IBO

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

BIOLOGY
STANDARD LEVEL
PAPER 3

Friday 5 May 2006 (morning)

1 hour

Candidate session number

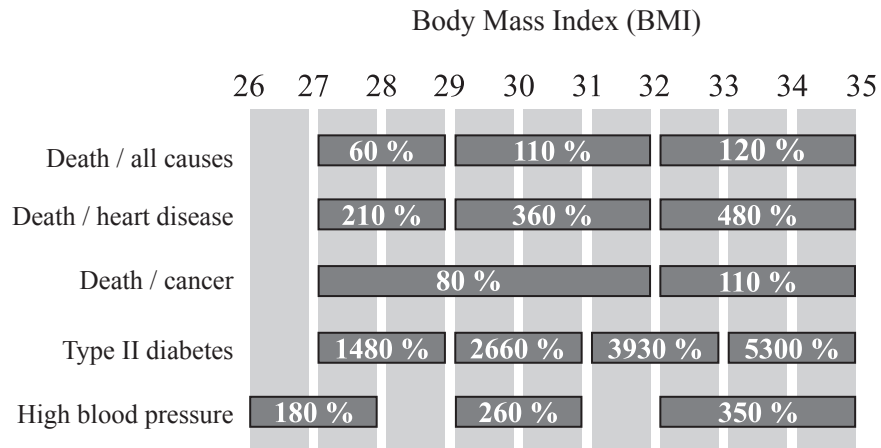| 0	0								

INSTRUCTIONS TO CANDIDATES

- Write your session 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 session 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. Obesity appears to be rising in most industrial nations. There are many health risks associated with obesity. To measure this disorder the body mass index (BMI) is used, which is the weight in kg divided by the height squared in metres (BMI = kg m^{-2}). The following chart shows the percentage increase in risk of death or disease due to the level of obesity. The percentage increase is obtained for all cases of death in individuals with a BMI lower than 19, cases of type II diabetes in individuals with a BMI between 22 and 23 and occurences of high blood pressure in individuals with a BMI lower than 23.

Body Mass Index (BMI)

	26	27	28	29	30	31	32	33	34	35
Death / all causes			60 %		110 %			120 %		
Death / heart disease			210 %		360 %			480 %		
Death / cancer			80 %					110 %		
Type II diabetes			1480 %		2660 %		3930 %		5300 %	
High blood pressure	180 %				260 %			350 %		

[Adapted from Scientific American, W Gibbs, Copyright © 1996 by Scientific American, Inc. All rights reserved]

(a)   State which condition has a greater risk of developing if the patient is obese.   *[1]*

. . . .

(b)   State the percentage increase in the risk of developing high blood pressure if the BMI of 33 is compared to the BMI of 22.   *[1]*

. . . .

(c)   Identify the percentage increase in risk of death from all causes if the BMI increases from 28 to 33.   *[1]*

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(This question continues on the following page)

(Question A1 continued)

(d) Calculate the percentage increase in the risk of dying of cancer, if a patient who is 2 m tall increases in weight from 120 kg to 132 kg. Show your working. *[2]*

. . . .

(e) Explain how obesity is related to heart disease. *[3]*

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A2. (a) Outline a harmful effect of a **named** food additive. *[2]*

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(b) Explain the function of tocopherol (vitamin E) in our diets. *[2]*

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Turn over

A3. (a) Discuss the relationship between osteoporosis and nutrition.   *[4]*

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(b) Distinguish between vegan and vegetarian diets.   *[2]*

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Turn over

Option B — Physiology of Exercise

B1. Sports science and technology help provide elite competitors with the slight advantage needed to win in world-class competition. Understanding how training builds strength and stamina requires knowledge of how the body produces energy.

The graph below shows the physiological demands during the men's 228 km cycling road race, which lasted about five hours, in the Atlanta Olympic Games. The results are shown as a percentage of the energy system used, considering 100% as the maximum capacity of that energy system.
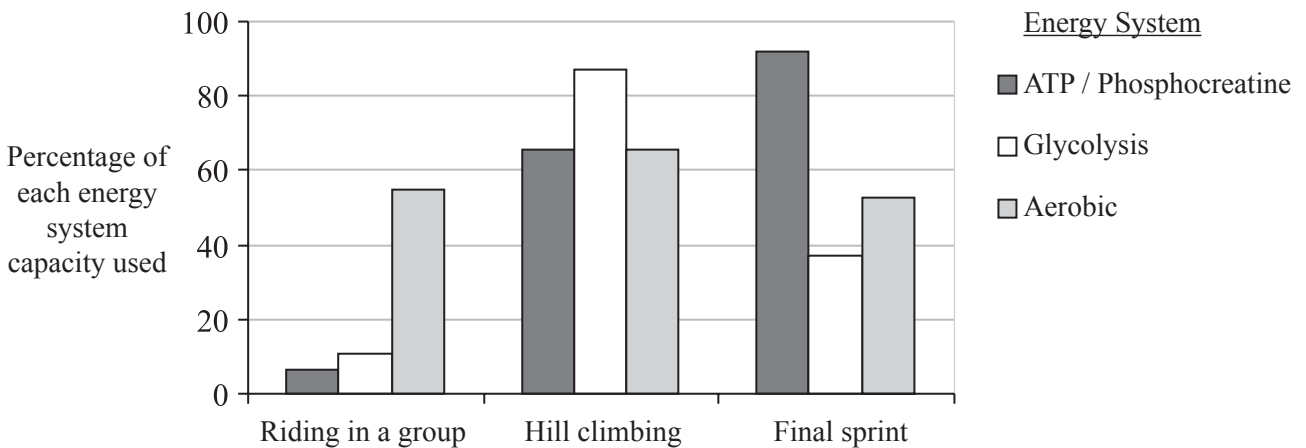
[Source: J Kearney, *Scientific American*, June 1996, page 44]

(a) (i) State the main source of energy used when cyclists sprinted at the end of the race. *[1]*

. . . .

(ii) Explain how this source of energy suits this particular type of exercise. *[2]*

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(This question continues on the following page)

(Question B1 continued)

(b) (i) Calculate the difference in percentage of system capacity used in phosphocreatine between riding in a group and hill climbing. Show your workings. *[1]*

. . . . %

(ii) Compare the ways of obtaining energy while riding in a group and hill climbing. *[2]*

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(c) Discuss **one** training method based on the data which could be adopted by athletes participating in this cycling race. *[2]*

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Turn over

B2. Vigorous exercise causes injuries to joints and muscles.

    (a)   Outline the following injuries.   *[2]*

        (i)   Dislocation: . . . .

               . . . .

        (ii) Sprain: . . . .

               . . . .

    (b)   State the types of movements at the knee joint.   *[1]*

        . . . .

    (c)   Adrenaline is secreted before or during vigorous exercise. Explain how it helps to supply more oxygen and glucose to muscles.   *[3]*

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

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               . . . .

        (ii) Describe how agility can be used as a measure of fitness.   *[1]*

               . . . .

               . . . .

    (b)   Explain what causes the triceps to relax when the biceps contracts.   *[2]*

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Turn over

Option C — Cells and Energy

C1. The hydrolysis of inorganic phosphate (PPi) by phosphatase enzyme provides energy for a wide range of reactions. A phosphatase (PPase) occurs bound to thylakoid membranes. This enzyme was purified from the thylakoid membranes of spinach leaves using chromatography. The activity of the membrane bound enzyme and the purified enzyme was measured.

The effect of the concentration of magnesium ions (Mg^{2+}) on the relative activity of these enzymes was determined using different concentrations of magnesium chloride. The concentration of inorganic phosphate used in both cases was of 1 mmol dm^{-3}.

Activity of phosphatase (arbitary units)	
Membrane bound	*Purified*
12 618	1215
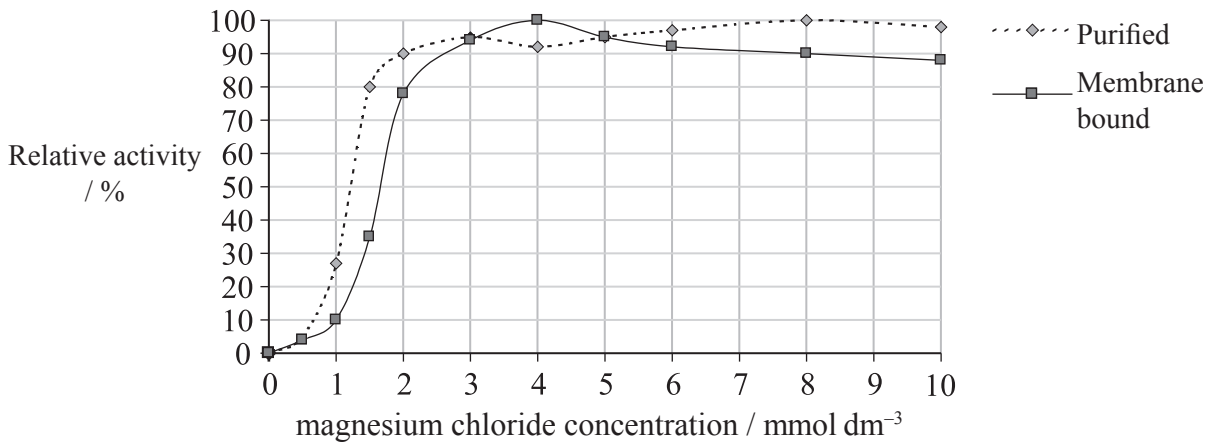
[Reprinted from Archive of Biochemistry and Biophysics, **346,** Jiang *et al,* page 105, copyright (1997), with permission from Elsevier.]

(a)   State the percentage of relative activity of the purified enzyme when the concentration of magnesium chloride is   *[2]*

(i)   1 mmol dm^{-3}: . . . . %

(ii)   2 mmol dm^{-3}: . . . . %.

(This question continues on the following page)

(Question C1 continued)

(b) Outline the effect of magnesium chloride on the relative activity of the membrane bound
 enzyme. *[2]*

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(c) Calculate the approximate ratio of inorganic phosphate to magnesium chloride concentration
 needed to achieve maximum activity in membrane bound enzymes. *[1]*

 . . . .

(d) (i) State the difference in phosphatase activity when membrane bound and when purified. *[1]*

 . . . .

 . . . .

 (ii) Suggest a reason for this difference. *[1]*

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C2. (a) State **two** functions of proteins. *[2]*

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

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(ii) Explain the production of reduced NADP ($NADPH+H^+$) in the process of photosynthesis. *[3]*

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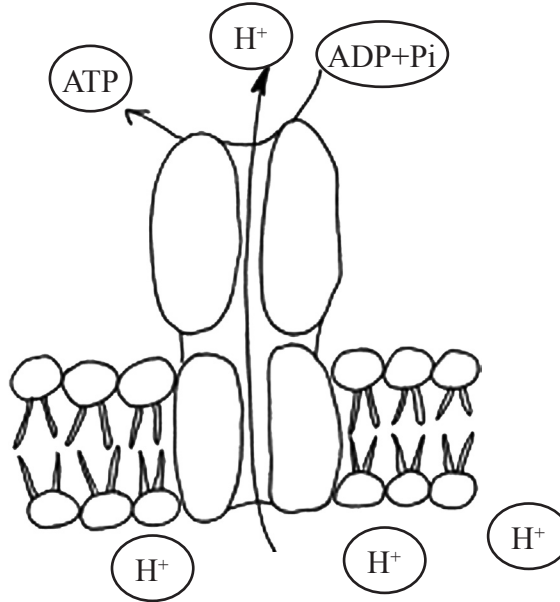
C3. The diagram below shows some features of ATP synthetase.

(a) Identify in which cell organelle the process below occurs? *[1]*

. . . .

(b) Explain the process represented by the diagram. *[3]*

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Option D — Evolution

D1. Evidence from bones, teeth, soft tissues and molecular data support the view that modern humans and chimpanzees are particularly closely linked. A complete cranium (*Sahelanthropus tchadensis*) found recently in Sahel, northern Chad, Africa has contributed to this idea.

Part of the known fossil record of hominids is shown below. Extinct species are indicated with the dates of the earliest and latest fossil evidence. Species are assigned to one of five categories based on brain and cheek-tooth size, posture and locomotion.
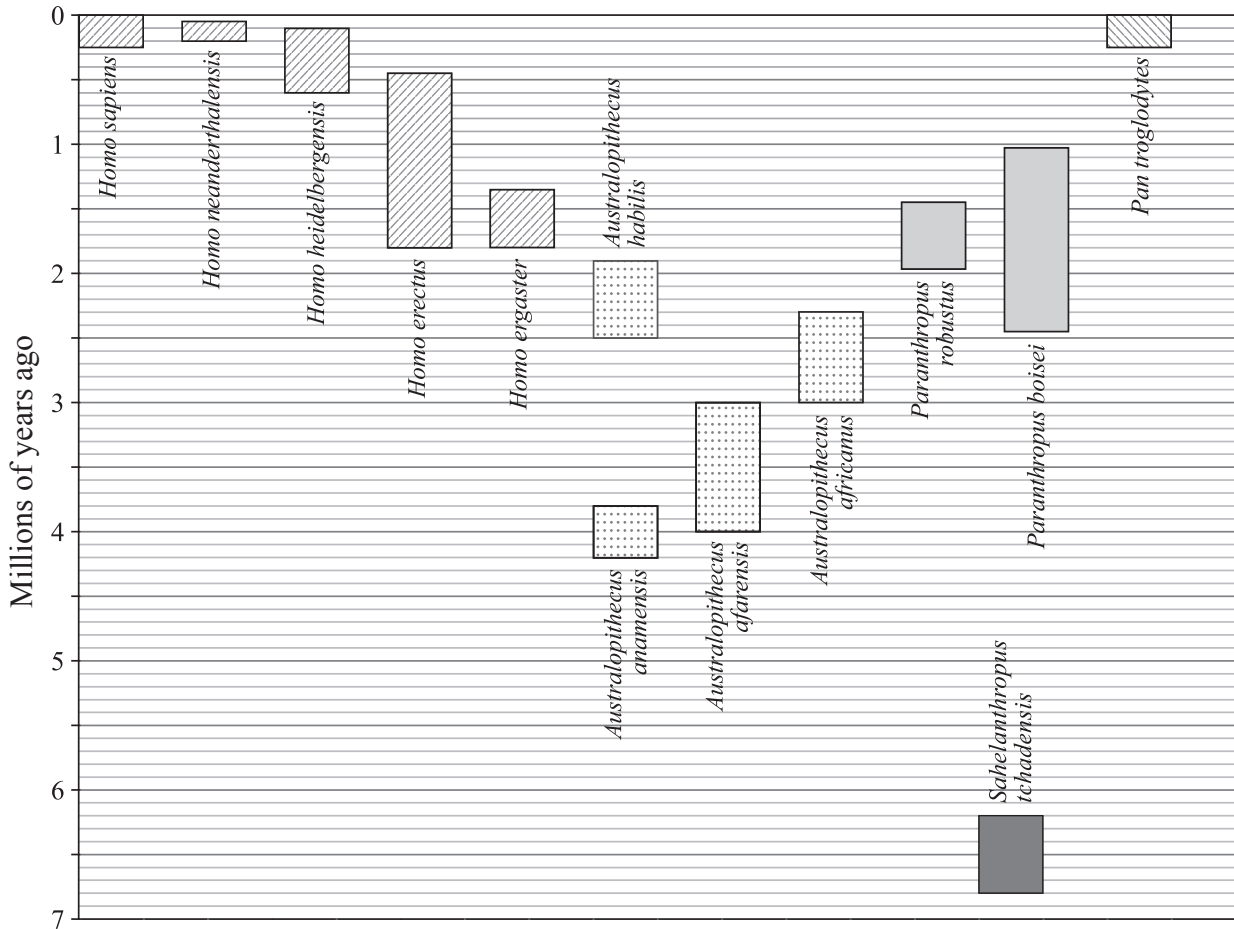
[Reprinted by permission from Macmillan Publishers Ltd: Nature, Fig 2 from B. Wood, 'Paleoanthropology: Hominid revelations from Chad', 418, pp133–135 (11 July 2002), copyright (2002)]

Key:

▨ Large brain, small teeth, bipedalism

▨ Small brain, very large teeth, facultative bipedalism (ability to walk or run on two legs, or as a quadruped, according to the circumstances)

▨ Small brain, large teeth, facultative bipedalism

▨ Small brain, small teeth, quadrupedalism

■ Insufficient evidence

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(Question D1 continued)

(a) State the approximate age of the oldest *Homo erectus* fossil found. *[1]*

. . . .

(b) State the possible age of the *Sahelanthropus tchadensis* fossil found recently. *[1]*

. . . .

(c) Using the data in the graph, identify the largest number of hominid species that lived at the same time and name each one. *[1]*

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(d) Discuss which genus is more closely related to *Paranthropus*. *[2]*

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(e) Suggest a method which can be used to determine whether *S. tchadensis* lived at the time when *H. sapiens* and *P. troglodytes* shared a common ancestor. *[1]*

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(f) Outline the method used to accurately date the fossil found in Chad. *[2]*

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D2. (a) According to the endosymbiotic theory, both mitochondria and chloroplasts have evolved from independent prokaryotic cells. Outline **three** characteristics of these organelles that support this theory. *[3]*

1: . . . .

. . . .

2: . . . .

. . . .

3: . . . .

. . . .

(b) State the name of **two** gases used in Miller and Urey's experiment to test the origin of organic compounds. *[2]*

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D3. (a) Outline Lamarck´s theory of evolution. *[2]*

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(b) Explain how the pentadactyl limb provides evidence for evolution. *[3]*

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Option E — Neurobiology and Behaviour

E1. An experiment tested the ability to trigger operant behaviour in rats. Rats were placed in front of a black Skinner box with a window through which they could observe an object fixed on a slowly rotating platform. The platform was divided into four equal sectors labelled A to D. Rats were rewarded with food if they pressed the lever when the object was within the reward sector. The number of times the rats pressed the lever in each sector was recorded.

The graph below shows the distribution of responses before and after 30 training sessions. Each dot represents the pressing of the lever five times. Before training the lever was pressed 455 times, while after training it was pressed a total of 240 times.

* = position of rat

direction of rotation of the platform

before training   after 30 training sessions
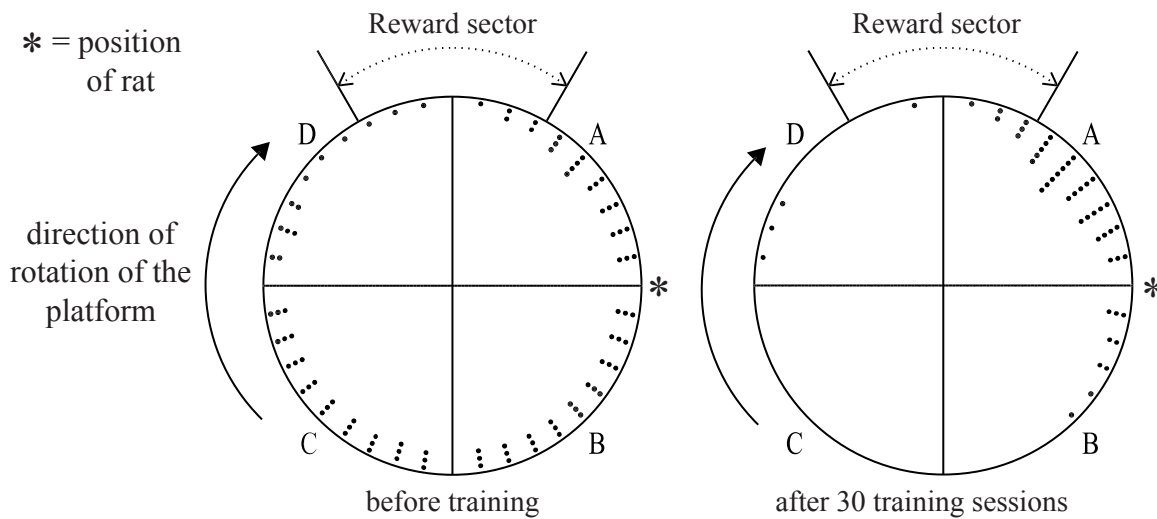
[modified from E Pastalkova *et al*, *Proceedings of the National Academy of Sciences*, (2000), **100**, page 2094, copyright 2000, National Academy of Sciences, USA.]

(a) State the sector where the lever was pressed the most by the rat after 30 training sessions. *[1]*

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(b) Compare the trend shown before and after training. *[2]*

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(This question continues on the following page)

(Question E1 continued)

(c) Calculate the proportion of the total responses (pressing of lever) in sector B **after training**.   *[1]*

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        ....

(d) Explain how operant conditioning could have affected the rat's behaviour in this experiment.   *[3]*

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(e) Suggest a reason for the low number of responses in the reward sector after training.   *[1]*

        ....
        ....

E2. Bees show social behaviour.

(a) State **two** other examples of animals which show social behaviour. *[1]*

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(b) Explain what would happen if all the drones in a bee colony were killed. *[3]*

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E3. (a) Complete the table to distinguish between rods and cones.   *[2]*

	Rod	**Cone**
Intensity of light needed		
Number of cells connected to one neurone of optic nerve		

(b) In the pain withdrawal reflex, if a hand is hurt, it is withdrawn automatically. Complete the pathway taken by the impulse.   *[1]*

pain receptor in skin receives stimulus (pain)

↓

passed to sensory neurone

↓

received by I. . . . . in grey matter

↓

motor neurone to II. . . . .

↓

hand withdrawn
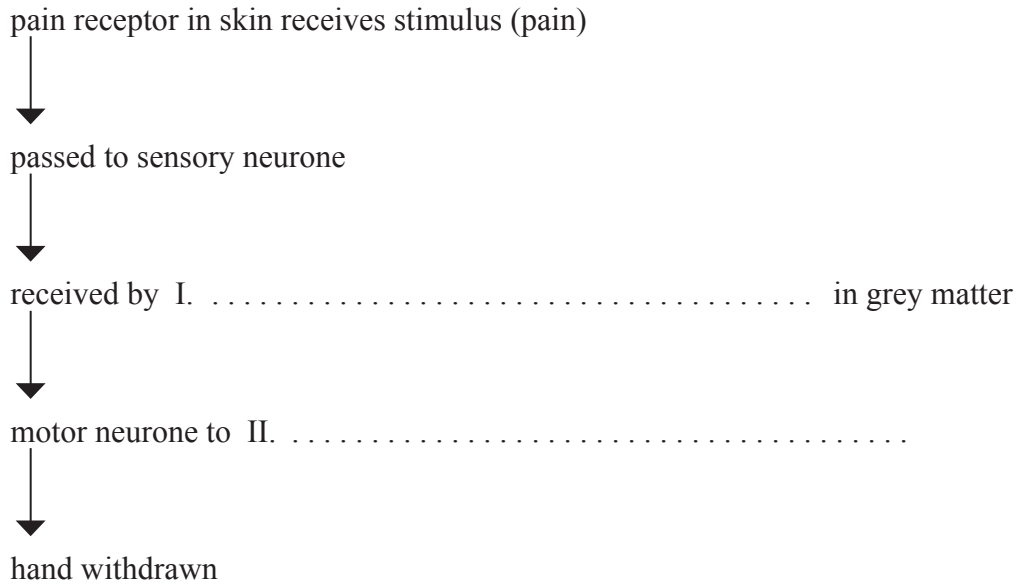
(c) Describe **one** example of migration either in birds or in mammals (other than humans).   *[3]*

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Option F — Applied Plant and Animal Science

F1.   From 1968 to 1990 the yield of six rice varieties was monitored. One of the varieties is IR8, the first widely grown modern rice variety in Asia. In the scattergram the other data (highest yield cultivar) represents the best yield amongst the other five varieties for that year.
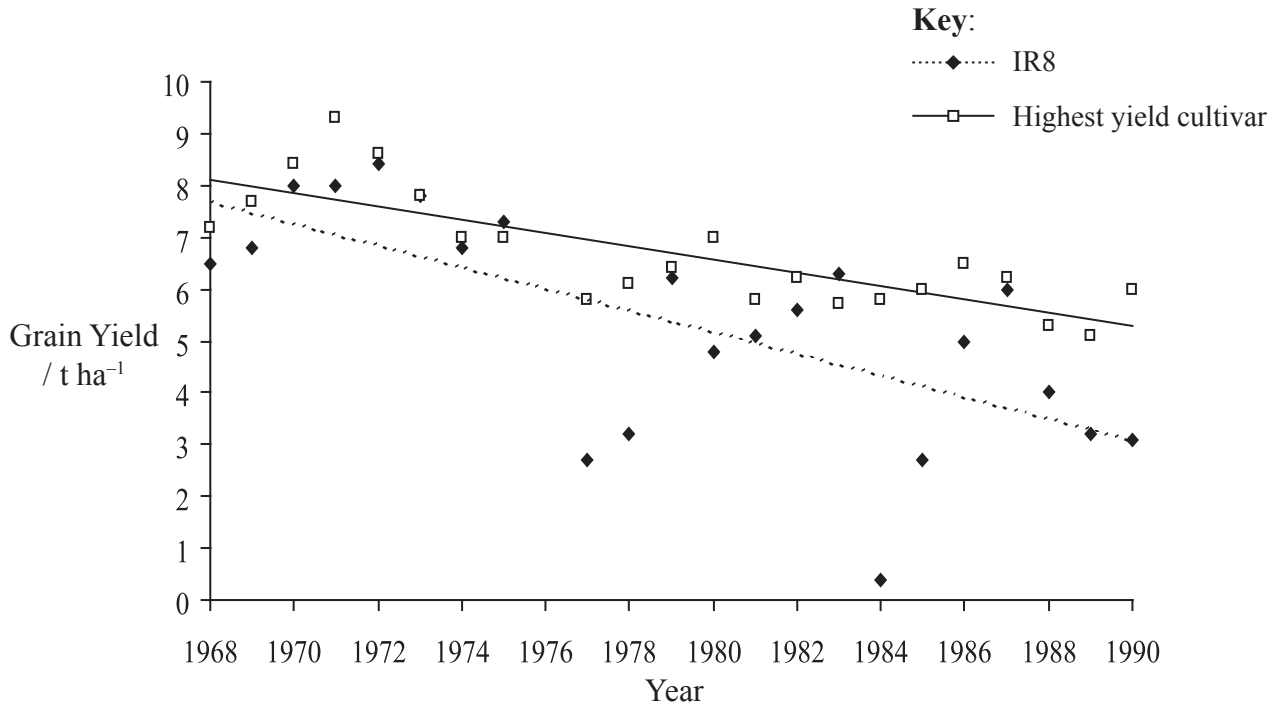
[Agricultural Sustainability in Economic and Statistical Considerations, Cassman *et al*, Copyright 1995.©John Wiley & Sons Limited. Reproduced by permission]

(a)   State the maximum yield of IR8.   *[1]*

....

(b)   Calculate the difference in yield of IR8 and the highest yield cultivar in 1990. Show your working.   *[2]*

....

(c)   Compare the yields of IR8 and highest yield cultivar throughout the last 20 years.   *[2]*

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(This question continues on the following page)

Turn over

(Question F1 continued)

(d) The graph shows lines which do not pass through all the points. Explain how these lines are plotted and describe what they are used for. *[3]*

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F2. (a) Outline how **one** animal breeding programme has led to improvement in yield. *[2]*

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(b) Define the term *outbreeding* giving an example. *[2]*

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(c) Explain how artificial insemination can affect the fecundity of animals. *[3]*

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(Question F1 continued)

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F3. Explain the effect of each of the following hormones at different stages in the micropropagation of plants. *[3]*

Auxin: . . . .

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Gibberellin:. . . . .

. . . .

Cytokinin: . . . .

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Option G — Ecology and Conservation

G1. Copepods are very small crustaceans and an important component of plankton in the Arctic sea ice. The distribution of copepods, which feed on microalgae, can be related to the food and predators. The biomass of microalgae was measured and the concentration of chlorophyll *a* was calculated. The graphs below show how the concentration of chlorophyll *a* and copepods change with depth.
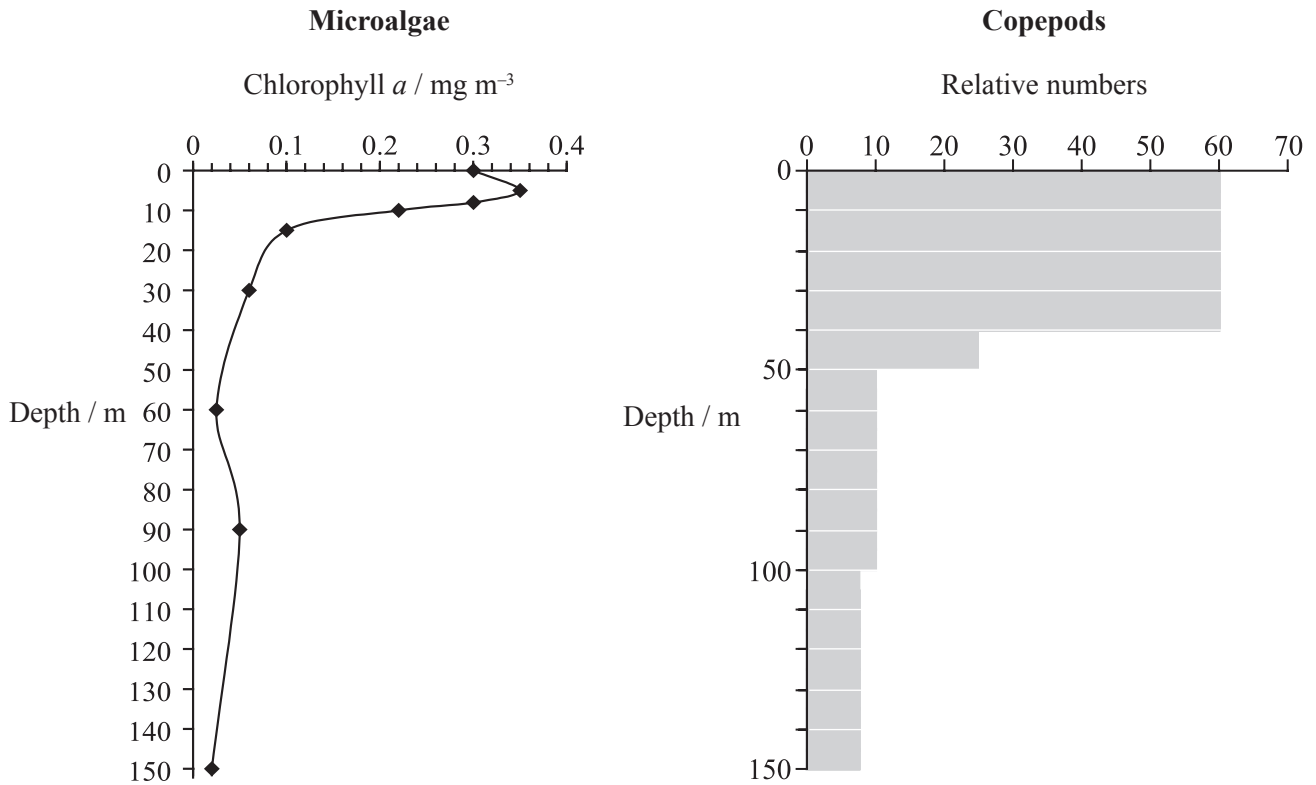
[Fortier *et al*, Journal of Plankton Research, (2001), **23**, page 1263 by permission of Oxford University Press.]

(a)   State the amount at a depth of 30 m below sea level of   *[2]*

(i)   chlorophyll *a*.

. . . .

(ii)   copepods.

. . . .

(This question continues on the following page)

Turn over

(Question G1 continued)

   (b)   Describe the distribution of microalgae. *[2]*

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   (c)   Discuss factors that could affect the distribution of copepods. *[3]*

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G2. (a) (i)   Define the term *mutualism*. *[1]*

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         (ii)   State the name of **two** organisms which present a mutualistic relationship. *[1]*

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   (b)   Explain the principle of competitive exclusion. *[3]*

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