IBO

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

BIOLOGY
STANDARD LEVEL
PAPER 3

Candidate number

Wednesday 12 May 2004 (morning)

1 hour

INSTRUCTIONS TO CANDIDATES

- Write your candidate number in the box above.
- Do not open this examination paper until instructed to do so.
- Answer all of the questions from two of the Options in the spaces provided. You may continue your answers on answer sheets. Write your candidate number on each answer sheet, and attach them to this examination paper using the tag provided.
- At the end of the examination, indicate the letters of the Options answered in the candidate box on your cover sheet and indicate the number of answer sheets used in the appropriate box on your cover sheet.

Option A – Diet and Human Nutrition

A1. The body mass index (BMI) considers the weight and height of a person and can be used to determine if a person is overweight or obese. The nomogram shows the body mass index for a range of weights and heights.

Weight / kg   Height / cm

Body Mass Index
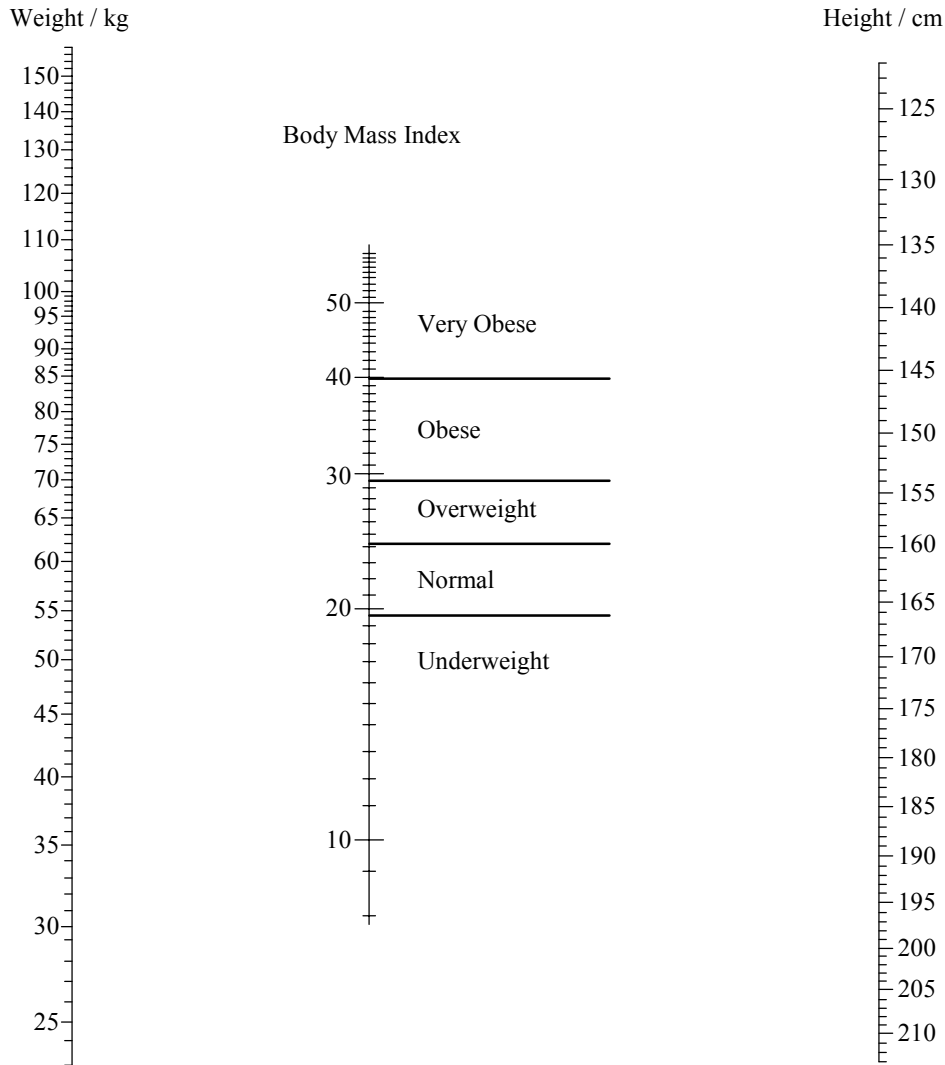
[Source: adapted from G Bray, *Obesity, Fat Intake and Chronic Disease*, (2000), www.acnp.org/g4/gn401000154/CH.html]

(a)   State the weight description of a 75 kg man who is 145 cm tall.   *[1]*

....

(b)   A woman of height 150 cm has a BMI of 40. Calculate the minimum weight she must lose to be considered normal.   *[1]*

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(This question continues on the following page)

(Question A1 continued)

(c) Outline the relationship between height and BMI for a fixed weight. *[1]*

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(d) Obesity may be caused by excess of lipids in the diet. Describe the significance of saturated and unsaturated lipids in the diet. *[3]*

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A2. (a) State **one** food source that is rich in fibre. *[1]*

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(b) State the name of a carbohydrate that constitutes fibre. *[1]*

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(c) Discuss why it is considered important to include fibre in the diet. *[3]*

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A3. (a) State **one** function of iodine and **one** function of zinc in the diet.   *[2]*

Iodine: . . . .

Zinc: . . . .

(b) Outline how **two** named food additives may have harmful effects.   *[2]*

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(c) Explain why hygienic food methods are important when handling foods.   *[3]*

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Option B – Physiology of Exercise

B1. A reliable method of estimating cardiovascular fitness is by measuring the oxygen consumption of the body, when the rate of heartbeat is at its maximum (V_{max}) during intense exercise. This test was used to measure fitness among 71 volunteers. Two weeks later the same individuals were asked to run for 2.1 km at two different speeds (V_{70} and V_{90}) and the power they developed during these runs was measured.

- V_{70} in which they ran at a speed where their rate of heartbeat was 70 % V_{max}.
- V_{90} in which they ran at a speed where their rate of heartbeat was 90 % V_{max}.
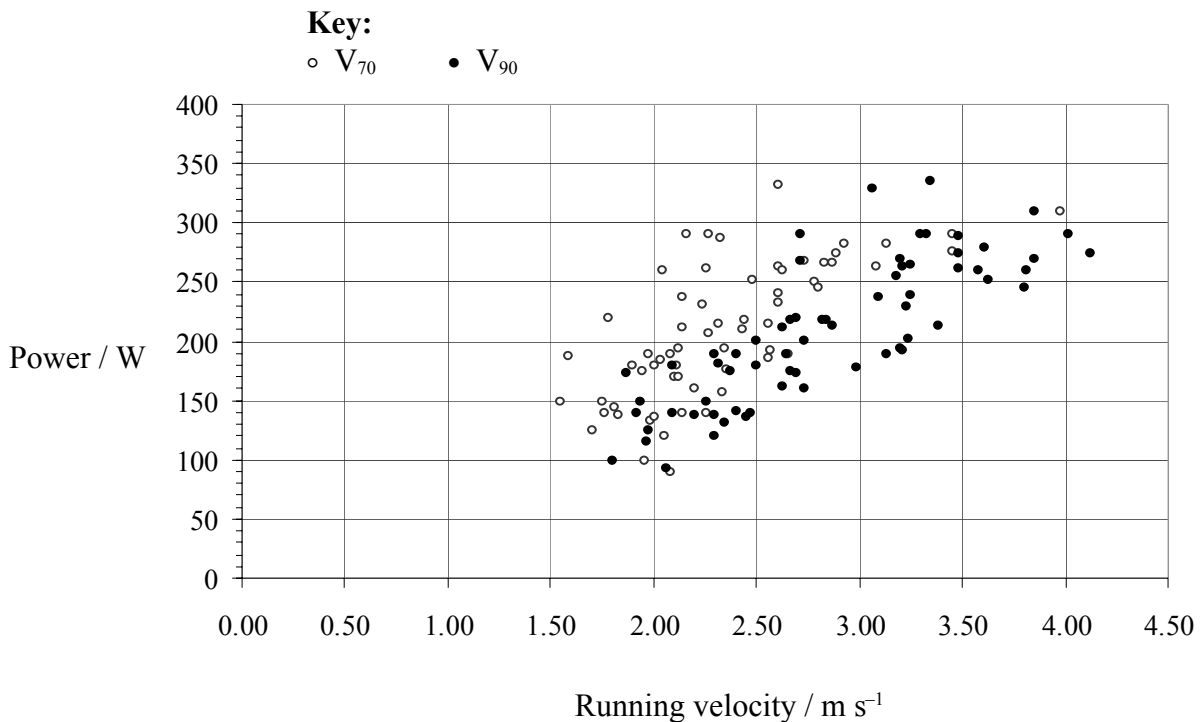
[Source: V J Leibetseder *et al.*, *Journal of Exercise Physiolog*y, (2002), **5** (3), page 11]

(a) State the maximum power developed by a runner at V_{70}. *[1]*

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(b) Outline the relationship between running velocity and power developed at V_{90}. *[1]*

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(This question continues on the following page)

(Question B1 continued)

    (c)   Compare the data for V_{70} and V_{90}.   *[2]*

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    (d)   Suggest why measurements of V_{max} are dangerous for older people.   *[1]*

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B2. (a)   Outline how stamina could be used as a measure of fitness.   *[1]*

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    (b)   Outline **two** ways that training can affect the muscles.   *[2]*

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    (c)   Discuss the ethics of using drugs to improve sporting performances.   *[3]*

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B3. (a)   Draw a labelled diagram to show the structure of a motor neuron and indicate with an arrow the direction of the nerve impulse.   *[3]*

(b)   State the structure which attaches muscles to bones.   *[1]*

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(c)   Explain how the structure of a long bone makes it suitable to its function.   *[3]*

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Option C – Cells and Energy

C1. The rate of carbon dioxide uptake by the green succulent shrub *Aeonium goochiae* can indicate the amount of photosynthesis taking place in the plant. This rate was measured at $15\,°C$ and $30\,°C$ over a 24-hour period. The units of carbon dioxide absorption are mg CO_2 h^{-1}.

The results are shown below. The centre of the graph corresponds to -2 mg CO_2 h^{-1} and the outer ring is $+2.5$ mg CO_2 h^{-1}.
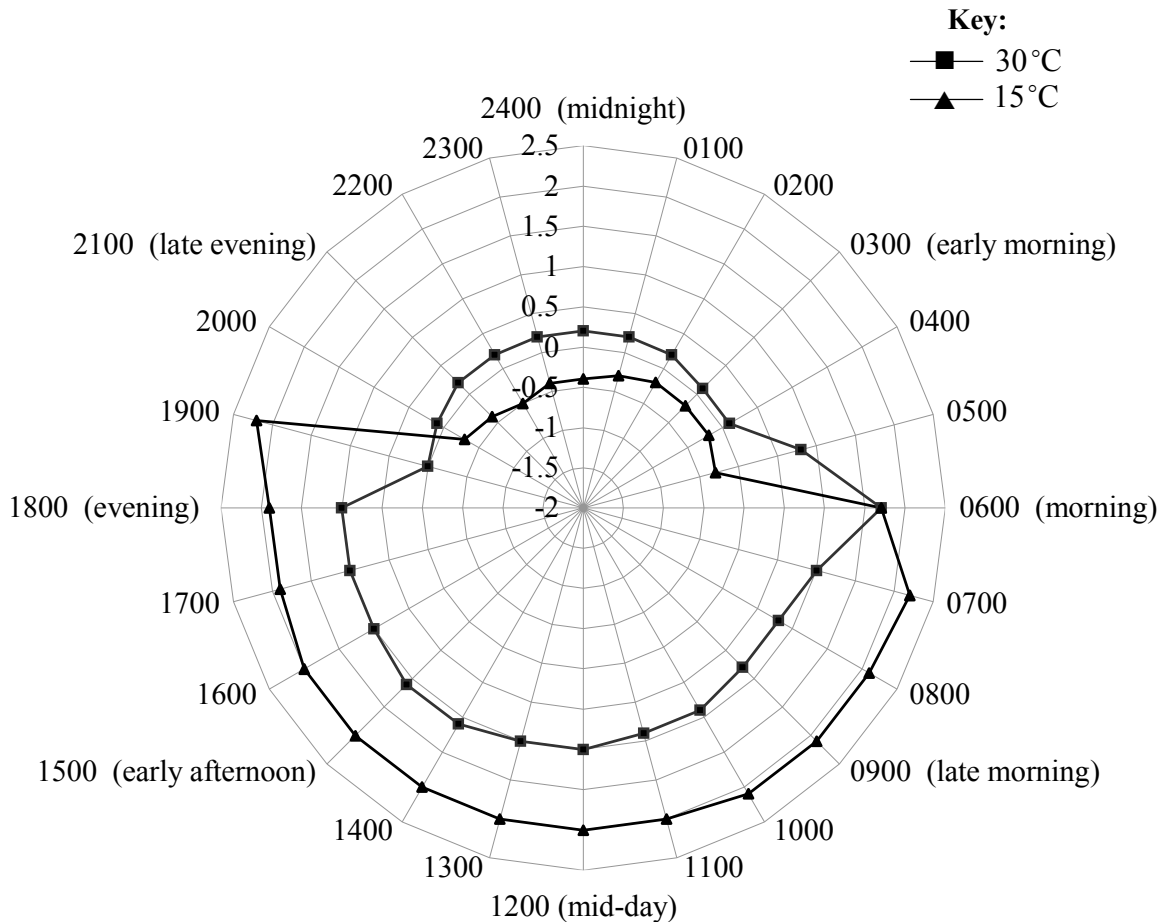
[Source: adapted from www.biologie.uni-hamburg.de/b-online/e24/9.htm]

(a) Identify a time that carbon dioxide uptake was the same at both temperatures.   *[1]*

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(b) State the maximum rate of carbon dioxide uptake at $15\,°C$.   *[1]*

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(This question continues on the following page)

(Question C1 continued)

(c) Compare the rate of carbon dioxide uptake at each temperature in daylight and darkness. *[3]*

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(d) Suggest why the carbon dioxide uptake may at times be negative. *[1]*

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C2. (a)   (i)   Identify the cell organelle shown in the micrograph below.   *[1]*

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(ii) Identify the structure labelled I above and explain how it is adapted for the organelle to function efficiently.   *[3]*

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(b)   Describe the role of acetyl CoA in the metabolism of lipids.   *[2]*

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C3. (a) Explain the significance of secondary structure to the structure of a protein. *[3]*

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(b) State the name of a competitive enzyme inhibitor. *[1]*

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(c) Outline the difference between competitive and non-competitive enzyme inhibitors. *[2]*

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Option D – Evolution

D1. Biochemical evidence from DNA can provide evidence for the ancestry of humans. The DNA from the mitochondria of 53 humans was studied. The subjects were divided into African and non-African populations according to their ethnic backgrounds and origins. The DNA was compared at two different places in the mitochondria and the number of differences was recorded. The number of pair differences can be used to estimate the age of the populations.

African

Class of pair differences in the DNA

non-African

Class of pair differences in the DNA
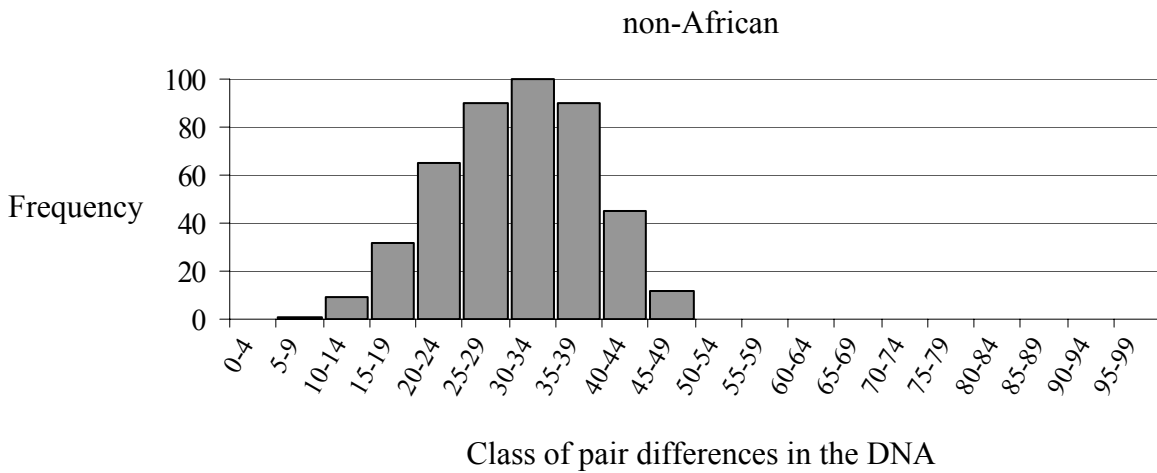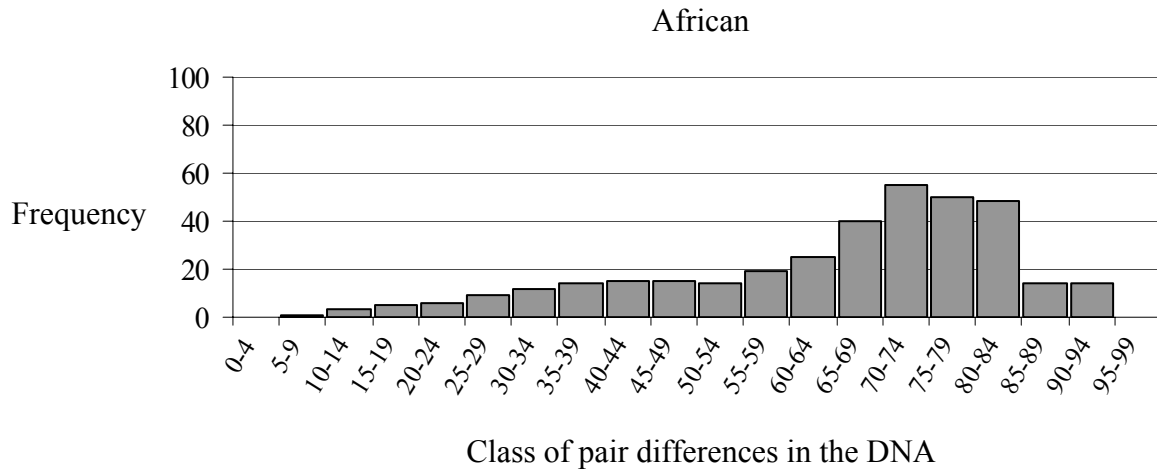
[Source: M Ingram, *Nature*, (2002), **408**, page 710]

(a) State the class of pair differences with the greatest frequency in Africans. *[1]*

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(This question continues on the following page)

(Question D1 continued)

(b)   Compare the data for the Africans and non-Africans.   *[3]*

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(c)   Deduce, with a reason, which population is the oldest.   *[2]*

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D2. (a) Explain briefly Darwin's theory of evolution. *[4]*

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(b) Outline **two** modern examples where evolution can be observed. *[2]*

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(c) State **two** ways in which the remains of past living organisms have been preserved. *[2]*

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D3. (a) State the taxonomic class to which humans belong. *[1]*

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(b) Discuss the anatomical features that enable bipedalism in humans. *[3]*

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Option E – Neurobiology and Behaviour

E1. In the bee *Centris pallida*, the male performs one of two mating behaviours known as patrolling or hovering. Patrolling bees search close to the ground, waiting to mate with virgin females as soon as they mature and emerge from their burrows. When a female emerges, the patrolling males spend so much time fighting among themselves that often none of them mate with the female so it flies to a tree to feed. The hovering bees fly higher than the patrolling bees, or fly around the trees. When a hovering bee sees a female he pursues her and tries to mate with her.

Scientists caught 100 hovering bees, 250 patrolling bees and 150 mating bees and measured the width of the head of each bee.
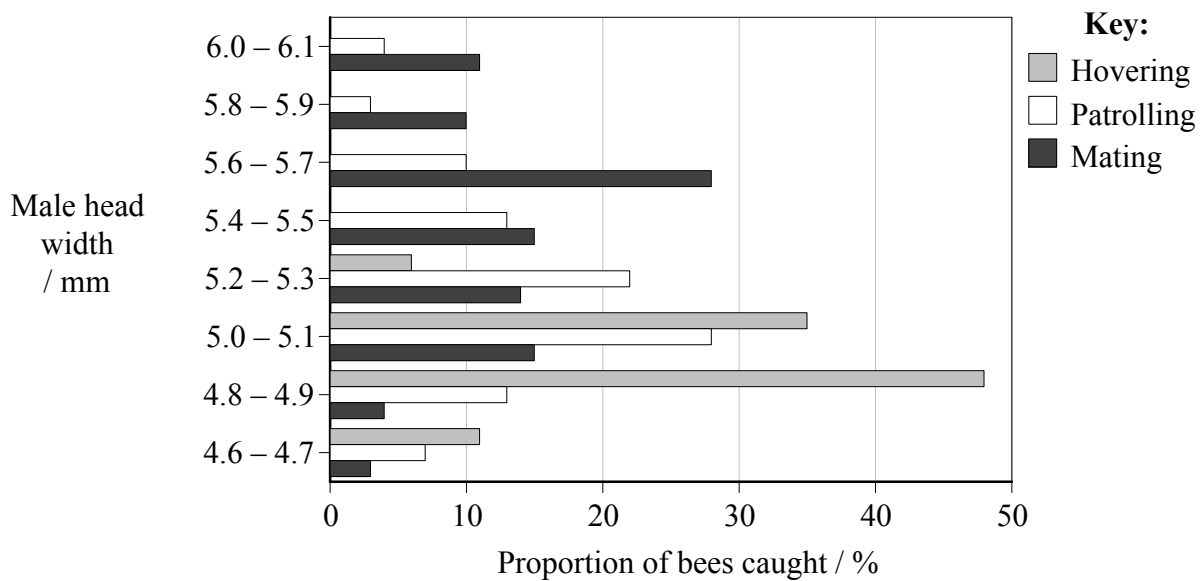
[Source: J L Chapman and M J Reiss, *Ecology Principle and Applications*, (1999), CUP, page 72]

(a) Identify the largest head width range found in the sample of hovering bees. *[1]*

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(b) Calculate the number of mating bees with head width from 5.8 to 5.9 mm. *[1]*

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....

(c) Deduce the relationship between head width and mating success. *[2]*

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(d) Suggest why bees with small heads tend to hover rather than patrol. *[1]*

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E2. (a) State the class of sensory receptor that is sensitive to light.   *[1]*

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   (b) Outline the pupil reflex.   *[2]*

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   (c) Identify the following structures in the human eye.   *[3]*
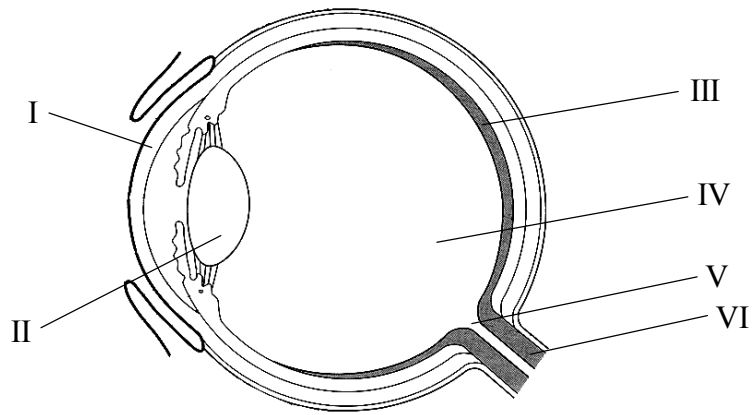
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E3. (a) Define the term *imprinting*. *[1]*

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(b) Outline the work of Lorenz on imprinting. *[3]*

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(c) Discuss how innate behaviour can improve an animal's chances of survival. *[3]*

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Option F – Applied Plant and Animal Science

F1. Since 1965, the eating habits of people in many countries have changed. People in countries where previously little meat was eaten began to eat meat, causing changes in world meat production. Differences in global meat production and the four main types of meat are illustrated below.

Meat production / $\times 10^6$ tonnes
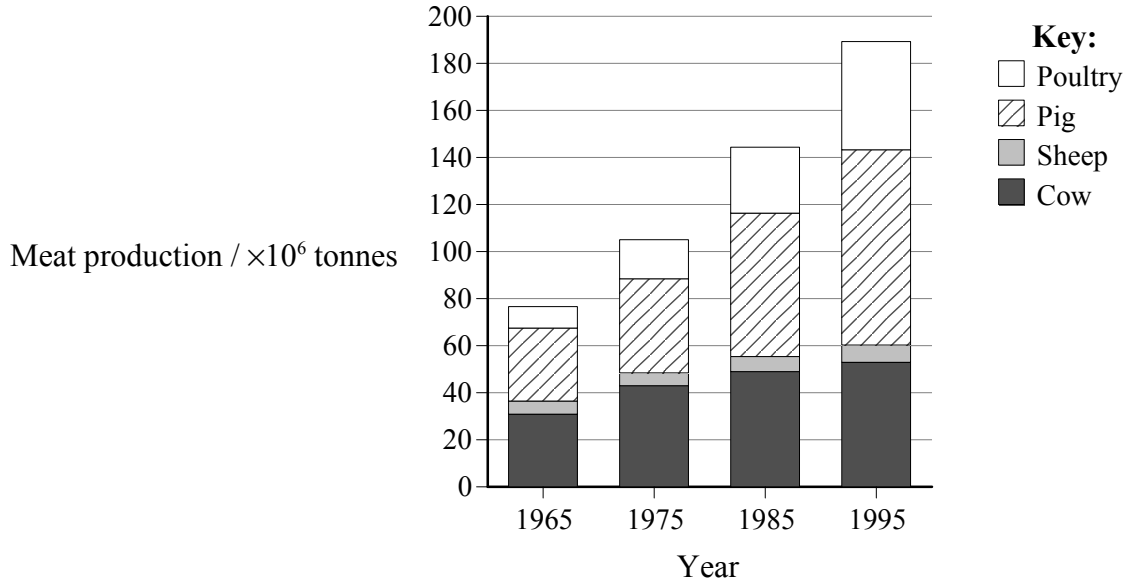
[Source: R Buckley (editor), *The Future of Farming: What Price the Food We Eat?*, (1997), Understanding Global Issues Limited, pages 8–10]

(a) Calculate the quantity of pig meat produced in 1995.   *[1]*

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(b) State which type of meat production had the least change from 1965 to 1995.   *[1]*

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(c) Compare cow and poultry meat production from 1965 to 1995.   *[3]*

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(d) Suggest **one** reason for the changes in pig meat production from 1985 to 1995.   *[1]*

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F2. (a) State **one** example of a plant grown to provide clothing. *[1]*

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(b) Discuss the practice of organic farming. *[3]*

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(c) Outline plant production by hydroponics. *[3]*

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F3. (a) State **one** advantage and **one** disadvantage of using antibiotics in livestock production.   *[2]*

Advantage: . . . .

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Disadvantage: . . . .

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(b) Describe how pruning can affect a decorative plant.   *[3]*

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Option G – Ecology and Conservation

G1. The Food and Agricultural Organization (FAO) gathered information to determine if marine ecosystems were being damaged by overfishing. The total fish captured in each of three oceans from the years 1960 to 2000 was compared to the overall world marine capture.
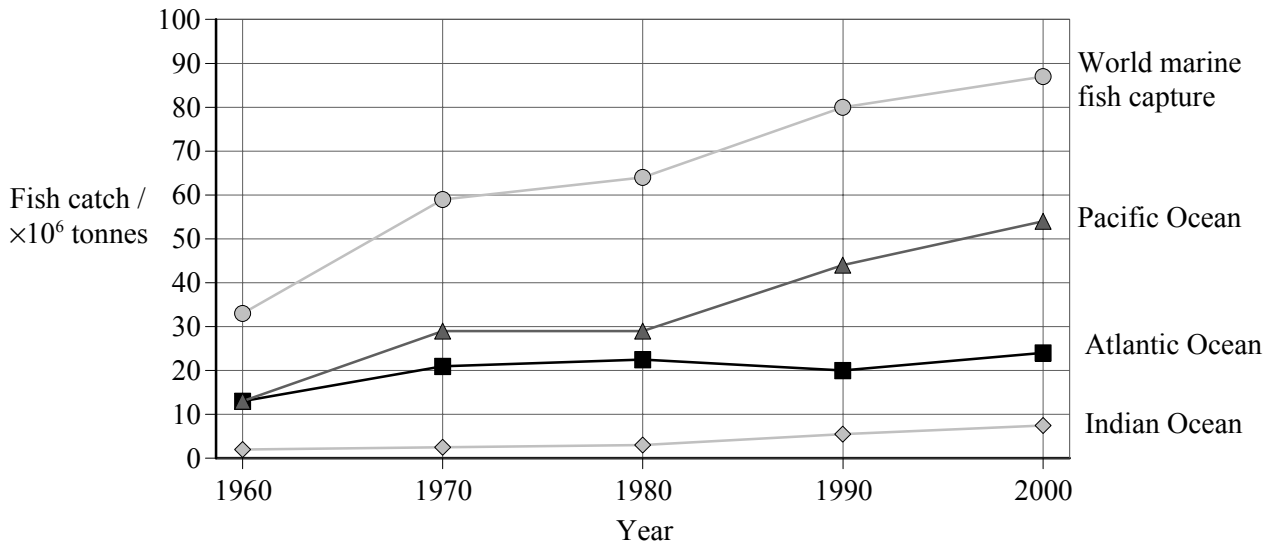
[Source: R Buckley (editor), *World Fishing: Beyond Sustainability*, (2002), Understanding Global Issues Limited, pages 8–9]

(a) Calculate the percentage of the world catch that came from the Atlantic Ocean in 1990. *[1]*

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(b) Compare the data from the Pacific Ocean with that from the Atlantic Ocean. *[3]*

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(c) Suggest **one** reason in each case for the change in the quantity of fish captured in the Atlantic and Indian Oceans from 1980 to 1990. *[2]*

Atlantic Ocean: . . . .

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Indian Ocean: . . . .

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G2. (a) State how gross production differs from net production in an ecosystem. *[1]*

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(b) State the units that would be used if constructing a pyramid of energy. *[1]*

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(c) Explain how parasitism differs from mutualism, giving an example of each. *[4]*

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G3. (a) State **one** advantage of *in situ* conservation of endangered species. *[1]*

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(b) Identify, giving a reason, why **one** named animal has become extinct in the past 1 000 years. *[2]*

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(c) Outline the factors that need to be considered in the management of a nature reserve. *[3]*

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