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Human Biology HBIO4

(Specification 2405)

Unit 4: Bodies and Cells In and Out of Control

Report on the Examination

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General Comments

There were some excellent answers to many of the questions with students demonstrating a sound understanding of the material covered in this unit. However, there were some areas where many students appeared to have rather limited knowledge and understanding, such as the functioning of the eye, antagonistic muscles and antibiotic resistance in bacteria.

Some mathematical weakness was evident in the use of a scale to convert measured units and even in simple division. However, most students were able to express a relationship as a simple ratio.

Students should be encouraged to make use of information given in the stem of a question as this is provided specifically for their guidance. In particular, complex information, such as that given in question 8 about the analysis of genetic material using selective digestion with a restriction enzyme, needs to be sufficiently assimilated before attempting to answer any questions based upon it.

Students should also be encouraged to include sufficient detail in their answers, for example in the description of active and passive immunity, sufficiently labelling genetic diagrams, and making use of precise numerical values when describing data or drawing conclusions from it.

Question 1

(a) Many students were very confused about the role of the ciliary muscles and suspensory ligament in adjusting the shape of the lens in order to focus the eye. Less than half got this completely correct.

(b) Although most knew that cones were present at the fovea, fewer understood it was the one-to-one connection with neurones that resulted in detailed vision. Some students used the word ‘acuity’ without explaining the basis for this.

Question 2

(a) Although most knew that a hormone was a chemical carried by the blood, or released from a ductless gland, only about one-quarter of students could give any further detail; such as affecting a specific target organ or activating an enzyme or a gene.

(b) Most students knew at least two effects of adrenaline, the best known being increase in heart rate, dilation of the pupils, vasoconstriction in the skin or gut and vasodilation in skeletal muscles.

Question 3

(a) While most students knew that muscles operate by contracting, there was much confusion about which of the two muscles in the diagram, **A** (the biceps) or **B** (the triceps), flexed the elbow joint and which extended it. Many students were aware that graded contraction of both muscles was involved in the maintenance of posture.

(b)(i) Less than one-third of students knew what happened to the lengths of the A-band, I-band and H-zone during muscle contraction. Many thought that one or more of these would actually lengthen.

(b)(ii) One-third of students were able to use the scale on the diagram correctly to calculate that, when the muscle contracted, each sarcomere would be reduced in length from

3 µm to 2 µm. Some clearly could not identify a sarcomere in the diagram but the majority of errors were due to mathematical weakness.

Question 4

(a) The concept of negative feedback was well understood, with over three-quarters of students being able to state something sensible about a departure from the norm causing changes that returned the condition back to the norm. Some used an example to explain their answer with temperature maintenance, not surprisingly, being the favourite.

(b) While more than three-quarters of students knew that shivering released heat, less than one-third were able to explain that this heat was the result of increased respiration.

(c) Most students were unable to explain how the inhalation of warm, humid air would help a person recover from hypothermia. Fewer than half were able to make even one valid point which, if they did, generally related to the idea of the warm air warming the blood in the lungs. Relatively few appreciated that inhaling warm air would reduce heat loss due to breathing. Hardly any understood that the inhalation of humid air would reduce the heat loss associated with evaporation of water in the lungs; some thought it might reduce *sweating*. The eventual knock-on effect of warmer blood on the ability of the hypothalamus to function and, hence, to coordinate temperature regulation mechanisms was virtually unknown.

Question 5

(a) The vast majority of students correctly read the figures 27 and 15 from the graph and expressed them as a ratio. Some did not simplify their answer to 9:5 or 1.8:1, and, hence, failed to obtain the second mark.

(b)(i) Nearly all students recognised the similarity in shape between the molecules of oestrogen and endoxifen. Some experienced difficulty expressing the concept of complementarity between endoxifen and the oestrogen receptor protein.

(b)(ii) Most students found part (ii) straightforward and were able to explain that tamoxifen, or endoxifen, would prevent oestrogen from binding with its receptor and (using information from Figure 4) suggested that the endoxifen-receptor protein complex would be unable to bind to DNA and, hence, would fail to stimulate cell division. Some knew that coregulators were also involved in the process and suggested that the endoxifen-receptor complex would not bind to these and, hence, would fail to activate a gene. Sensible suggestions such as these were accepted by examiners.

Question 6

(a) Around half the students understood that the presence of a gene for kanamycin resistance, indicated by survival in a kanamycin-containing growth medium, meant that the Bt gene would also be present in the maize tissue.

(b) Many students clearly misunderstood this question as their answers would have been more appropriate to part (a), Relatively few students were able to explain that, since the maize plants had been selected on a kanamycin-containing medium, they were all derived from cells with the Bt gene which would have been copied and passed on to all offspring cells by mitosis.

(c) This question was generally answered very poorly. A common and totally unexpected error was the idea that human consumption of maize containing a gene for resistance

to the antibiotic kanamycin would make *humans* resistant to kanamycin and, apparently, thus untreatable with this antibiotic. Others thought that kanamycin itself was being consumed and that this might prove toxic to humans. Very few students appreciated that the gene for kanamycin resistance might be transferred to other, pathogenic, species of bacteria thereby rendering these pathogens untreatable with kanamycin. Even those students who did appreciate that bacteria could be thus transformed often thought that the recipient bacteria would become resistant to "antibiotics" in general.

(d) Most students knew that the human digestive system had a lower pH than the pH 10 required for activation of the Bt protein. Thus, the vast majority scored at least 2 marks. The best answers went on to hypothesise that the non-activated Bt toxin (or a denatured Bt protein) would not be able to combine with receptors on the human gut epithelium. Some even suggested that there were no receptors for the Bt toxin in the human gut, unlike in that of the corn borer moth larva, hence, it being safe for humans to consume the Bt-maize.

Question 7

(a) Around two-thirds of students correctly identified ions **A** and **B** as sodium and potassium, respectively. It was quite common for these names to be transposed and "calcium" was another occasional error.

(b) Just over half the students could explain that the refractory period was the time during which a new action potential could not be generated.

(c)(i) Around one-third of students were able to deduce from the graph that the refractory period lasted 2 milliseconds and that this meant that the maximum frequency of impulses in this neurone was 500 per second.

(c)(ii) Students had a great deal of difficulty in expressing themselves unambiguously. Many did not convey the concept that, as the intensity of a stimulus increased, so too would the frequency of impulses being sent along the sensory neurone. Thus, they were also unable to explain that, since the maximum frequency of impulses in the neurone was 500 per second, stimuli of intensity that should have produced a higher frequency would still only be able to send 500 impulses per second and, hence, be indistinguishable.

Question 8

(a) Simply to state that "bases are found in pairs" was a typical, inadequate answer to this question. A description of DNA containing two chains of nucleotides, or joined by pairs of bases, was required. Additionally, the fact that each 'base pair' occupied a set length along the DNA molecule was also required to justify the use of a 'base pair' as a suitable unit for measuring the length of a piece of DNA. Two-thirds of students scored zero marks for this question.

(b)(i)&(ii)Parts (i) and (ii) were marked as a whole since the concepts required overlapped.

Just over half the students scored at least one mark. Many failed to state that a primer would be a *single-stranded* polynucleotide (some even thought it was a protein). Rather more knew that it would be able to bond via complementary base pairing to the target; i.e. part of the haemoglobin gene.

(b)(iii) There was much greater success in part (iii). It was generally appreciated that PCR would make multiple copies of the target DNA.

(c)(i) More than half of the students scored zero marks in this part question. A major problem was a failure to assimilate the information given, resulting in misinterpretation of the data. These students did not appreciate that the site of cleavage by the restriction enzyme was also the site of the sickle-cell mutation and that this site was in the *middle* of the 110-base-pair section of DNA replicated in the PCR. Others did not address the actual question, about the *parents*' DNA, but included much irrelevant information about the DNA of the fetus. A succinct statement that the data showed both parents to be heterozygous and that the 110-base-pair section from their $\mathbf{H^A}$ allele would be cut in half, while their other, $\mathbf{H^S}$, allele would not, was a rarity.

(c)(ii) Success in part (ii) paralleled that in part (i), and for similar reasons. One major failing was a lack of confidence among students. The fetus did *not* have "a high risk" of suffering from sickle cell anaemia, the data showed this was a 100% certainty.

Question 9

(a) In answering this genetics question, students were at liberty to give one genetic diagram showing dihybrid inheritance, or two separate monohybrid genetic diagrams (the option chosen by most), or even no diagram at all if their prose was sufficiently accurate.

The stem of the question encouraged students to *label* their diagrams. A major problem with an unlabelled diagram was to ascertain which offspring genotype represented the group O, Rhesus positive phenotype: examiners did not consider it their job to do this on the student's behalf.

The points required were the parental genotypes, $\mathbf{I^AI^Odd}$ (mother) and either $\mathbf{I^AI^ODD}$, or $\mathbf{I^AI^ODd}$ (father); that the allele $\mathbf{I^O}$ could be inherited from each parent; that allele **D** came from the father and **d** from the mother; and that, hence, a baby of genotype $\mathbf{I^OI^ODd}$, = O Rhesus positive, could be produced. Unlabelled genetic diagrams frequently left it unclear that the baby had inherited **D** rather than **d** from the father and that the baby's genotype was $\mathbf{I^OI^ODd}$, rather than any of the other possible genotypes.

Some students introduced the added complication of X and Y chromosomes which were, as far as possible, simply ignored by examiners. Just over one-quarter of students scored full marks, but many more *could* have done so, had they labelled their genetic diagrams.

In part (ii), just over half of the students realised that there were many other males in the population with the $\mathbf{I^O}$ allele and the **D** allele in their genotype or, alternatively, that the famous footballer in question could have been homozygous for the $\mathbf{I^A}$ allele. Many students cited the low probability from part (i) as a justification, not understanding that this was entirely irrelevant.

(b)(i) A major failing in parts (i) and (ii) was the use of the term "immune response", which was given in the question, without giving any details of the nature of this response. In (i), it was important for students to state that the *blood* of the first fetus contained the D-antigen and that some of the fetus's blood mixed with that of the mother *at birth*. This would have triggered an immune response in the mother, whereby she *made* anti-D antibodies and retained the ability to do so. This would enable anti-D antibodies to pass across the placenta during her next pregnancy. While over two-thirds of students were able to make at least one valid point, less than one-fifth scored full marks.

(b)(ii) Success in part (ii) was even lower than in part (i). Relatively few students understood that the injected anti-D antibodies would combine with, or destroy, any D-antigen that had entered the mother's blood. This would prevent a primary active immune response against the D-antigen.

Question 10

(a) The role of hormones in controlling the menstrual cycle was well known and over half the students scored full marks. Points most frequently omitted were that the site of oestrogen production was the ovary (or the follicle within it) and that LH caused formation of the corpus luteum; a strange omission if a candidate knew the meaning of 'LH'.

(b)(i) Although the mechanism of kidney functioning was outside the scope of the Specification, it was anticipated that students would know that urine was derived from blood. It was hoped that they would deduce that, since hormones such as FSH were carried in the blood, they could be lost from the body in the urine and their concentration in the urine would be proportional to their production. Just under two-thirds of students were able to make at least one valid point, but very few could make three.

(b)(ii) Since this part required only translation of information from graphic to verbal form, all students should have been able to score highly but, in practice, only one-fifth gained full marks. Carelessness of expression, lack of precision and omission of detail all contributed to failures to score marks. Students should be encouraged to make use of numerical values; for example, certain changes in pattern in the graph occurring at particular ages. Students should also realise that, in order to describe a *difference*, they need to give *two* descriptions: in this case, one feature for women *and* the corresponding feature for men.

(b)(iii) The vast majority of students knew at least one change that occurred in a woman's body between the ages of 40 and 50 years, and just under half could give two.

(c)(i) Many students thought, incorrectly, that FSH levels were *high* during the final 5 days of the menstrual cycle. Better answers showed understanding that the amount of FSH released varies throughout the cycle and that a standard was needed if valid comparisons were to be made to show the effects of caffeine and of alcohol on FSH concentration. Although around two-thirds of students were able to make at least one valid point, a complete story came from only a tiny minority.

(c)(ii) In this part, most students were able to give two points of comparison between the use of the standard deviation and the range as measures of variability in data. These points were usually that the SD made use of all of the data (or showed the spreads about the mean) while the range just used the two extremes. Better students went on to explain why the SD was preferable – e.g. that it enabled a statistical test to be carried out or that the extremes used in the range were likely to be anomalies and, hence, were less representative – but only about one-tenth of students were in this category.

(d)(i) The vast majority of students understood the term *null hypothesis* and were able to state one satisfactorily.

(d)(ii) This question differentiated very well across the ability range. Many students wrote at length but said precious little. Better responses were more succinct and sought to amass at least five pieces of evidence which included points both for and against the journalist's suggestion.

There was only one point in favour of the suggestion, based on the trends shown by the mean values. The most common criticisms given by students were the small sample size and the fact that other variables were not controlled (age being the favourite). Many also pointed out that the SD values overlapped which would indicate that any apparent trend might be as much due to chance variation as to the effect of either caffeine or alcohol. Relatively few students made use of the null hypothesis they had just stated in part (i); i.e. most failed to recognise that the null hypothesis should be accepted. Some of the less-common criticisms raised by students were the consequence of the small group size; that it was possibly non-representative or atypical; that many of the women were consuming both caffeine and alcohol and,hence, there were two independent variables operating at the same time; the need for repetition; the non-standardised measure of alcohol consumption as 'number of drinks per week' and the potential for unreliable reporting of this.

Mark Ranges and Award of Grades

Grade boundaries and cumulative percentage grades are available on the Results statistics page of the AQA Website.