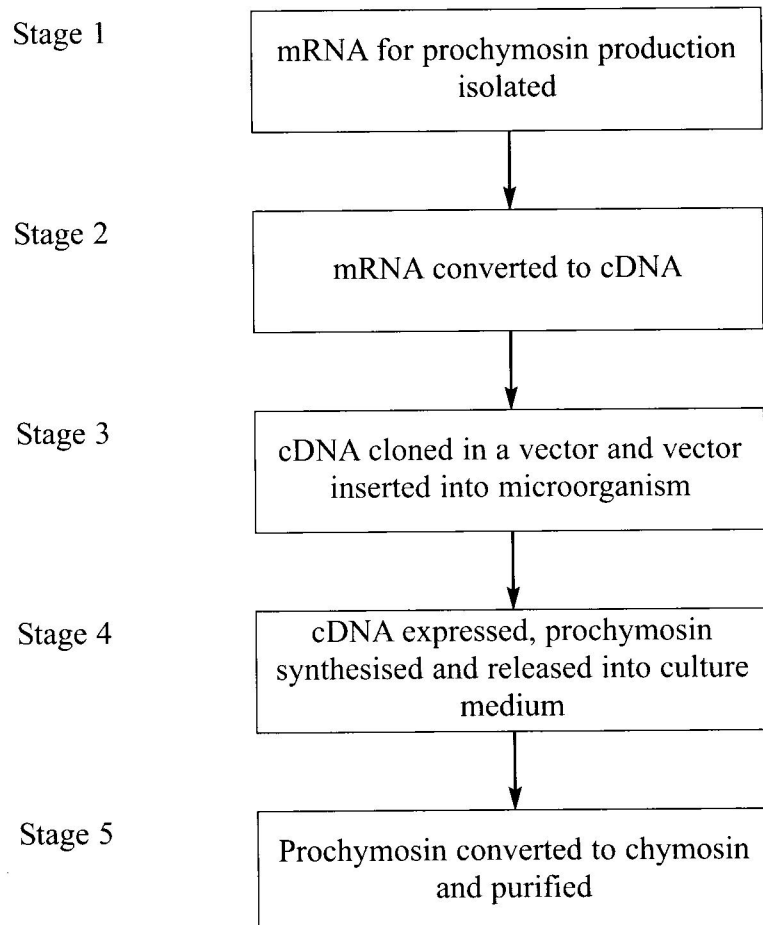
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3. (a) Explain what is meant by a **genetically modified organism**.

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(3)

(b) The flow diagram below shows some of the stages in the production of the enzyme chymosin using a genetically modified microorganism. This enzyme is first synthesised as an inactive precursor, prochymosin, which is then converted to chymosin.



(i) Name the enzyme used to convert mRNA to cDNA in stage 2.

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(1)

(ii) In stage 4, cDNA needs to be converted to DNA in order for prochymosin synthesis to occur. Describe how this conversion occurs.

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(3)

(iii) What is the commercial use of chymosin?

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(1)

(iv) Suggest **two** advantages of using chymosin from genetically modified organisms in commercial processes, rather than mammalian rennin.

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(2)

Q3

(Total 10 marks)

## Synoptic Section

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*The questions in this section are designed to give you the opportunity to make connections between different areas of biology and to use skills and ideas developed throughout the course in new contexts. You should include in your answers any relevant information from the whole of your course.*

4. Many synthetic chemicals present in the environment have an effect on living organisms. Some of these chemicals are described as being endocrine-disrupting. These are chemicals that interfere with the production, action or breakdown of natural hormones in the body.

One such group of chemicals is called environmental oestrogens, because they mimic the effects of the female hormone oestrogen. These chemicals include DDT, PCBs (polychlorinated biphenols) and dioxins, as well as products released from the combustion of petrol and those used in the manufacture of certain plastics. They disrupt hormonal functions by interacting with receptor molecules on cell surface membranes, inhibiting metabolic enzymes and altering carrier proteins.

- (a) State where oestrogen is produced in the female body and describe its role in the menstrual cycle.

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(3)



- (b) Describe the role of a carrier protein in active transport across a cell surface membrane.

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**(2)**

- (c) Describe **two** ways in which an environmental oestrogen could inhibit an enzyme.

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**(4)**

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- (d) Environmental oestrogens have a number of effects in humans. They have been linked to a reduced sperm count in males and to early sexual development in females. In men, a normal sperm count is between 20 and 300 million sperm per  $\text{mm}^3$ . A sperm count of less than 20 million per  $\text{mm}^3$  is described as low, while a count in excess of 300 million per  $\text{mm}^3$  is high.

The table below shows the changes in the percentage of men with high and low sperm counts over a period of fifty years.

Time period	Percentage of men with high sperm counts	Percentage of men with low sperm counts
Before 1950	50	5
1951–1960	45	4
1961–1970	28	14
1971–1980	21	11
1981–1990	15	18

- (i) Suggest an explanation for the changes shown in the table, and predict a possible consequence of these changes.

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(3)

- (ii) If environmental oestrogens are ingested by a woman in the early stages of pregnancy, there is a risk of reproductive disorders in her male offspring. Explain how the environmental oestrogens may pass from the mother to the fetus.

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(2)

Q4

(Total 14 marks)



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Haemoglobin is a respiratory pigment. A haemoglobin molecule is made up of a protein with a quaternary structure, combined with four non-protein haem groups.

(a) Explain what is meant by **quaternary structure**.

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(2)

(b) Describe **two** properties of haemoglobin that enable it to function efficiently as a respiratory pigment.

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(2)

(c) A point mutation has occurred in the gene **H** which controls the synthesis of normal haemoglobin. This mutated allele **H<sup>S</sup>** is codominant to the normal allele **H<sup>N</sup>**, and results in the synthesis of an abnormal type of haemoglobin which reduces the ability of the blood to carry oxygen. In the homozygous state, the **H<sup>S</sup>** allele causes the condition sickle cell anaemia.

(i) Explain what is meant by a **point mutation**.

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(3)

- (ii) A woman is homozygous for the  $H^S$  allele and her partner is heterozygous. Using a genetic diagram, determine the probability that their first child will have sickle cell anaemia.

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Q5

(Total 11 marks)

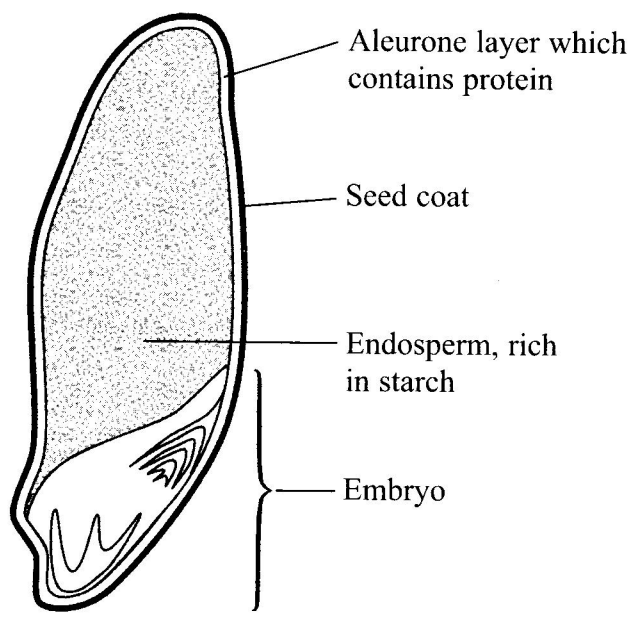
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6. A barley seed contains an embryo which is surrounded by a starch-rich food store called the endosperm. Beneath the seed coat is the aleurone layer which contains protein.

The process of germination starts when the seed takes up water, causing it to swell. The presence of water stimulates the embryo to release gibberellins. These diffuse into the aleurone layer where they stimulate the synthesis of several enzymes which hydrolyse the starch in the endosperm.



When seeds are stored they may lose their viability (ability to germinate). This is because some enzymes, such as oxidoreductases, become inactive. The cell membranes also gradually break down and cells exude (release) sugars. Simple tests can be carried out on a batch of seeds to test their viability.

(a) Describe a test that you could carry out to determine whether or not a seed was exuding sugars.

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(b) A test for the activity of oxidoreductases involves TTC (triphenyl tetrazolium chloride). TTC is a hydrogen acceptor. It is colourless in the oxidised state, but it turns red when reduced. The seeds are cut lengthwise and immersed in a solution of TTC for 30 minutes. Then they are removed and examined.

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(i) Give **one** example of a naturally occurring hydrogen acceptor, and name the metabolic pathway in which it is involved.

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(2)

(ii) The red TTC colour was found to be particularly dark in the embryo and in the aleurone layer. Suggest why the staining should be particularly dark in these areas.

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(c) Describe **one** role of gibberellin in plants, other than in seed germination.

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(2)

Q6

(Total 9 marks)

The Sun releases vast quantities of energy into space. A tiny fraction of this energy is intercepted by the Earth. Some reaches the surface of the Earth where it is used by living organisms, passing from one trophic level to the next along food chains.

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- (a) Explain why only about 10 per cent of the energy within one trophic level is passed on to the next trophic level.

[illegible]



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- (b) ATP is often described as the ‘energy currency’ of a cell. Describe the structure of ATP and explain why it is essential to active transport. Include in your answer examples of active transport.

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Q7

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TOTAL FOR PAPER: 70 MARKS

END