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

N05/4/BIOLO/HP3/ENG/TZ0/XX+

88056003

BIOLOGY
HIGHER LEVEL
PAPER 3

Friday 11 November 2005 (morning)

1 hour 15 minutes

Candidate session number

0	0							

INSTRUCTIONS TO CANDIDATES

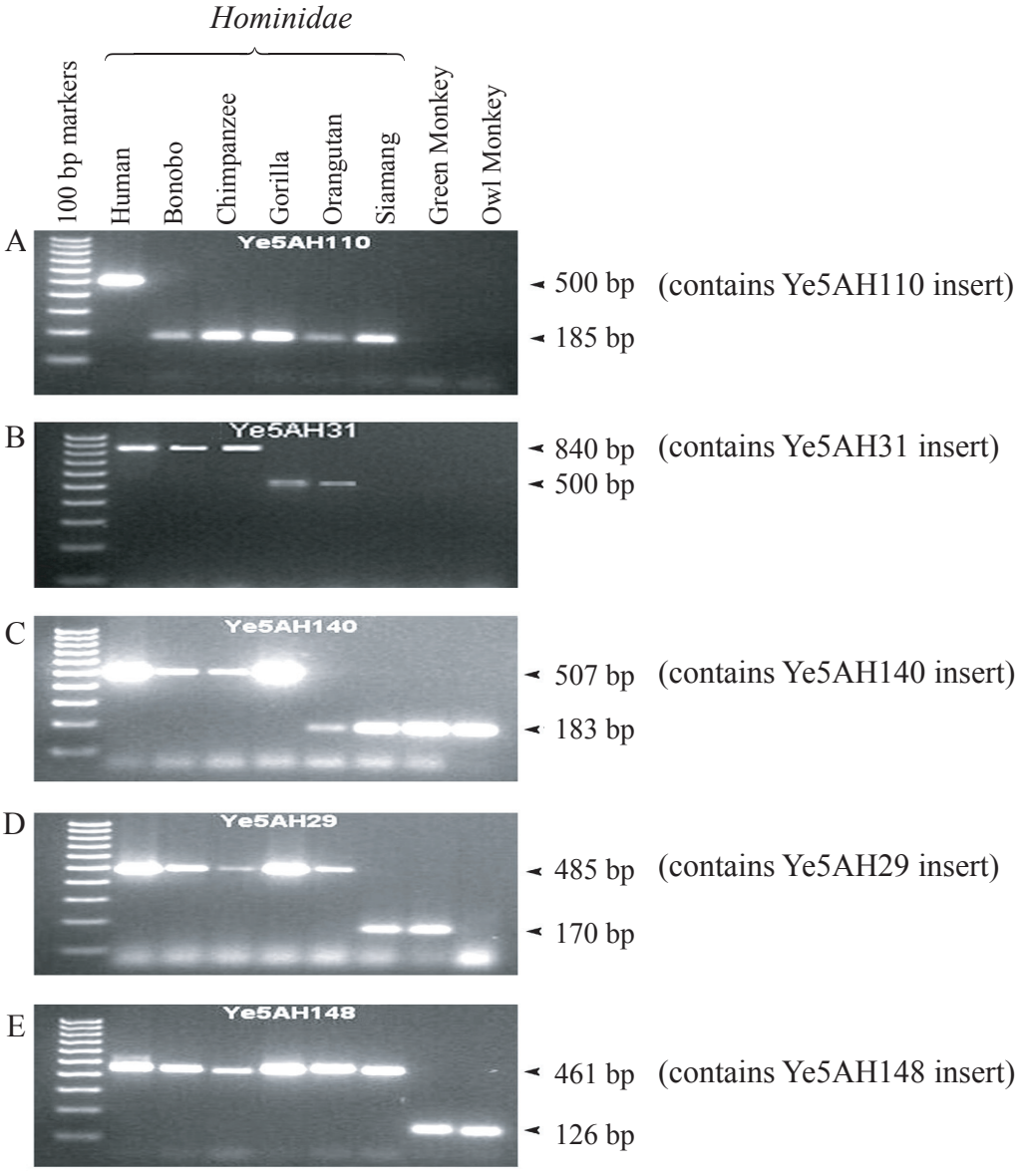
- Write your session number in the boxes above.
- Do not open this examination paper until instructed to do so.
- Answer all of the questions from two of the Options in the spaces provided. You may continue your answers on answer sheets. Write your session number on each answer sheet, and attach them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

Option D — Evolution

D1. Researchers often use short pieces of DNA called Alu sequences to study relationships within populations and between species. The function of these sequences is not known. However, they have the ability to copy themselves at random and insert into other parts of the genome, increasing the DNA fragment size. Alu sequences have inserted into the genome of primates throughout their evolution. One particular group of sequences (Ye) began inserting into the genome relatively early in the evolution of *Hominidae* and continues to insert itself at low rates.

The gel electrophoresis samples below were used to determine the phylogenetic origin of individual Ye5 sequences in primates. The larger DNA fragment in each case contains the Ye5 insert and the smaller fragments are the same region of DNA but without the insert. The green monkey and the owl monkey diverged from the *Hominidae* approximately 25 million years ago.

Key:
bp = base pairs



[Source: A H Salem *et al.*, *PNAS 100 (22)*, pages 12787–12791, copyright 2003 National Academy of Sciences, USA]

(This question continues on the following page)

(Question D1 continued)

(a) State which Alu insert is found in all of the *Hominidae* species but not in the other species. *[1]*

. . . . . .

(b) Calculate the size of the Ye5AH140 insert. *[1]*

. . . . . .

. . . . . .

(c) Identify, giving a reason, which insert has the most recent origin. *[2]*

. . . . . .

. . . . . .

. . . . . .

. . . . . .

(d) Analyse the data to determine whether bonobos are most closely related to chimpanzees or orangutans. *[2]*

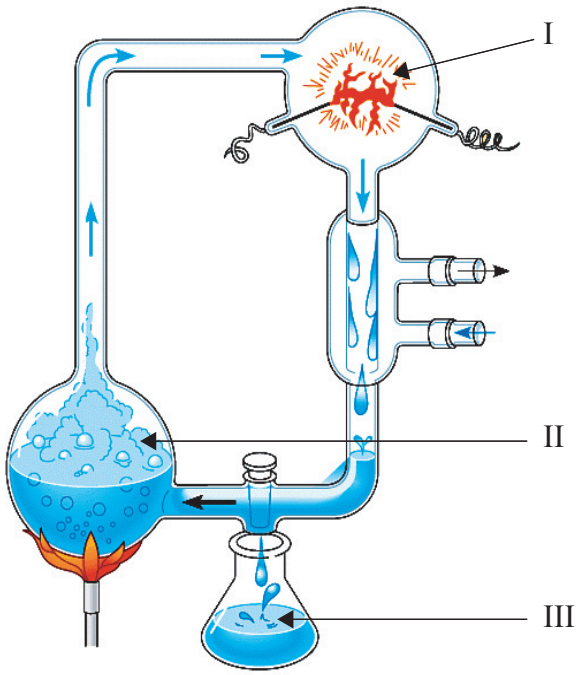
. . . . . .

. . . . . .

. . . . . .

. . . . . .

D2.



[Source: Campbell and Reece, *Biology*, 6th edition, (2003)]

(a) (i) The apparatus above was used in the Miller-Urey experiment. State what condition of pre-biotic Earth is simulated by I. *[1]*

. . . . . .

. . . . . .

(ii) State **two** substances used in II to simulate the early atmosphere of the Earth. *[1]*

1. . . . . .

2. . . . . .

(iii) Identify a compound (not RNA) isolated in III by Miller-Urey in this experiment. *[1]*

. . . . . .

(b) State **two** roles of RNA in pre-biotic Earth. *[1]*

. . . . . .

. . . . . .

. . . . . .

D3. (a) Discuss the process of speciation. *[7]*

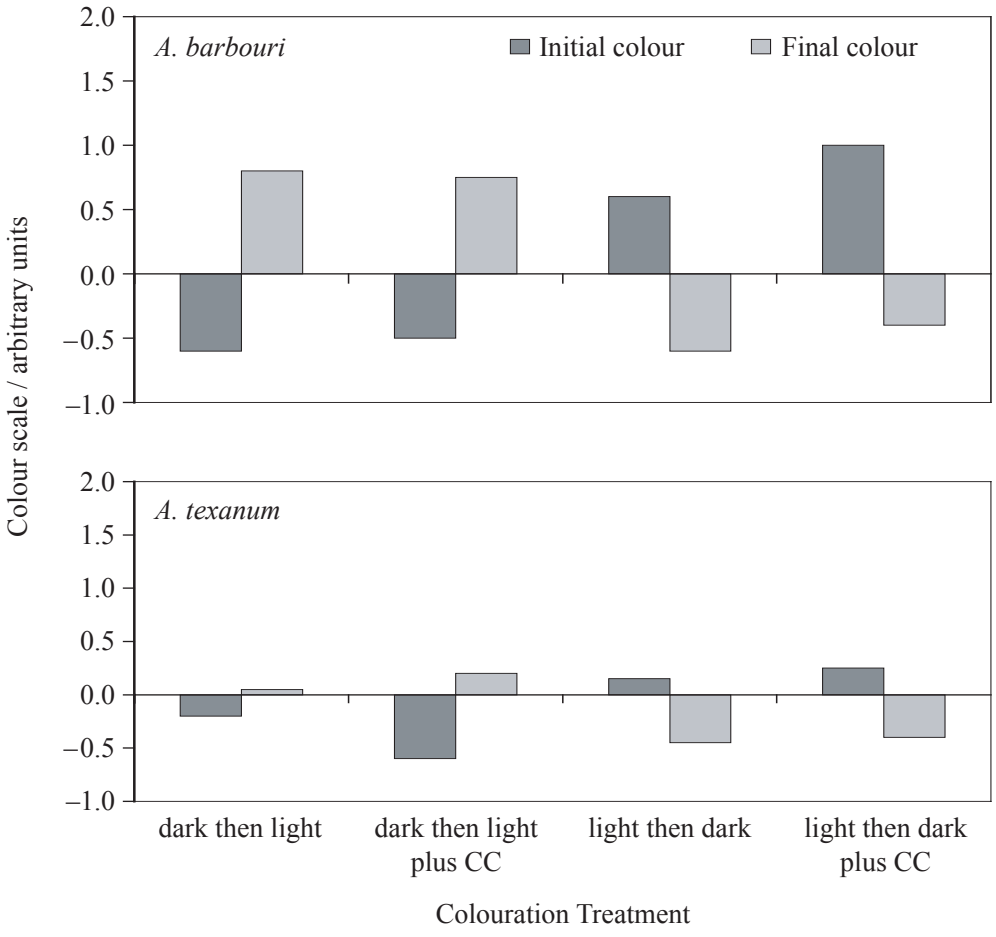
(b) Outline Lamarck's theory of evolution. *[3]*

Option E — Neurobiology and Behaviour

E1. Colouration is an important adaptive trait that can protect an organism from predators. Behaviour and colour change were studied in two larval amphibian species. *Ambystoma barbouri* is found in streams containing the predatory sunfish. *A. texanum* is found in temporary ponds and streams which lack the predator.

A. barbouri larvae are significantly darker than *A. texanum* larvae. This contrasts with the natural habitats of the species as *A. barbouri* is typically found in areas with light substrate and *A. texanum* live in ponds with dark substrate.

Experiments were performed to measure the amount of behavioural colour change due to predation risk. Larvae were initially kept on a dark or light background and then switched to the opposite background in the presence and absence of predator chemical cues (CC) which simulate the presence of a predator. The graphs below show the change from initial to final colour. Higher values indicate a lighter colour.



[Source: T S Garcia and A Sih, *Oecologia*, (2003), **137**, pages 131–139]

(This question continues on the following page)

(Question E1 continued)

(a) Identify the colouration treatment and species in which the greatest colour change was observed when the larvae were in the presence of chemical cues. *[1]*

. . . . . .

. . . . . .

(b) State the relationship between the background colour and the initial colour of the larvae. *[1]*

. . . . . .

. . . . . .

(c) Outline the effect of predator chemical cues (CC) on colour change when the larvae are initially on a dark background. *[2]*

. . . . . .

. . . . . .

. . . . . .

. . . . . .

(d) Suggest **one** behaviour that the larvae could use to avoid predation. *[1]*

. . . . . .

. . . . . .

(e) Research has indicated that *A. barbouri* evolved from *A. texanum* over 10 000 years ago when it moved from ponds into streams. Discuss how natural selection may have affected the colour change behaviour. *[2]*

. . . . . .

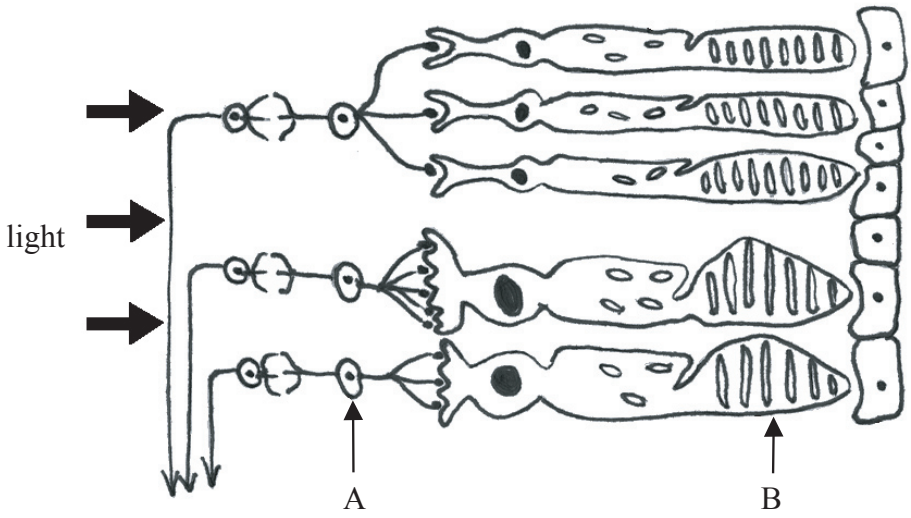
. . . . . .

. . . . . .

. . . . . .

. . . . . .

E2. (a) Label the following structures of the retina. *[1]*



A. . . . . .

B. . . . . .

(b) Outline how visual stimuli are processed. *[3]*

. . . . . .

. . . . . .

. . . . . .

. . . . . .

. . . . . .

. . . . . .

. . . . . .

E3. (a) Discuss the role of the autonomic nervous system in humans and its relationship with the conscious part of the brain. *[5]*

. . . . . .

. . . . . .

. . . . . .

. . . . . .

. . . . . .

. . . . . .

. . . . . .

. . . . . .

. . . . . .

. . . . . .

. . . . . .

(b) Outline the role of natural painkillers in the human body. *[4]*

. . . . . .

. . . . . .

. . . . . .

. . . . . .

. . . . . .

. . . . . .

. . . . . .

. . . . . .

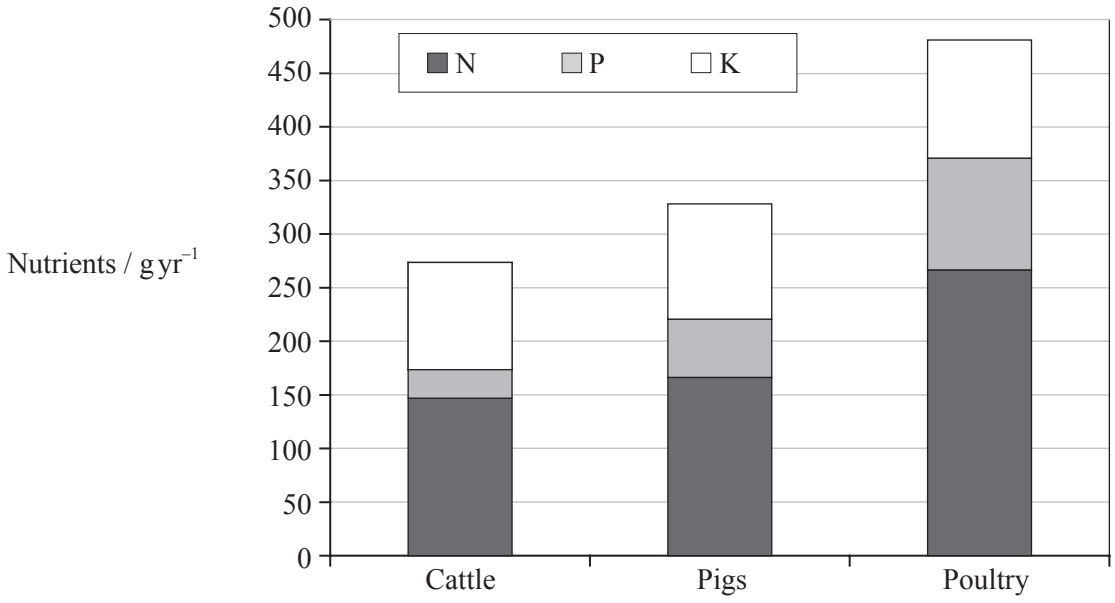
. . . . . .

. . . . . .

Option F — Applied Plant and Animal Science

F1. Intensive animal rearing techniques have dramatically increased the yields of domesticated animals. However, pollution from pig, cattle and poultry farms has become an environmental challenge. Manure is the major waste problem due to a number of issues including disposal, odour, and soil and water pollution. Part of the solution is to reduce the amount of waste generated. One method is to use the manure as fertilizer.

The graph below shows the amount of nitrogen (N), phosphorus (P) and potassium (K), contained in the manure of different farm animals per kg of animal.



[Source: Y L Henuk and J G Dingle, *World's Poultry Science Journal*, **59**, pages 350–359]

(a) Determine the amount of potassium found in cattle manure. *[1]*

. . . . . .

(b) Calculate the amount of potassium found in pig manure as a percentage of the total nutrients. *[1]*

. . . . . .

(c) Compare the amounts of nutrients in the different animal manures. *[2]*

. . . . . .

. . . . . .

. . . . . .

. . . . . .

(This question continues on the following page)

(Question F1 continued)

(d) Poultry manure has a pH of 8.0. Suggest why this would be important in farming. *[1]*

. . . . . .

. . . . . .

(e) Suggest **one** other economic use for manure. *[1]*

. . . . . .

. . . . . .

F2. (a) Define the term *outbreeding*. *[1]*

. . . . . .

. . . . . .

(b) Outline how plant breeding programmes have improved the yield of a named crop. *[3]*

. . . . . .

. . . . . .

. . . . . .

. . . . . .

. . . . . .

. . . . . .

. . . . . .

F3. (a) Outline **three** commercial uses of plant growth regulators. *[3]*

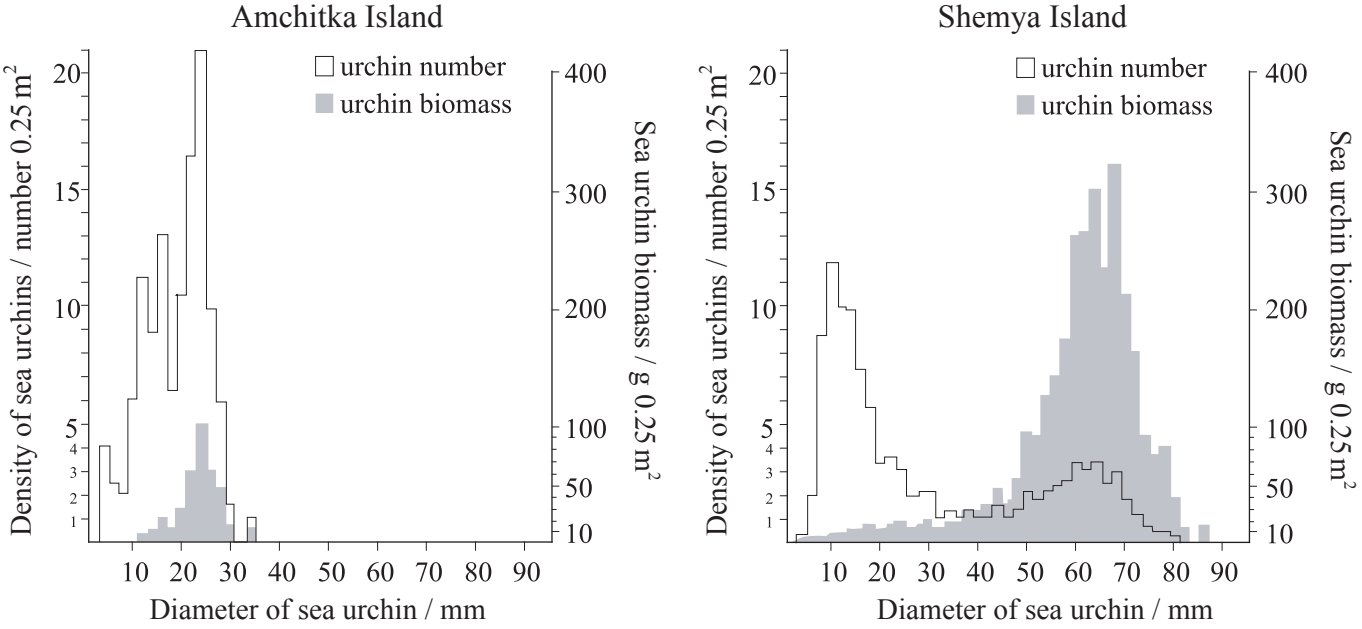
(b) Explain the control of flowering in long day plants. *[7]*

Blank page

Option G — Ecology and Conservation

G1. Destruction of subtidal and intertidal kelp (seaweed) and seagrass beds has been observed over a wide geographical range. Removal of sea urchins (*Strongylocentrotus sp.*) by experimental manipulation and accidental oil spill has resulted in the rapid development of marine vegetation. The presence and absence of kelp beds has a major effect on the structure of the marine community.

A survey was carried out of two of the western Aleutian Islands with and without sea otters (*Enhydra lutris)*. Sea urchin size, density and biomass were measured. Densities and biomass were recorded per $0.25\,m^2$. Data was collected from Amchitka Island (with sea otters) and Shemya Island (without sea otters).



[Source: reprinted with permission from J A Estes and J F Palmisano, *Science*, (1974), **185**, pages 1058–1060, copyright © 1974 AAAS]

(a) (i) State the diameter of sea urchins with the most frequent biomass on Amchitka Island. *[1]*

. . . . . .

(ii) Suggest, giving a reason, which island would have the oldest sea urchins. *[1]*

. . . . . .

. . . . . .

(This question continues on the following page)

(Question G1 continued)

(b) Compare the sea urchin densities and biomass on Shemya Island and Amchitka Island. *[2]*

. . . . . .

. . . . . .

. . . . . .

. . . . . .

(c) Deduce the trophic level of the sea urchins in this marine community. *[1]*

. . . . . .

. . . . . .

(d) Explain the observed differences in sea urchin populations on the two islands. *[2]*

. . . . . .

. . . . . .

. . . . . .

. . . . . .

G2. Outline the roles of living organisms during ecological succession on new soil. *[3]*

. . . . . .

. . . . . .

. . . . . .

. . . . . .

. . . . . .

. . . . . .

. . . . . .

G3. (a) Discuss the impact of humans on the global nitrogen cycle. *[7]*

(b) Outline the biological consequences of acid precipitation on an aquatic community. *[3]*

Blank page

Option H — Further Human Physiology

H1. Doses of aspirin from 75 to 325 mg day^{-1} have been used in patients to help prevent cardio-vascular disease. However, there has been little research into the effect of aspirin on renal function in older patients. One test of renal function is known as a clearance test which involves estimating the rate of production of glomerular filtrate by measuring the concentration of creatinine in the urine.

A five-week study was carried out on 83 older patients (56-98 years of age) treated with low-dose aspirin (100 mg day^{-1}) and 40 control patients who received no aspirin. Other medications and diet were kept constant from one week prior to the start of the study. Aspirin was given to the patients for two weeks and then stopped. Blood and urine samples were monitored prior to treatment (baseline) and at the end of week 2 and week 5.

The table below shows blood and urine levels of different metabolites starting with baseline levels, after two weeks on aspirin, and at the end of the five-week period.

	Control Group			**Aspirin Treatment Group**		
	Baseline	**Week 2**	**Week 5**	**Baseline**	**Week 2**	**Week 5**
Blood urea / mg 100 cm^{-1}	19.00	18.60	19.10	18.00	22.40	20.40
Blood creatinine / mg 100 cm^{-1}	0.70	0.70	0.72	0.72	0.77	0.70
Urine creatinine clearance / ml min^{-1}	52.70	60.00	58.00	71.00	57.00	60.00
Blood uric acid / mg 100 cm^{-1}	4.30	4.30	4.30	4.40	4.70	4.70

[Source: R Segal *et al*., *American Journal of Medicine*, (2003), **115**, pages 462–466]

(a) Calculate the percentage change in blood uric acid concentration from baseline to the end of week 2 for the aspirin treatment group. *[1]*

. . . . . .

. . . . . .

(b) Suggest why the researchers collected the baseline data. *[1]*

. . . . . .

. . . . . .

(This question continues on the following page)

(Question H1 continued)

(c) Describe the effect of two weeks of aspirin treatment. *[2]*

. . . . . .

. . . . . .

. . . . . .

. . . . . .

. . . . . .

(d) Deduce whether the effect of aspirin on renal function is likely to be permanent. *[3]*

. . . . . .

. . . . . .

. . . . . .

. . . . . .

. . . . . .

H2. Outline the different ways that respiratory CO_2 can be transported in the blood back to the lungs. *[3]*

. . . . . .

. . . . . .

. . . . . .

. . . . . .

. . . . . .

. . . . . .

H3. (a) Outline the contents of saliva and gastric juice. *[4]*

. . . . . .

. . . . . .

. . . . . .

. . . . . .

. . . . . .

. . . . . .

(b) Explain how the ileum absorbs and transports sugar and lipids. *[6]*

. . . . . .

. . . . . .

. . . . . .

. . . . . .

. . . . . .

. . . . . .

. . . . . .

. . . . . .

. . . . . .

. . . . . .

. . . . . .

. . . . . .

. . . . . .

. . . . . .