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

M06/4/BIOLO/HP3/ENG/TZ2/XX+

22066015

BIOLOGY
HIGHER LEVEL
PAPER 3

Friday 5 May 2006 (morning)

1 hour 15 minutes

Candidate session number

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INSTRUCTIONS TO CANDIDATES

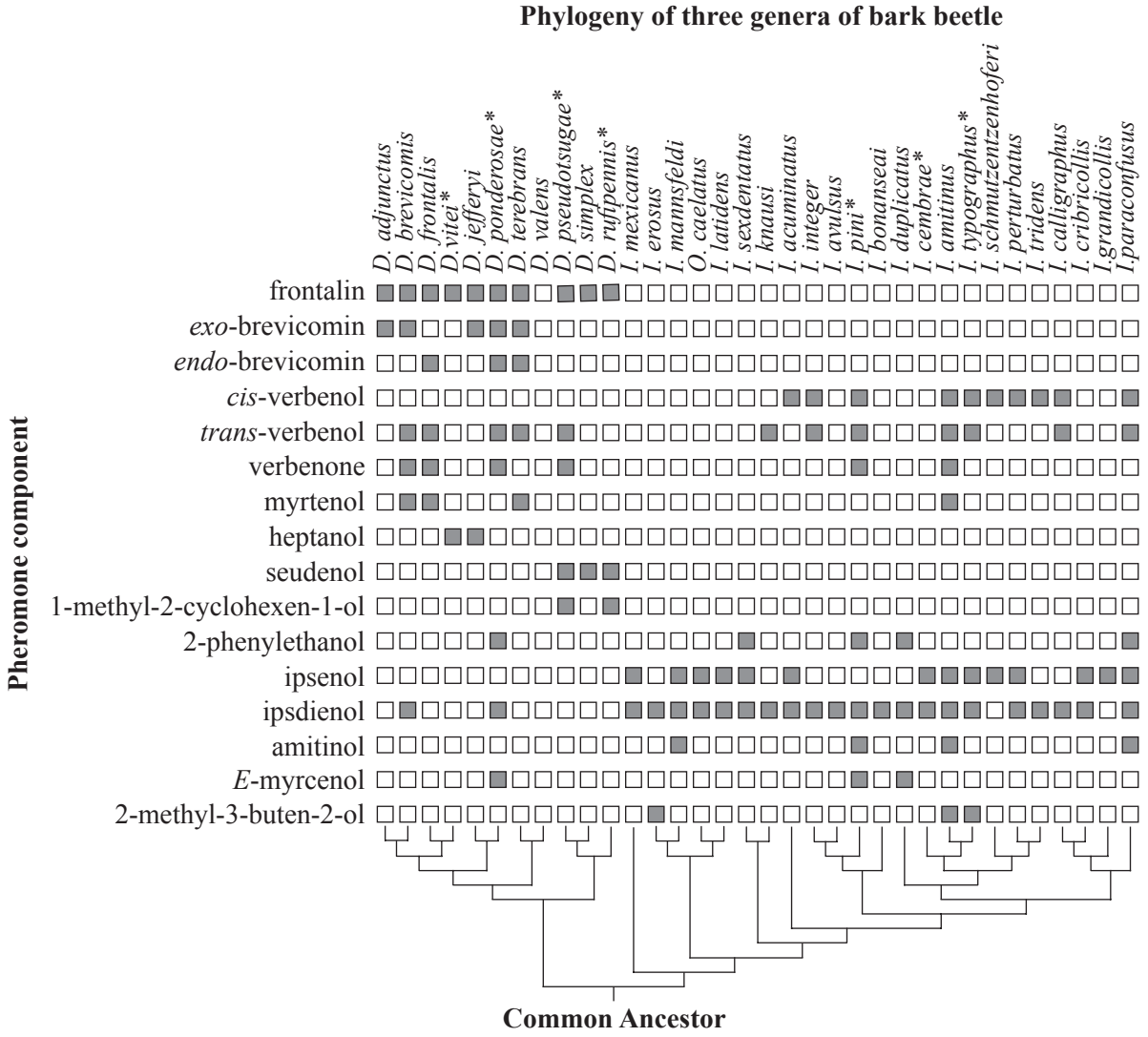
- Write your session number in the boxes above.
- Do not open this examination paper until instructed to do so.
- Answer all of the questions from two of the Options in the spaces provided. You may continue your answers on answer sheets. Write your session number on each answer sheet, and attach them to this examination paper and your cover sheet 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.

0120

Option D — Evolution

D1. Many organisms use pheromones (chemical signals) to communicate with each other. These pheromones are unique mixtures of chemicals that are typically species-specific. The way in which different species' pheromones have evolved has caused debate among investigators. Some scientists believe that gradual evolution (gradualism) of pheromones has occurred while others believe that pheromone evolution occurs through sudden major shifts (punctuated equilibrium).

The pheromone components of 34 species of bark beetle from three genera, *Dendroctonus, Ips* and *Orthotomicus* were analysed. The data below compares the distribution of pheromone components to an established phylogeny for three genera.



Key: ■ = component present
□ = component absent
* = species that have additional chemical components that are unique to them (not listed)

[Source: Symonds and Elgar, *Proceedings of Royal Society London B*, (2004), **271**, pp 839–846 The Royal Society]

(This question continues on the following page)

(Question D1 continued)

(a) List the **two** most common pheromone components of bark beetles. *[1]*

1. . . . . .

2. . . . . .

(b) Analyse how the pheromone components of *D. pseudotsugae*, *D. simplex*, and *D. rufipennis* illustrate a close phylogenetic relationship. *[3]*

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(c) Adjacent species connected with a bracket (⌊⌋) show the closest evolutionary relationship. Deduce whether adjacent species of *Dendroctonus* show gradual change **or** sudden major shifts in pheromone evolution. *[2]*

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D2. (a) State **two** conditions that existed on pre-biotic Earth. *[1]*

1. . . . . .

2. . . . . .

(b) Outline **one** example of how the beak size of Galapagos finches shows an adaptation to a specific diet. *[1]*

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(c) In a population where allele "A" is completely dominant to allele "a", calculate the frequency of both phenotypes if the frequency of allele "A" is 0.8. *[2]*

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D3. (a) Distinguish between gene mutations and chromosomal mutations with a named example of each. *[4]*

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(b) (i) Define the term *species*. *[1]*

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(ii) Discuss the process of speciation. *[5]*

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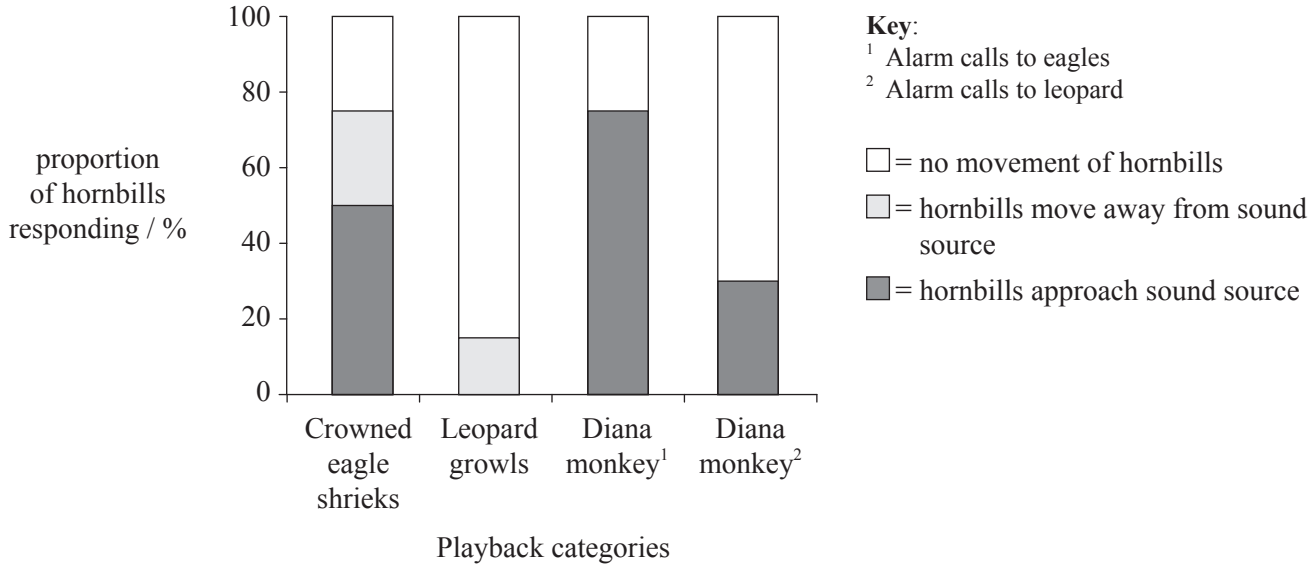
Option E — Neurobiology and Behaviour

E1. In West African forests, the animal community includes Diana monkeys (*Cercopithecus diana*), crowned eagles (*Stephanoaetus coronatus*), leopards (*Panthera pardus*), and large birds called yellow-casqued hornbills (*Ceratogymna elata*). Crowned eagles prey on both Diana monkeys and hornbills, leopards prey only on Diana monkeys. The crowned eagles and leopards use surprise during an attack. An appropriate response to predators using surprise tactics is an alarm call. Diana monkeys produce one alarm call for crowned eagles and a different alarm call for leopards. Hornbills often feed in the same trees as Diana monkeys and hear their calls. Sounds made by predators and prey were recorded and played back to hornbills. The hornbill responses are shown in the bar chart below.



[Source: Rainey, Zuberbühler & Slater, *Proceedings of Royal Society London B*, (2004), **271**, pp 755–759 The Royal Society]

(a) Identify the playback sound which produced the most varied behavioural response in hornbills. *[1]*

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(This question continues on the following page)

(Question E1 continued)

(b) (i) Compare the behavioural response of hornbills to crowned eagle shrieks **and** to leopard growls. *[2]*

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(ii) Suggest a reason for the most common response of hornbills to the shriek of a crowned eagle. *[1]*

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(c) Evaluate the importance of Diana monkey alarm calls to hornbills while both are feeding in trees. *[3]*

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E2. (a) List **two** classes of human sensory receptors. *[1]*

1. . . . . .

2. . . . . .

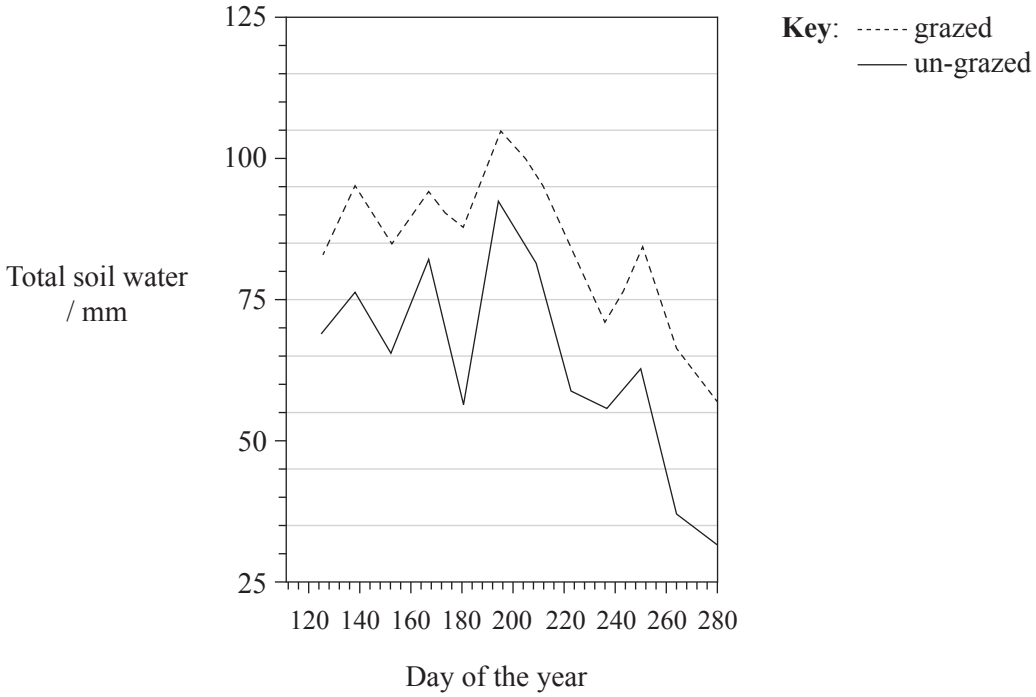
(b) Draw the gross structure of the brain. *[2]*

E3. (a) Outline the social organization of honey bee colonies. *[3]*

(b) Explain the process of synaptic transmission. *[7]*

Option F — Applied Plant and Animal Science

F1. A study was conducted on how cattle grazing affects the water content of soils. One area studied was a pasture of alfalfa (*Medicago sativa*). A special probe was used to take measurements of soil water to depths of 300 mm. The range of measurements obtained were used to calculate the total soil water content expressed in mm. Results from part of the study during the growing season for the year 2000 are shown below.



[Source: Mapfumo *et al.*, *Canadian Journal of Soil Science*, (2003), **83**, pp 601–614]

(a) State the overall trend in total soil water content during the study period. *[1]*

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(b) Identify the day on which the difference in total soil water content of grazed and un-grazed areas was greatest. *[1]*

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(This question continues on the following page)

(Question F1 continued)

(c) Discuss the effects of grazing on the total soil water content. *[4]*

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F2. (a) Compare the control of flowering in a long-day plant with the flowering of a short-day plant. *[2]*

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(b) Outline **two** commercial uses of plant growth regulators. *[2]*

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F3. (a) Discuss both advantages and disadvantages of intensive livestock rearing techniques. *[6]*

(b) Outline the need to maintain the biodiversity of wild plants. *[4]*

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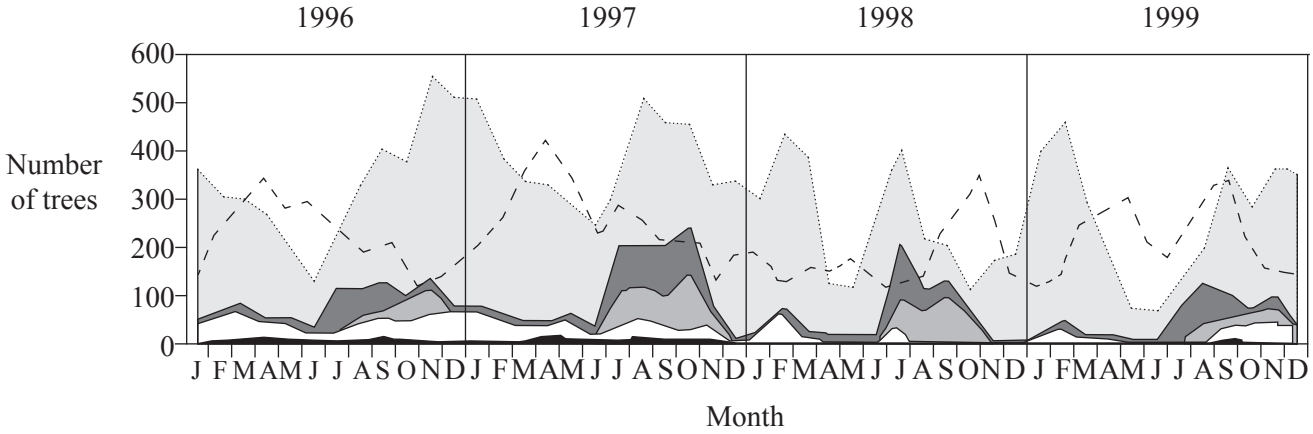
Option G — Ecology and Conservation

G1. The relationship between climatic factors with plant flowering and fruiting was recently investigated in the rainforests of the Philippines. In that tropical region important climatic factors include the amount of rainfall and sunlight. Typhoons (massive storms with powerful winds and torrential rainfall) occur between July and November. Solar radiation reaches a maximum in April and September. The graph below shows the numbers of flowering trees (– – –) and fruiting trees (·····). The area under the dotted line shows the number of fruiting trees with each of five seed dispersal mechanisms.



Key: Seed dispersal mechanisms of fruiting trees

- bird dispersed
- dispersed by gravity
- wind dispersed
- fruit bat dispersed
- dispersed by other mammals

[Source: Hamann, *Journal of Ecology*, (2004), **92**, pp 24–31]

(a) Compare the flowering pattern with the fruiting pattern in 1996. *[2]*

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(b) Discuss the influence of solar radiation on flowering patterns during the four years. *[2]*

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(Question G1 continued)

(c) Explain the timing of seed dispersal by gravity and wind. *[2]*

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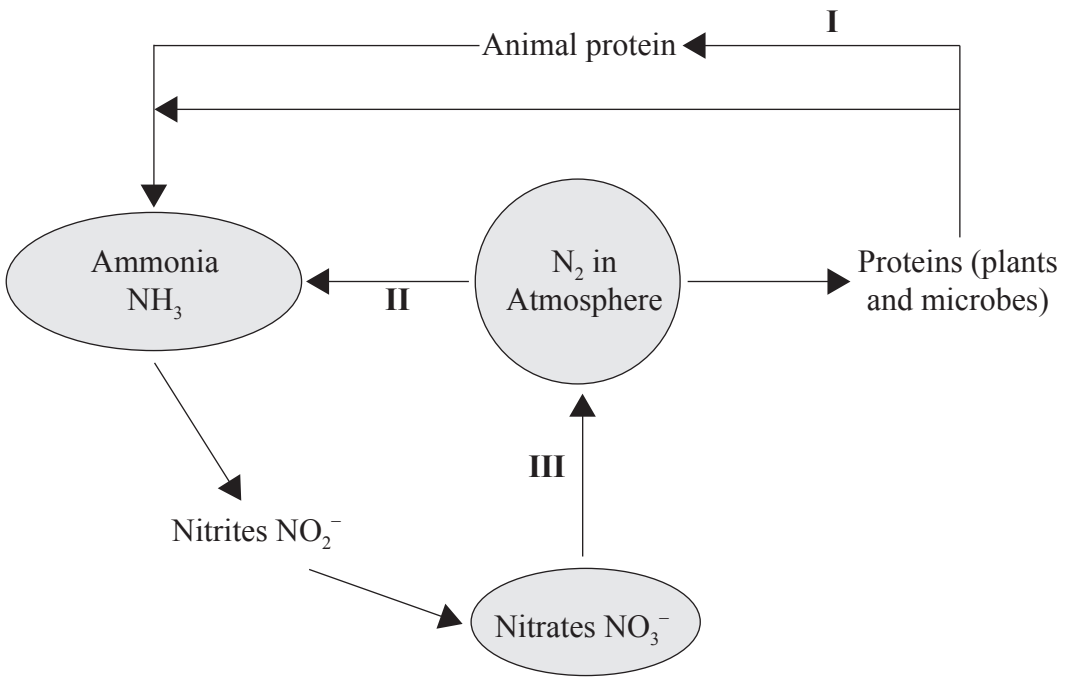
G2. (a) List **two** international measures that would promote the conservation of fish. *[1]*

1. . . . . .

2. . . . . .

(b) In the diagram of the nitrogen cycle below what processes are represented by I, II and III? *[3]*



I. . . . . .

II. . . . . .

III. . . . . .

G3. (a) Explain the methods being used to reduce ozone depletion. *[6]*

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(b) Using specific examples, outline how species can interact through

(i) herbivory. *[2]*

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(ii) mutalism. *[2]*

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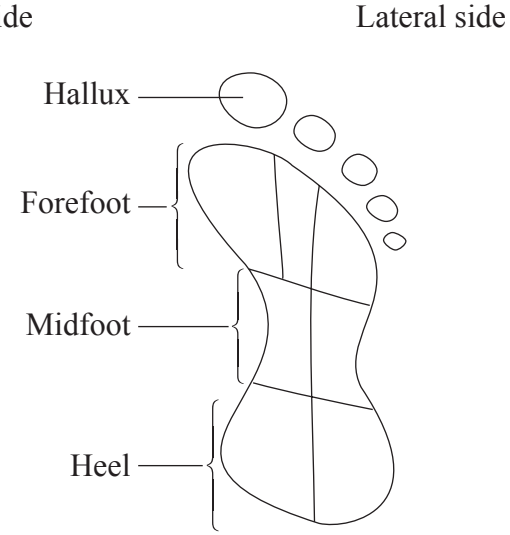
Option H — Further Human Physiology

H1. Stress fractures and other injuries to the knee and lower leg are common problems among soccer (football) players worldwide. The causes of these injuries might be related to various risk factors, including the soccer shoe itself. Development of soccer shoe designs that minimize injuries depend on knowledge about the amount of force acting on different regions of the sole of the foot. The regions are shown below.



The left side of the table below shows research data for peak pressures recorded during soccer-specific movements. The data corresponds to regions of the foot as listed in the centre of the table.

The right side shows research data for the distribution of forces in various regions of the foot during soccer-specific movements.

Peak pressure / kPa				Force / arbitrary units		
Run	**Sprint**	**Kick**	**Region on foot**	**Run**	**Sprint**	**Kick**
298	59	680	Medial heel	7.8	1.5	9.2
294	56	728	Lateral heel	8.8	1.8	13.7
140	57	271	Medial midfoot	2.4	0.5	2.7
191	95	374	Lateral midfoot	9.8	3.5	13.0
414	595	295	Medial forefoot	18.7	27.7	11.1
336	406	310	Central forefoot	15.6	19.2	11.5
293	295	403	Lateral forefoot	18.2	17.6	19.7
348	486	380	Hallux	9.6	14.7	8.8
187	253	264	Second toe	4.9	8.1	5.6
199	227	273	Lateral toes	4.1	5.4	4.7

[Source: Eils *et al*., *The American Journal of Sports Medicine*, (2004), **32**, pp 140–145, copyright 2004 by Sage Publications, Inc, Reprinted by permission of Sage Publications, Inc.]

(This question continues on the following page)

(Question H1 continued)

(a) (i) State which region on the forefoot experiences the greatest peak pressure during sprinting. *[1]*

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(ii) Calculate the percentage increase in peak pressure from running to kicking on the lateral heel. *[1]*

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(b) Deduce which region of the foot had the least variation in total force during soccer movements. *[1]*

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(c) Describe the changes in the distribution of forces on the foot when a soccer player starts to sprint. *[3]*

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H2. (a) Outline why cellulose remains undigested in the human alimentary canal. *[2]*

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(b) Explain **two** structural features that adapt an epithelial cell of a villus for food absorption. *[2]*

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