IB DIPLOMA PROGRAMME
PROGRAMME DU DIPLÔME DU BI
PROGRAMA DEL DIPLOMA DEL BI

N02/410/S(3)

BIOLOGY
STANDARD LEVEL
PAPER 3

Thursday 14 November 2002 (morning)

1 hour 15 minutes

Name

Number

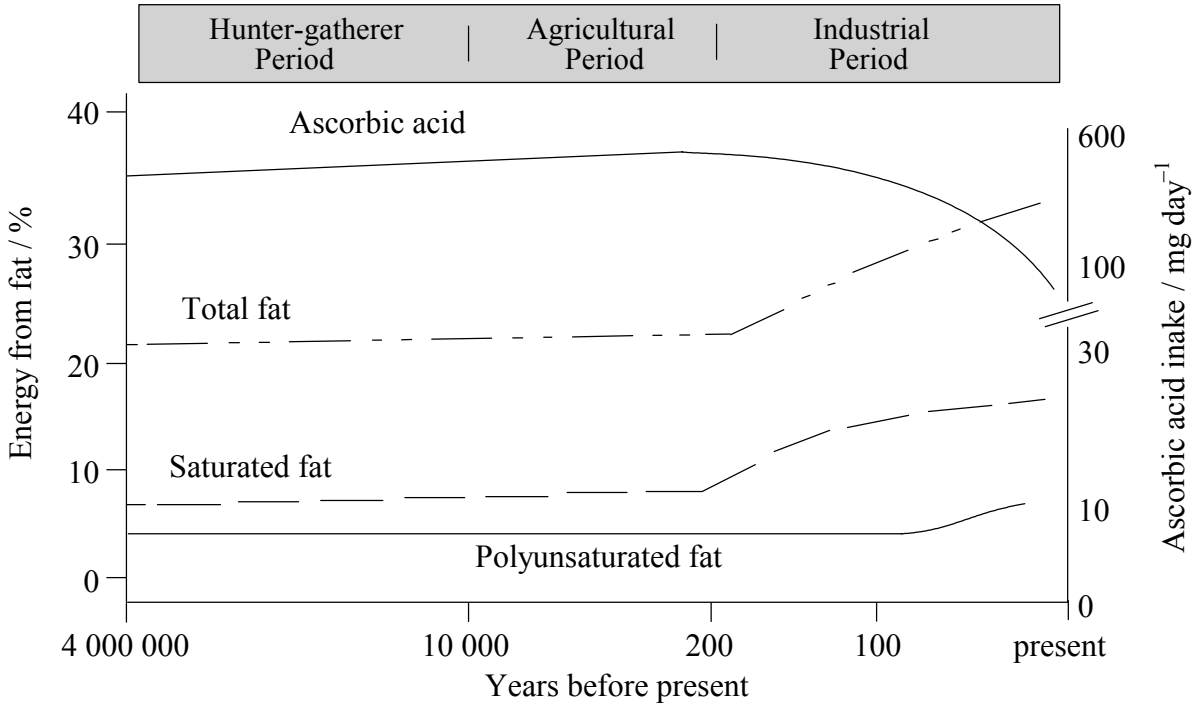
INSTRUCTIONS TO CANDIDATES

- Write your candidate name and number in the boxes above.
- Do not open this examination paper until instructed to do so.
- Answer all of the questions from three of the Options in the spaces provided. You may continue your answers in a continuation answer booklet, and indicate the number of booklets used in the box below. Write your name and candidate number on the front cover of the continuation answer booklets, and attach them to this question paper using the tag provided.
- At the end of the examination, indicate the letters of the Options answered in the boxes below.

OPTIONS ANSWERED		EXAMINER	TEAM LEADER	IBCA
		/15	/15	/15
		/15	/15	/15
		/15	/15	/15
NUMBER OF CONTINUATION BOOKLETS USED	. . . . .	TOTAL /45	TOTAL /45	TOTAL /45

Option A – Diet and human nutrition

A1. A recent study of evolutionary aspects of the human diet considered the intake of ascorbic acid and fat. Fat can be classified as saturated, monounsaturated and polyunsaturated. The graph below is based on data from three periods of time: hunter-gatherer, agricultural and industrialized.



[Source: Simopoulos, *The Journal of Nutrition*, (2001), **131** (115), page 3066S]

(a) Compare the changes in the intake of saturated fat with polyunsaturated fat among hunter-gatherer, agricultural and industrial populations over the whole time span. *[2]*

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(b) The graph above does not include the third source of fat, monounsaturated fat. Using the given data, estimate the percentage of energy from monounsaturated fat in the diet of the earliest hunter-gatherers. *[1]*

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(c) Besides fat, state **one** other group of compounds which supplies energy in the diet. *[1]*

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(This question continues on the following page)

(Question A1 continued)

(d) Suggest a reason for the change in the intake of

(i) ascorbic acid in industrialized populations. *[1]*

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(ii) saturated fats in industrialized populations. *[1]*

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A2. (a) Outline the fate of the products of ingested proteins. *[2]*

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(b) Discuss whether meat is essential in the human diet. *[4]*

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A3. (a) Suggest how economic conditions in a country can cause malnutrition. *[2]*

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(b) State **two** roles for chemical additives in the diet. *[1]*

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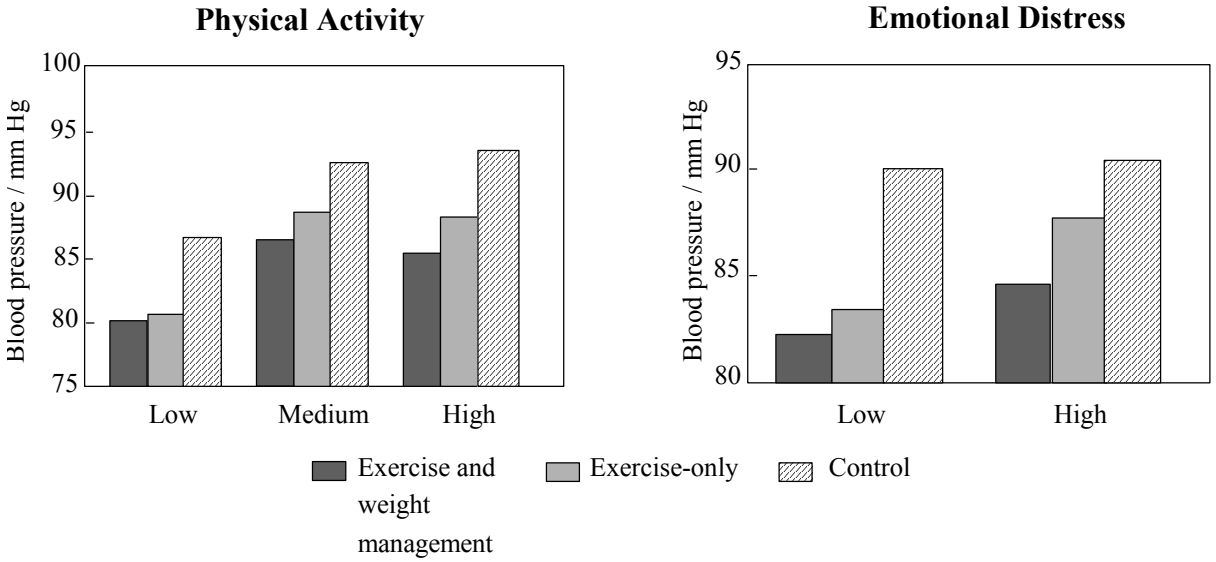
Option B – Physiology of exercise

B1. A recent study examined the effects of exercise and weight loss on blood pressure. To qualify for the study, a person had to be physically inactive, overweight and mildly hypertensive (slightly elevated blood pressure). Each of the 100 participants was randomly assigned to one of three groups:

- a combined exercise and weight management group
- an exercise-only group
- a control group (no exercise and no weight management).

Blood pressure was measured during periods of physical activity and emotional distress. Physical activity was classified as low, medium or high, and emotional distress was classified as low or high. The following data was collected over six months.



[Source: Steffen *et al.*, *Medicine and Science in Sports and Exercise*, (2001), **33** (10), pages 1635–1639]

(a) Identify which group of participants shows the least amount of change in blood pressure during daily life. *[1]*

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(b) Compare the changes in blood pressure in the three groups during physical activity. *[3]*

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(Question B1 continued)

(c) Using the data, evaluate the effects of exercise and weight management on blood pressure. *[2]*

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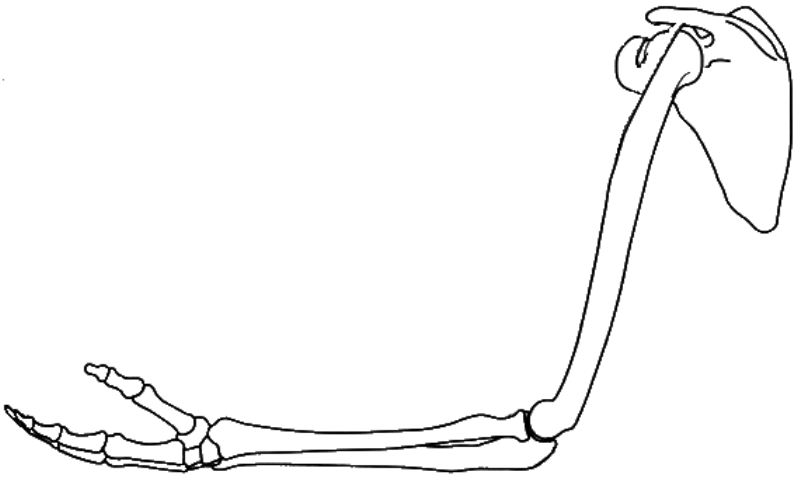
B2. (a) Draw the antagonistic muscles required to move the elbow. *[2]*



[Source: Adapted from J Vellacott and S Side, *Understanding Advanced Human Biology*, (1998), Hodder & Stoughton, page 155]

(b) Explain how skeletal muscle contracts. *[3]*

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B3. (a) Define the term *fitness*. *[1]*

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(b) Describe how training relates to repaying the oxygen debt after vigorous exercise. *[3]*

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Option C – Cells and energy

C1. The bacterium *Bacillus anthracis* causes anthrax, an acute infectious disease. It secretes a toxin that can kill the host during infection. One component of the toxin is an antigen, which attaches to cell membrane receptors. Once attached, the antigen enables two other components of the toxin to enter the cell and disrupt cellular activities causing cell death.

An investigation of the membrane receptors for the anthrax antigen was conducted. Mutant cells lacking the receptor were produced. The ability of these cells to bind the antigen and the viability of the cells at various concentrations of antigen was compared with cells that possessed the receptor. Both types of cells then had additional DNA introduced into them by means of genetic engineering. The DNA was thought to code for the receptor protein. Antigen binding and cell viability was again compared. The results are shown below.

Figure 1

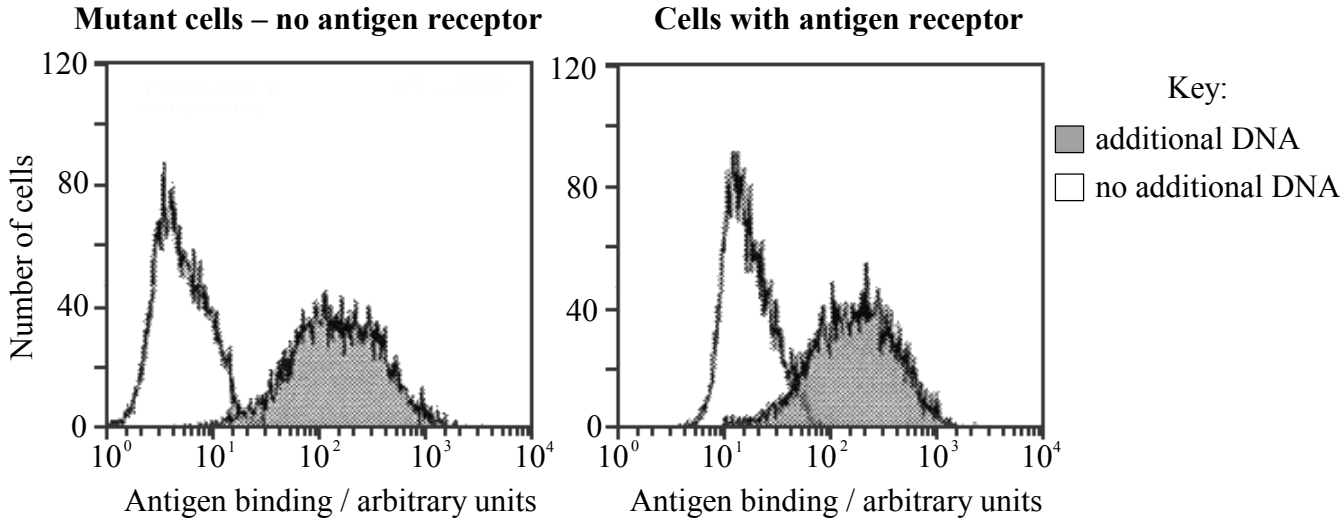
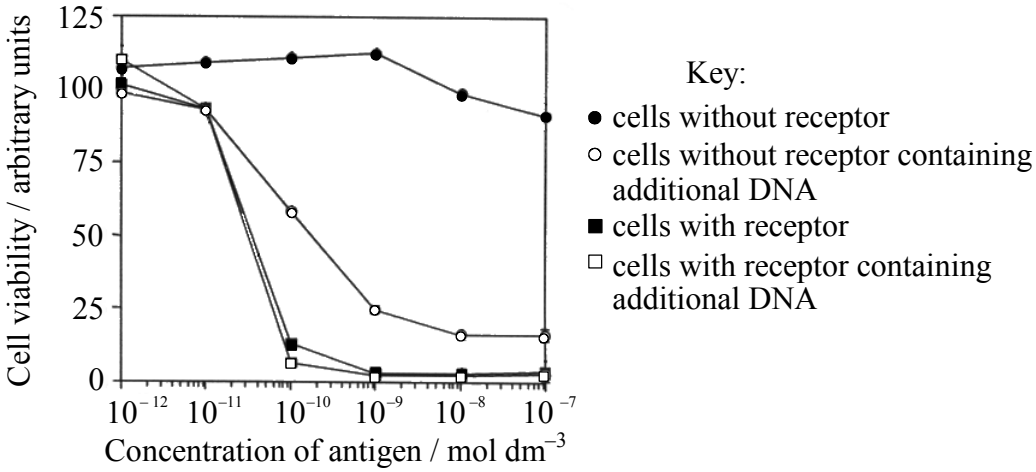


Figure 2



[Source: Adapted from Bradley *et al*., *Nature*, (2001), **414** (8), pages 22–29]

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(Question C1 continued)

(a) Compare antigen binding in figure 1. *[2]*

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(b) Using figure 2, deduce the effect of the additional DNA on cell viability. *[3]*

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C2. (a) Draw the structure of a mitochondrion. *[1]*

(b) State **two** outcomes from the process of glycolysis. *[2]*

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(c) Discuss the meaning of *oxidative phosphorylation* based on chemiosmosis. *[3]*

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C3. (a) Compare the adaptive significance of carbon dioxide fixation in C_4 and CAM plants. *[3]*

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(b) Outline how light intensity acts as a limiting factor for photosynthesis. *[1]*

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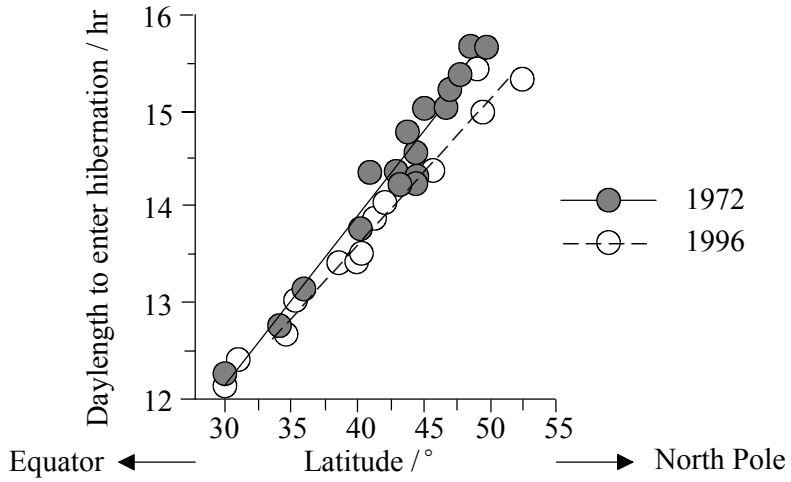
Option D – Evolution

D1. The mosquito (*Wyeomyia smithii*) uses daylength as a guide to either continue development of its larvae or to begin hibernation. This response to daylength is genetically controlled. Longer daylengths maintain development whereas shorter daylengths induce hibernation. In the northern regions of the northern hemisphere, even though daylengths are longer, winter arrives earlier than in regions closer to the equator. The following data is from an experiment to determine if *W. smithii* has adapted to later onsets of winter as a consequence of global warming. In 1972 and 1996, larvae were collected at various locations in the United States at latitudes $30-50^{\circ}$ North. The larvae were examined to determine what daylength induced hibernation. Each circle on the following graph represents one larval population.



[Source: Bradshaw and Holzapfel, *Proceedings of the National Academy of Sciences of USA*, (2001), **98** (25), pages 14509–14511]

(a) Outline the relationship between daylength and latitude for the larval populations in 1972. *[1]*

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(b) Compare the data of 1972 with 1996. *[2]*

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(c) Explain how the data illustrates an evolutionary response to a longer growing season due to a later onset of winter. *[2]*

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D2. (a) State **one** radioisotope used for the dating of rocks and fossils. *[1]*

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(b) Define the term *half-life*. *[1]*

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(c) Explain how the approximate age of a fossil could be determined using a radioisotope. *[2]*

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D3. (a) State **two** major physical features which define humans as primates. *[2]*

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(b) The following fossils are arranged chronologically from oldest to most recent.

A. afarensis, A. africanus, A. robustus, H. habilis, H. erectus, H. sapiens

Identify **two** fossils which show a major increase in brain size over the preceding fossil. *[1]*

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(c) Discuss how cultural evolution in humans depended on increases in brain size. *[3]*

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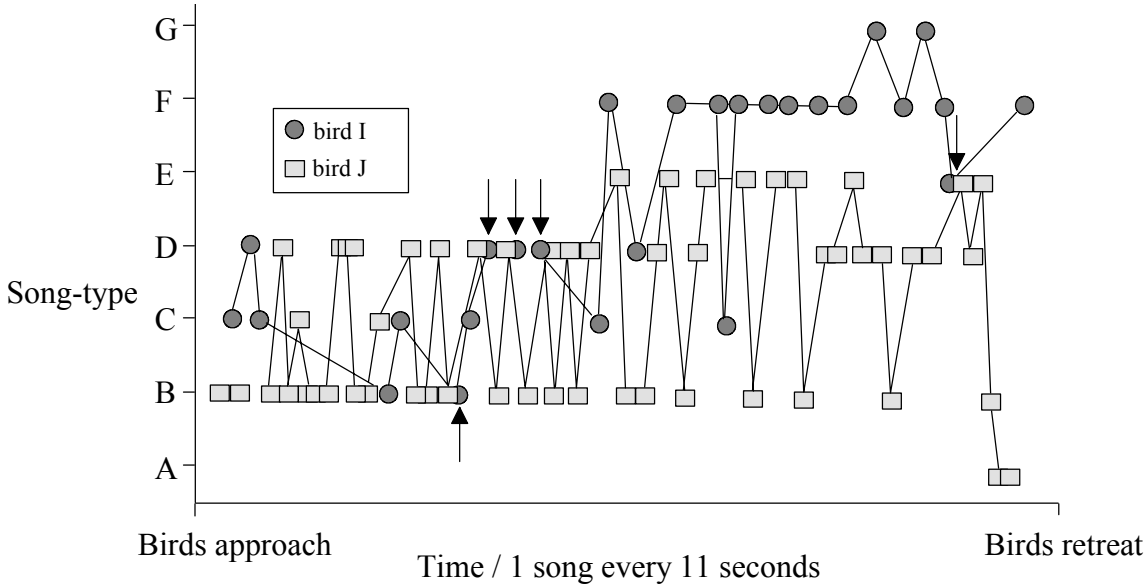
Option E – Neurobiology and behaviour

E1. Banded wrens *(Thryothorus pleurostictus*) are known to sing actively in defence of their territories during the breeding season. Males possess over twenty different song-types. When two males approach each other near a boundary they engage in counter-singing and some song-types will be shared. The following diagram shows the pattern of song-types used during an interaction between two males at their territorial boundary in the Guanacaste Conservation Area, Costa Rica. The arrows indicate when both males sang identical song-types in succession. The interaction ended without a fight when the males retreated from the boundary.



[Source: Molles and Vehrencamp, *Proceedings of the Royal Society Biological Sciences,* (2001), **268** (1480), pages 2013–2018]

(a) Identify which song-types are shared between both males. *[2]*

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(b) Describe the changes in the song-type pattern during the entire interaction. *[2]*

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(c) Deduce how a male banded wren can communicate aggressive behaviour. *[2]*

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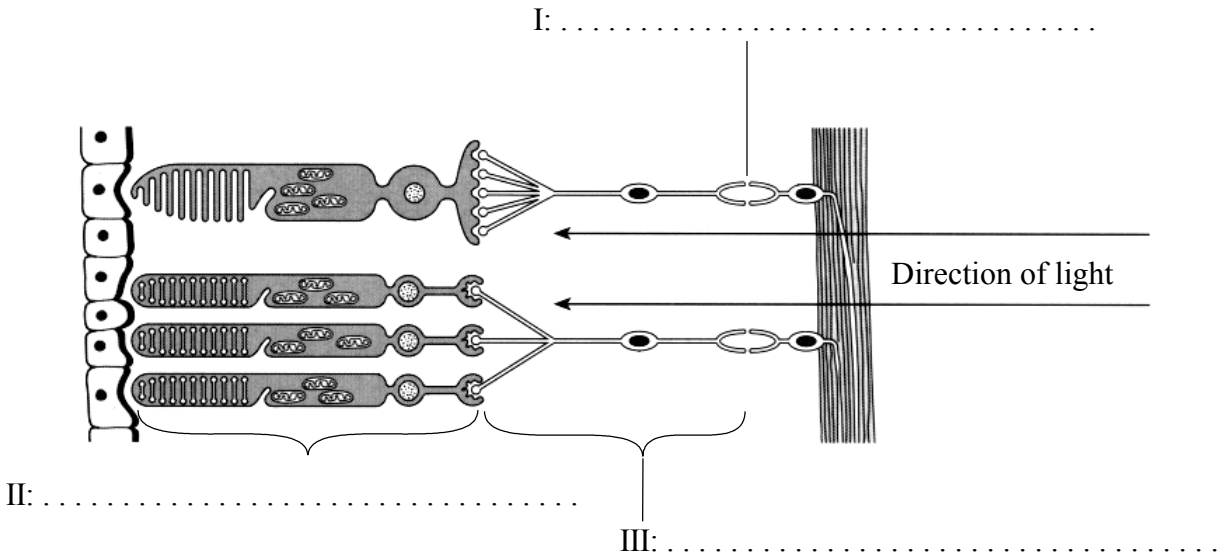
E2. (a) State the name of each of the labelled structures I, II and III in the retina. *[2]*



[Source: Adapted from A Allott, *Biology for the IB Diploma*, (2001), Oxford University Press, page 135]

(b) Explain how human perception of the colour yellow would depend on the eye **and** the brain. *[4]*

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E3. (a) Compare the investigations of Pavlov and Skinner into learned behaviour. *[2]*

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(b) Define the term *insight learning*. *[1]*

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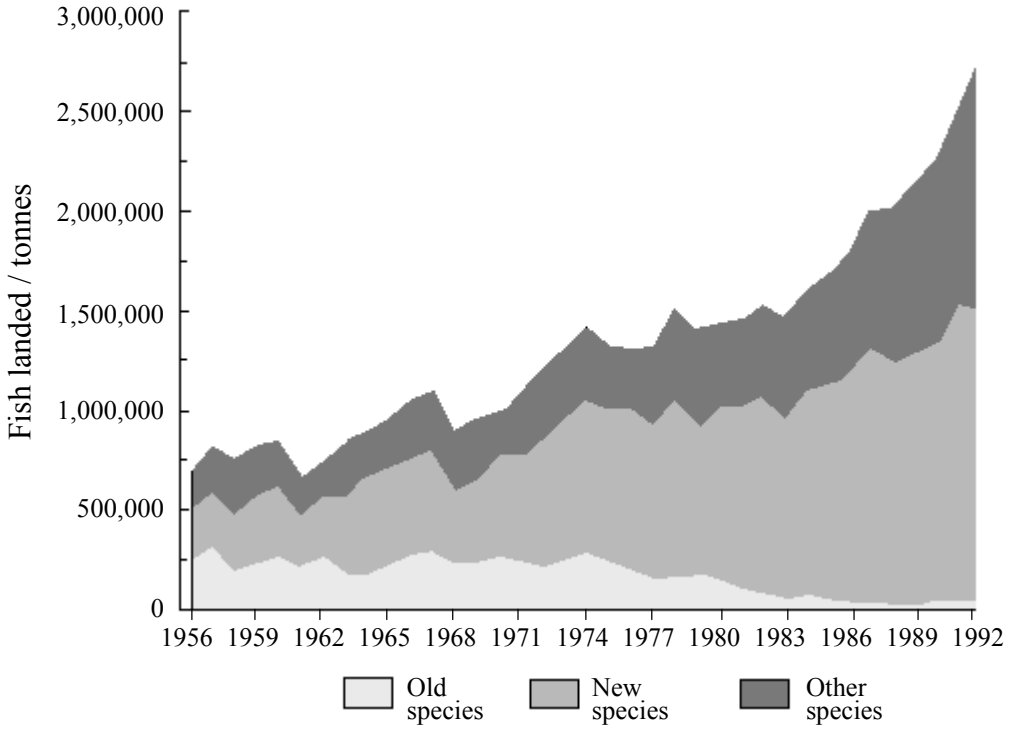
Option F – Applied plant and animal science

F1. A study of fishery yields from the East China Sea ecosystem was conducted. The fish landed were divided into three categories:

- "old species" are fish stocks of high economic value
- "new species" are less desirable fish stocks
- "other species" are fish stocks of low value, used for aquaculture and livestock feed, and occasionally for human consumption.

The following data shows trends in the amount of fish in each category that were landed on boats.



[Source: Chen *et al*., *Marine Fisheries Review*, (1997), **59** (4), pages 1–7]

(a) Identify the overall trend in the quantity of fish landed in the East China Sea. *[1]*

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(b) Calculate the percentage change in the quantity of "new species" between 1956 and 1992. *[1]*

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(This question continues on the following page)

(Question F1 continued)

(c) Suggest **two** reasons for the increase in landings of "other species". *[2]*

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(d) Discuss the use of fish meal for livestock production. *[2]*

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F2. (a) Define the term *leaf area index*. *[1]*

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(b) Outline how intensive monoculture can lead to increased crop production in terms of efficient land use. *[2]*

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F3. (a) Draw the generalized structure of a dicotyledonous insect-pollinated flower. *[3]*

(b) State **one** difference between pollination and fertilization. *[1]*

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(c) Explain how commercial production of cut flowers requires a scientific understanding of pollination and fertilization. *[2]*

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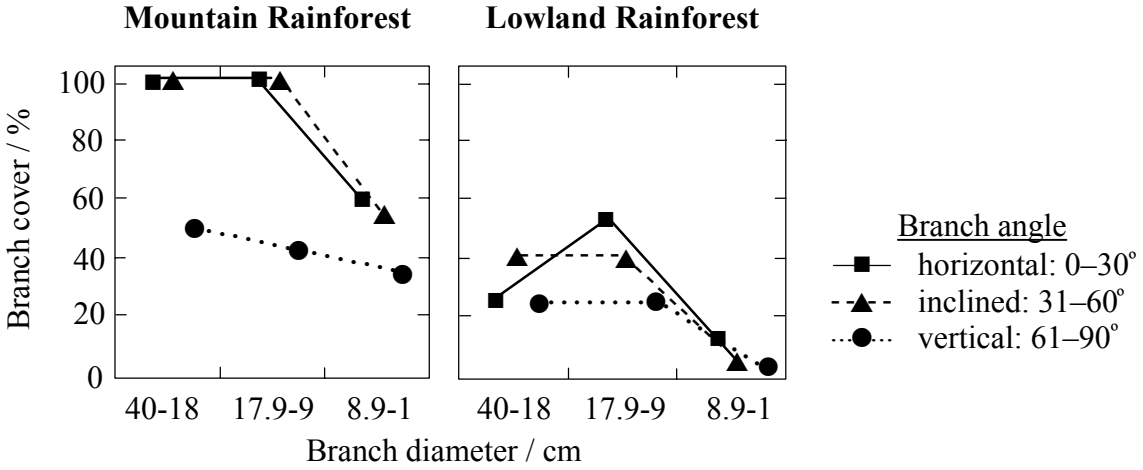
Option G – Ecology and conservation

G1. Plants called epiphytes grow above the ground on the surface of other plants such as trees. Epiphytes play an important role in rainforests because they can absorb vast amounts of precipitation water (rain and fog), retain minerals effectively and contribute enormous amounts of humus.

An investigation was carried out in Ecuador to determine the distribution and abundance of epiphytes in lowland and mountain rainforests. Branch cover was measured for different branch diameters and different branch angles. (The larger the branch diameter, the closer it was to the trunk of the tree.) The results are shown below.



[Source: Freiberg and Freiberg, *Journal of Tropical Ecology*, (2000), **16**, pages 673–688]

(a) Outline the percentage of branch cover on horizontal branches of trees in mountain rainforests. *[1]*

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(b) Analyse how the branch angle affects the percentage of branch cover in mountain rainforests. *[2]*

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(This question continues on the following page)

(Question G1 continued)

(c) Compare the percentage of branch cover between mountain rainforests and lowland rainforests for inclined branches. *[2]*

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(d) Suggest a reason for the overall difference in branch cover by epiphytes in mountain rainforests and lowland rainforests. *[1]*

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G2. (a) Draw the water cycle in a named terrestrial ecosystem. *[2]*

(b) Describe **two** ways that living organisms could change their abiotic environment during the course of primary succession to climax communities. *[2]*

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G3. (a) State **three** factors that can affect the distribution of animal species. *[1]*

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(b) Discuss why an index of diversity could be useful in monitoring environmental change. *[3]*

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(c) Outline the conservation role of **one** named international agency. *[1]*

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