INTERNATIONAL BACCALAUREATE
BACCALAURÉAT INTERNATIONAL
BACHILLERATO INTERNACIONAL

N01/410/S(3) A

**BIOLOGY**
**STANDARD LEVEL**
**PAPER 3**

Tuesday 6 November 2001 (morning)

1 hour 15 minutes

Name

Number

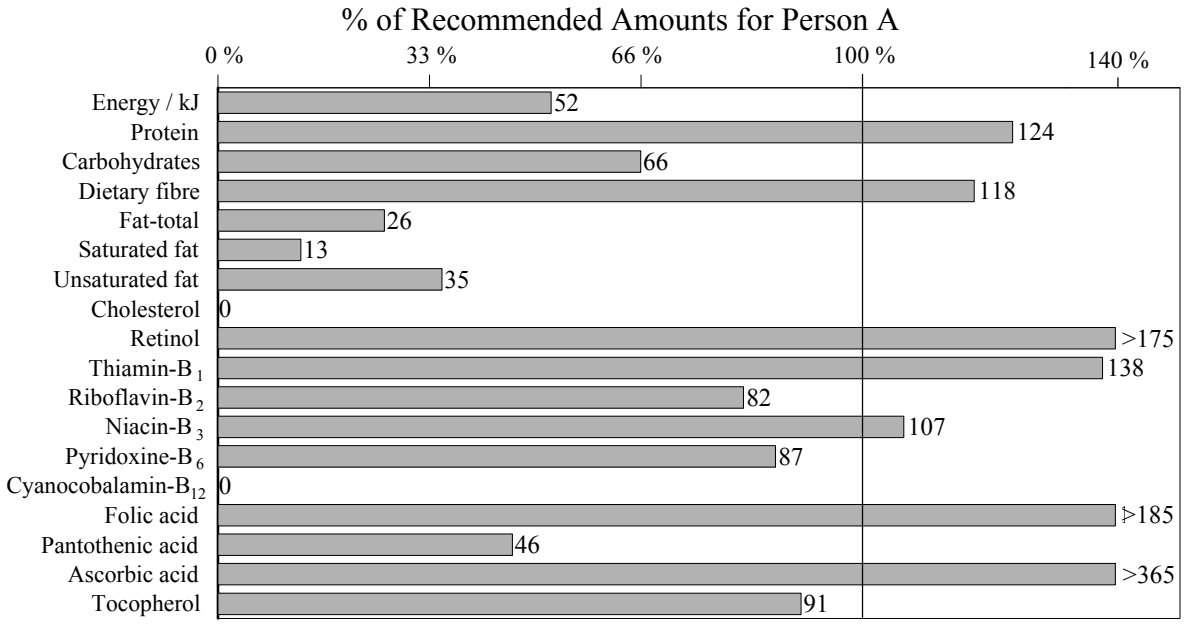
INSTRUCTIONS TO CANDIDATES

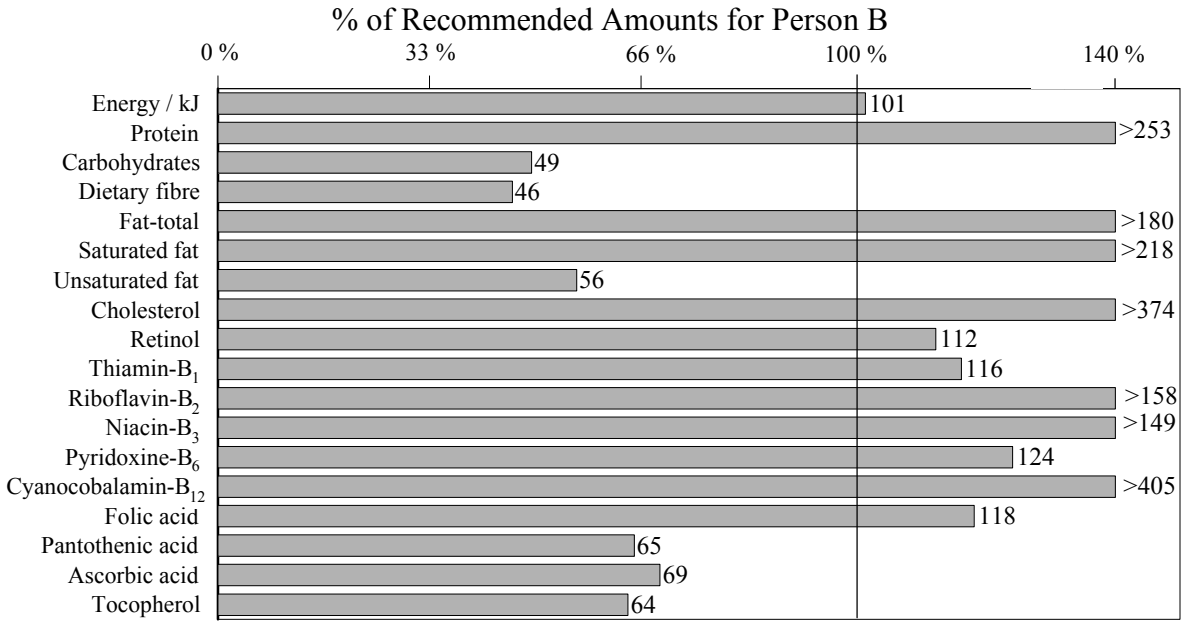
- Write your candidate name and number in the boxes above.
- Do not open this examination paper until instructed to do so.
- Answer all of the questions from three of the Options in the spaces provided. You may continue your answers in a continuation answer booklet, and indicate the number of booklets 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.** The data below shows the analysis of the food intake of two 16 year old females of similar size and activity. Person A is a vegetarian, person B consumes a mixed diet.




[Source: *The Food Processor II*, ESHA Research, 1988]

(a) State **two** deficiencies in the diet of person A. *[1]*

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*(This question continues on the following page)*

*(Question A1 continued)*

(b) Compare the analysis of diet A and diet B. *[3]*

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(c) Suggest **one** consequence of each diet. *[2]*

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**A2.** (a) Lipid is an important constituent of a balanced diet. State **two** functions of lipid. *[1]*

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(b) According to the label on a jar of peanut butter, two spoonfuls of peanut butter contain 16 g of lipid. This represents 24 % of the daily recommended intake of lipid. Based on this information, calculate the mass of lipid an average person should consume per day. *[1]*

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(c) Discuss the significance of diets which are rich in lipid. *[3]*

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(d) State **one** function for each of the lipid-soluble vitamins retinol and tocopherol. *[1]*

Retinol: . . . . . .

Tocopherol: . . . . . .

**A3.** Outline the importance of hygienic methods of food handling and preparation. *[3]*

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**Option B – Physiology of exercise**

**B1.** The following table shows the energy sources used for muscle contraction for a 70 kg person having a muscle mass of 28 kg.

| Energy Source | Rate of ATP Use / mmol $s^{-1}$ | Total ATP Available / mmol |
|---|---|---|
| Muscle ATP | — | 223 |
| Creatine phosphate | 74 | 446 |
| Muscle glycogen to lactate | 39 | 6,700 |
| Muscle glycogen to $CO_2$ | 17 | 84,000 |
| Liver glycogen to $CO_2$ | 6 | 19,000 |
| Adipose tissue fatty acids to $CO_2$ | 7 | 4,000,000 |

[Source: Stryer, L. *Biochemistry*, W H Freeman & Co, 1997, page 778]

(a) Calculate the amount of time creatine phosphate could be used as an ATP source in muscle. *[1]*

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(b) Explain the rate of ATP use when glycogen is converted to lactate instead of $CO_2$. *[2]*

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(c) Explain how the different energy sources are used to complete a marathon run that lasts over two hours. *[2]*

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**B2.** (a) Explain the need for warm-up and cool-down routines. *[2]*

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(b) When athletes such as soccer (football) players train certain principles are applied, including *specificity* and *progressive overload*. Outline what is meant by each of these terms. *[2]*

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**B3.** (a) In soccer players, movement at the hip and knee joints is particularly important. Compare the movement at each of these joints. *[3]*

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(b) State the type of neurone which stimulates the muscles responsible for movement at the knee and hip joints. *[1]*

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(c) Outline **three** events involving the neurotransmitter in synaptic transmission. *[2]*

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**Option C – Cells and energy**

**C1.** The efficiency of photosynthesis can be stated as (i) the energy required to fix one molecule of $CO_2$ and (ii) the ratio of the amount of water transpired to the amount of $CO_2$ fixed during photosynthesis. The following table compares $C_3$, $C_4$ and CAM plants.

| Plant Type | $C_3$ | $C_4$ | CAM |
|---|---|---|---|
| Energy required (ATP utilised : $CO_2$ fixed) | 3 : 1 | 5 : 1 | 6.5 : 1 |
| Transpiration ratio (mol $H_2O$ : mol ( $CO_2$) | 700 : 1 | 300 : 1 | 70 : 1 |

[Source: Salisbury and Ross, *Plant Physiology* (4th edition), Wadsworth Co, 1992, page 257]

(a) Compare the amount of energy required to fix one molecule of $CO_2$ by the **three** types of plant. *[2]*

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(b) Using the data provided, explain the adaptive significance of the **three** types of plant. *[4]*

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**C2.** (a) State the structure which transports glycoproteins from the Golgi apparatus to the cell surface. *[1]*

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(b) Outline the 'induced fit' model for enzyme activity. *[2]*

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(c) Explain how a non-competitive inhibitor reduces enzyme activity. *[2]*

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**C3.** Explain the roles of ATP and ribulose bisphosphate (RuBP) carboxylase in the light-independent reactions of photosynthesis. *[4]*

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## Option D – Evolution

**D1.** The beta-chain of the human haemoglobin molecule is 146 amino acids long. The sequence of amino acids in the beta-chain of other animal species varies, but there is also much similarity in the sequences.

The table below indicates the amino acids found at specific locations in the beta-chains of haemoglobin in four animal species.

**Comparison of the Haemoglobin Beta-chain in Four Species**

| | Common Name of Species | | | |
|---|---|---|---|---|
| Amino acid Position | Human | Gibbon | Monkey | Unidentified Animal |
| 1 | VAL | VAL | VAL | VAL |
| 5 | PRO | PRO | GLY | GLY |
| 6 | GLU | GLU | ASP | GLU |
| 8 | LYS | LYS | LYS | LYS |
| 9 | SER | SER | ALA | ALA |
| 12 | THR | THR | ALA | LEU |
| 16 | GLY | GLY | GLY | ASP |
| 21 | ASP | ASP | GLU | GLU |
| 43 | GLU | GLU | GLU | ASP |
| 52 | ASP | ASP | ASP | GLY |
| 113 | VAL | VAL | VAL | VAL |
| 121 | GLU | GLU | GLU | ASP |
| 125 | PRO | GLN | GLN | GLU |
| 130 | TYR | TYR | TYR | TYR |

[Source: Biology Lab, Dumas]

(a) Using this data, *[1]*

(i) state the animal that is least closely related to humans.

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(ii) state the **two** animals that are most closely related to each other. *[1]*

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*(This question continues on the following page)*

*(Question D1 continued)*

(b) Based on the data provided, deduce whether the unidentified species is a member of the same genus as humans *(Homo)*. *[2]*

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(c) Explain how variations in a specific protein such as haemoglobin can indicate phylogeny. *[2]*

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**D2.** (a) Outline the hypothesis that the first catalysts involved in polymerisation reactions were clay minerals. *[2]*

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(b) State **two** characteristics of mitochondria which support the idea that they were once independent prokaryotes. *[2]*

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*(This question continues on the following page)*

*(Question D2 continued)*

(c) Outline the evidence for natural selection involving predation by birds of the peppered moth (*Biston betularia*). *[2]*

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**D3.** Discuss the anatomical evidence which suggests that humans are a bipedal species of African ape. *[3]*

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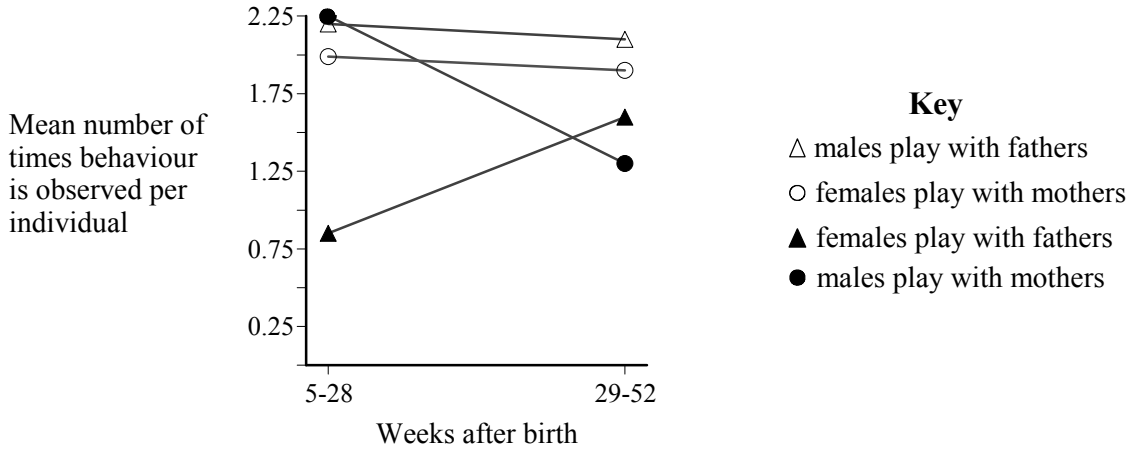
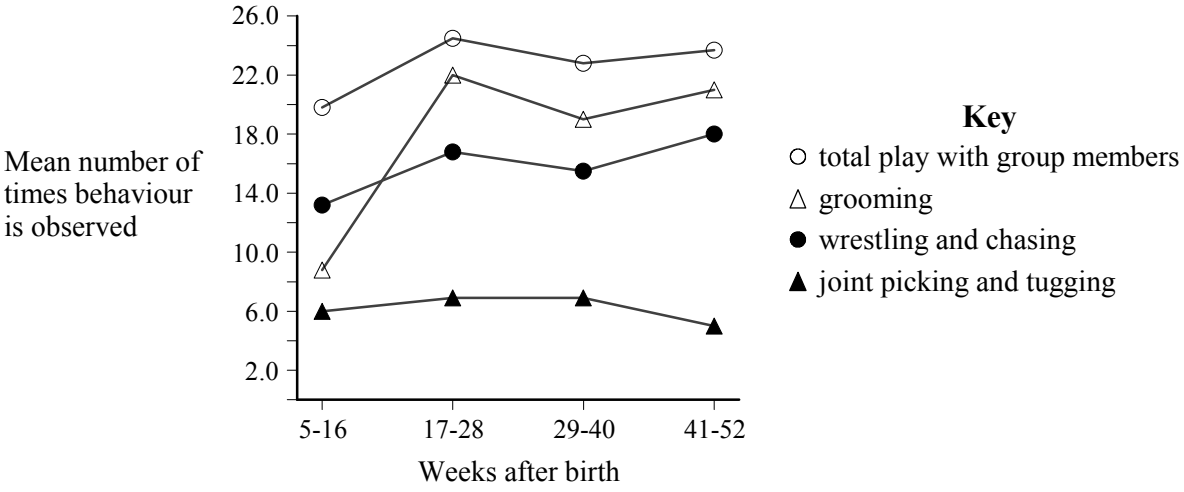
## Option E – Neurobiology and behaviour

**E1.** Lion tamarins, *Leontopithecus rosalia*, are primates that live in lowland forests of south-eastern Brazil. Their hands and digits are extremely long. The tamarins use these long digits for probing and picking as they investigate new objects. Investigatory behaviour is social, so that two or more animals in a family group might jointly examine an object. The social development of lion tamarins includes grooming and interactive play behaviour with other group members such as chasing and wrestling. In a study of a captive group of six males and five females, the following data were collected in four 12-week blocks during the first year of life.




[Source: Mittermeier *et al*, *Ecology and Behaviour of Neotropical Primates*, (1988), **2**, pages 299-319]

(a) Outline the play behaviour of *L. rosalia* males and females with their mothers and fathers. *[3]*

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*(This question continues on the following page)*

*(Question E1 continued)*

(b) Calculate the percentage of total play that is wrestling and chasing during weeks 41 to 52. *[1]*

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(c) Compare changes in the frequency of grooming activities with the frequency of other activities. *[2]*

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**E2.** (a) (i) Hair cells in the inner ear are involved in balance and hearing. State what type of sensory receptor a hair cell is. *[1]*

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(ii) State **two** other types of sensory receptors. *[1]*

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(b) Explain how phototaxis improves an organism's chances of survival. *[2]*

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**E3.** (a) Outline an example of imprinting in a vertebrate animal. *[2]*

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(b) Discuss the role of altruistic behaviour in a social organisation with reference to a named example. *[3]*

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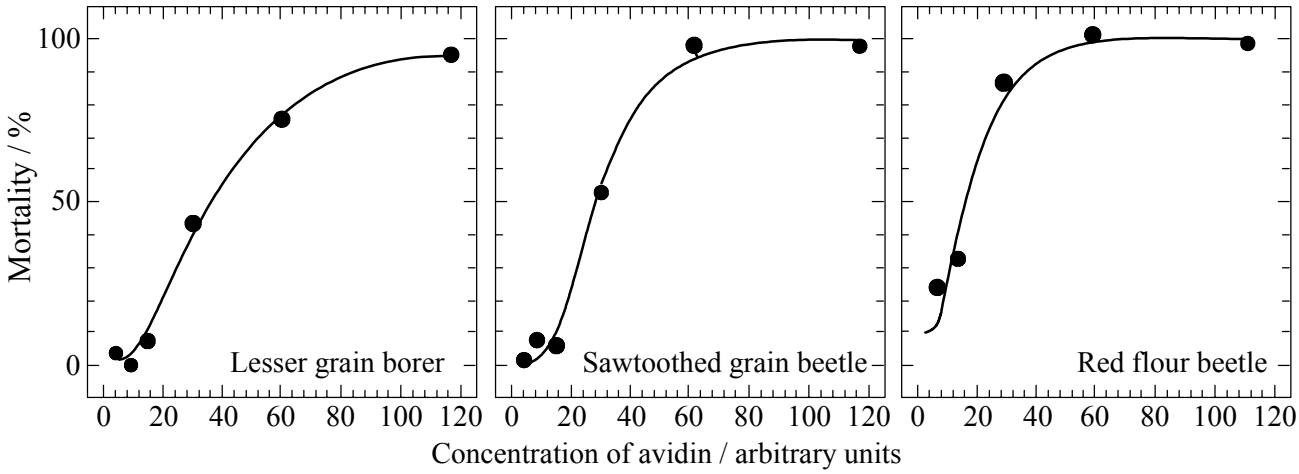
**Option F – Applied plant and animal science**

**F1.** Avidin is a glycoprotein found in chicken eggs and has been incorporated into genetically modified corn. Avidin in the corn binds to biotin which is an important vitamin required by insects. Because of this property, avidin was investigated as a possible insecticide. The data below shows the effect of avidin on the lesser grain borer *(Rhyzopertha dominica)*, the sawtoothed grain beetle *(Oryzaephilus surinamensis)* and the red flour beetle *(Tribolium castaneum)*, all of which consume stored corn.




[Source: Kramer *et al*, *Nature Biotechnology*, (2000), **18**, pages 670-674]

(a) Identify which species was most effectively controlled at a concentration of 20 units of avidin. *[1]*

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(b) State the concentration of avidin needed to cause 50 % mortality in the lesser grain borer. *[1]*

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(c) State the minimum concentration of avidin required to kill at least 75 % of all **three** species. *[1]*

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(d) Suggest **two** reasons for the different responses by the three species to avidin. *[2]*

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**F2.** (a) Explain **three** ways that international collaboration could help to solve the world food problem. *[3]*

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(b) Outline **two** methods that scientists can use to measure plant productivity. *[2]*

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(c) Explain how our knowledge of genetics has led to an improvement in the yield of wheat crops. *[2]*

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**F3.** Outline how people have used selection in the domestication of animals to produce breeds more suitable for human use. *[3]*

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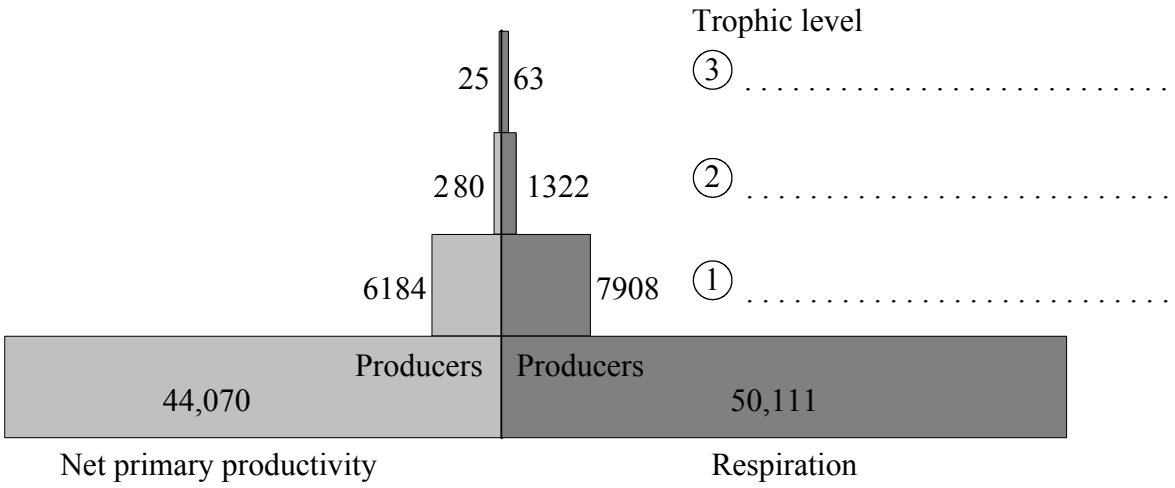
**Option G – Ecology and conservation**

**G1.** The following is a pyramid of energy for a river ecosystem, showing net primary productivity and respiration. Measurements are in kilojoules per square meter per year ($kJ\ m^{-2}y^{-1}$).




[Source: Raven *et al, Environment*, Saunders College Publishing, 1993, page 55]

(a) Label the trophic levels marked ①, ②, ③ on the diagram. *[1]*

(b) Calculate gross production for the producers. *[1]*

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(c) Explain the amount of net primary production transferred at each stage from the producers to the top of the pyramid and how this compares to the theoretical value. *[3]*

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**G2.** (a) Describe how the abiotic factors of both temperature and water may affect plant distribution. *[4]*

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(b) The Venus fly trap, *Dionaea muscipula*, is a plant which photosynthesises. It also captures and digests insects in order to obtain additional nitrogen. Discuss difficulties in assigning the Venus fly trap to one trophic level. *[2]*

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**G3.** (a) Outline **two** advantages in conserving endangered species *in situ*. *[2]*

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(b) During the last 100 years alien species have invaded ecosystems more frequently. Suggest **two** reasons why alien species have spread more readily during the last 100 years. *[2]*

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