

Version



**General Certificate of Education (A-level)
June 2012**

Biology

BIOL5

(Specification 2410)

Unit 5: Control in Cells and in Organisms

Report on the Examination

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General Comments

The paper produced a wide range of marks and it was pleasing to see a greater proportion of students achieving a mark of 80 or more this year. Similarly, the standard of essays was better, with more scripts achieving a mark of 12 or more for scientific content. There were some truly outstanding scripts at the top end of this range, which showed a thorough knowledge and understanding of the unit content. Students were able to apply this to unfamiliar contexts and express themselves clearly, using correct scientific terminology. However, at the other end of the scale, it was clear that some students were ill-prepared for this examination. In such cases, answers were vague or poorly expressed. Similarly, some students failed to gain marks because they did not read carefully the information provided. They found questions that required application of knowledge demanding. This was most notable in Questions 4, 5, 7 and 8. There were also some common misconceptions seen, which have been described below in the appropriate questions.

Question 1

- (a)(i) Most students correctly gave the base sequence of the anticodon as **UGC**.
- (a)(ii) Almost all students correctly gave the base sequence of DNA as **TGCTAC**. However, a minority of weaker students failed to read the stem of the question carefully enough. They replaced the thymine bases in this sequence with uracil.
- (b) Most students were aware that DNA contains introns or mRNA only contains exons. Weaker students were often let down by vague answers, such as 'mRNA contains exons' and 'mRNA is spliced'.
- (c) It was widely appreciated that a change in the base sequence of mRNA could result in different amino acids being coded for or would produce a change in the primary structure of the toxin. A common response seen by a minority of weaker students was 'different amino acids are produced'. This was not credited.
- (d) Most students gained at least one mark for stating that acetylcholine would not be broken down. However, the ability to tell the rest of the story correctly proved to be a good discriminator. Weaker students often thought that depolarisation would be prevented, resulting in the muscles not being able to contract. Some students attempted to explain this in terms of the inability to reabsorb acetylcholine into the presynaptic membrane. They thought that this would prevent any further release of acetylcholine. It was usually only better students who went on to describe the opening of sodium ion channels. Similarly, the importance of the 'continuous' aspect of muscle contraction was only appreciated by the best students.

Question 2

- (a) Almost all students correctly stated that the I-band would shorten and that the A-band would not change in width.
- (b) Most students gained one mark for the principle of dividing the measured width by the actual width. However, only better students were able to convert the measured width to micrometres. Students who failed to score often divided the actual width by the measured width.

- (c) Most students were aware that ATP is needed for the attachment between actin and myosin. However, the ability to tell the rest of the story in terms of the 'power stroke', detachment of the myosin heads and the return to their original position proved to be a good discriminator.

Question 3

- (a)(i) Students who failed to score typically failed to convey the idea of 'after' or 'before'. They usually gave the response 'as oestrogen increases, LH increases'. Similarly, some students simply repeated information given in the stem of the question and went no further than stating that 'oestrogen causes LH to be released'.
- (a)(ii) A minority of weaker students focused on the part of the graph where the concentration of progesterone remained high.
- (b)(i) This proved to be an excellent discriminator. Just under half of the students gained full credit for describing the role of progesterone in inhibiting the production of FSH and LH. They then linked this to a follicle not being stimulated and ovulation being prevented. However, some students only referred to the effect of progesterone on FSH or LH, which limited their mark. Two common misconceptions seen by weaker students were that 'eggs are not *produced*' and that '*follicles* are not released'.
- (b)(ii) Students who failed to score typically repeated information given in the stem of the question e.g. 'it lasts for three years' or 'it is continuously released'. A common misconception seen by weaker students is that oral contraceptives are digested.

Question 4

- (a) Many students gained two marks for mentioning chemoreceptors and the medulla (or equivalent). However, only the best students conveyed the importance of *more* impulses being sent to the sinoatrial node (SAN) in increasing the heart rate. Some weaker students failed to read the stem of the question carefully enough. They explained why, rather than how, the heart rate increases during increased intensity of exercise.
- (b)(i) The role of Group **B** in ensuring that the results were only due to omega-3 fatty acids or not due to something else in the oil was only given by a minority of students. Those who failed to score typically gave 'stock' *How Science Works* responses, which could apply to any investigation. These almost always involved the need to compare groups or results, or that Group **B** acted as a control or placebo, without any further qualification. Students should be reminded of the need to relate their answers to the specific investigation outlined.
- (b)(ii) This proved to be a good discriminator. Just over one third of students gained full credit. However, over half of students gained two marks for stating that Group **A** showed a greater change in heart rate and that the differences between the two groups are significant. It was usually only better students who referred to the fact that the standard deviations did not overlap. Unfortunately, some students failed to appreciate that the negative values for the change in the mean heart rate compared the heart rate before and after treatment i.e. at low intensities of exercise, the mean change in heart rate after exercise was lower for Group **A** after taking omega-3 fatty acids. Similarly, despite the question asking how information in the graph supported the conclusion, some weaker students criticised the methodology of the investigation.

These responses usually referred to the sample size not being known or a control group not being used.

Question 5

- (a) Most students correctly described the type of enzyme as 'restriction' or 'endonuclease'. The most common incorrect response seen was 'DNA polymerase'.
- (b)(i) The students who gained full credit appreciated that the jellyfish gene acted as a marker allowing scientists to identify the cells that had taken up the human gene. However, very few students knew the significance of this in terms of only implanting embryos which fluoresced into surrogate sheep. It was not uncommon for some weaker students to state that the *DNA* would fluoresce or be visible under a microscope. A minority thought that the *milk* would glow green if the human gene had been taken up. There were also some students who confused this marker gene with using two different marker genes for antibiotic resistance. They thought that the human gene would disrupt the jellyfish gene. Hence, cells that had taken up the human gene would not glow. Unfortunately, poor expression let down some students. Typical examples included 'allow cells that have taken up the Factor IX protein to be identified', 'implant cells that glow into the *nucleus*' and 'the jellyfish gene acts as a *probe*'.
- (b)(ii) Very few students appreciated that the promoter allowed the human gene to be expressed only in the mammary glands, or that sheep would not have to be killed in order to recover Factor IX. Weaker students were, again, often let down by poor expression, such as 'the Factor IX gene will be in the milk'. Some simply repeated information given in the stem of the question regarding the promoter's role in allowing transcription. This was sometimes followed by a brief account of translation. Similarly, a minority of students thought that haemophilia can be treated by drinking milk containing Factor IX.
- (c)(i) Both routes through the mark scheme were frequently seen in scripts from better students. Students who failed to score typically fell into one of two camps. Some thought that the embryos had failed to implant or had not been fertilised. Others thought that the hormone levels of the surrogate sheep were too low for successful implantation or that insufficient nutrients were available to support the growth of the embryo.
- (c)(ii) Most students scored one mark for the idea that reporting failed attempts would allow methods to be improved, or that the same work or errors would not be repeated. However, it was usually only the very best students who went on to explain that this would save time or money.

Question 6

- (a) This proved to be an excellent discriminator and just less than half of students gained full credit. This was usually for describing the production of cAMP and its effect on glycogenolysis or gluconeogenesis. Very few students were able to name the enzyme within the plasma membrane as adenylate cyclase. Similarly, there was sometimes confusion between the activation of this enzyme and intracellular enzymes. Some students thought that adenylate cyclase directly affects glycogenolysis or gluconeogenesis. This said, the correct use of scientific terms beginning with 'g' was generally good and only a minority of weaker students

confused 'glycogen' and 'glucagon'. The terms 'glyconeogenesis' and 'glucogenolysis' also appeared in weaker answers.

- (b)(i) Most students were aware that glucose in food would affect the results or that eating would affect the blood glucose concentration. Very few students referred to the importance of allowing the blood glucose concentration to return to normal.
- (b)(ii) Students who failed to score typically stated that type 2 diabetes is not a genetic disease.
- (b)(iii) The most common advantages given for gene therapy were the avoidance of injections and the longer-lasting effect. The most common disadvantages given were the possible side effects, which were usually linked to the virus, and that the long-term effects are not known. Surprisingly, relatively few students made reference to the fact that rats are different from humans. As in question 4(b)(i), weaker students seemed to rely on 'stock' *How Science Works* answers to gain credit for the 'against' side of the evaluation. They typically referred to unknown sample sizes and the influence of unnamed 'other factors'. These were not credited.

Question 7

- (a) Weaker students typically gave vague answers such as 'light would affect the results', 'to control a variable' or 'roots grow underground so it must be kept dark'. A minority thought that roots are positively phototropic or that light would allow photosynthesis to occur.
- (b) Just under half of students appreciated that the results indicated the root tip responds to gravity or that IAA is produced in the root tip. Weaker students usually gave vague answers that did not refer to the root tip.
- (c)(i) Half of the students answering this question scored at least one mark for the idea that the upper side of the root grew faster than the lower side. Weaker students often failed to appreciate that both sides of the root grew and therefore did not give a comparative statement. The specification content for BIOL5 requires that students should understand 'the role of IAA in controlling tropisms in flowering plants'. Despite this, it was clear that some students had no knowledge of geotropism. Some answers referred to 'weaker' and 'stronger' gravity, or that gravity only acts on the lower side of the root. Similarly, it was very clear that some students did not know that IAA inhibits growth in roots. Students who made these errors could still gain one mark for the idea that the upper side of the root grew faster than the lower side. Indeed, this mark was frequently awarded to students who located IAA on the upper side of the root and thought that IAA stimulated growth in roots.
- (c)(ii) Over one third of students were aware that removing part of the root tip would result in less IAA being produced. However, it was only the very best students who linked this to faster growth or less inhibition of the lower side of the root.

Question 8

- (a)(i) Although the negative correlation was usually indicated, only the better students appreciated the wide range in the age of onset or the overlap in values. Very few students were aware that the wide range in age of onset for the same number of CAG repeats suggests that other factors may also be involved.

- (a)(ii) A minority of weaker students gave answers that were out of context. Some thought that the allele for Huntington's disease is recessive and would therefore be passed on to offspring without a person knowing. Others thought that people with Huntington's disease would survive well into adulthood and then reproduce.
- (b)(i) Most students correctly identified Person **K** as testing positive for Huntington's disease. They went on to explain that this person has the fragment that moved the shortest distance and linked this to a greater number of CAG repeats. A minority of students failed to link correctly the distance moved with the length of the fragment.
- (b)(ii) Students who failed to gain credit often referred to using DNA sequencing or probes to highlight sequences and 'restriction mapping'.
- (b)(iii) Misconceptions seen in responses by weaker students included partial digestion of DNA, Person **L** only having one allele of this gene and the probe not being able to attach to the other fragment.

Question 9

- (a) The most commonly seen error was dividing by the final milk production of 18.0, rather than the initial milk production of 22.9.
- (b)(i) Most students correctly related the change in water intake to sweating or panting. Weaker students usually went no further than to state that water is lost from the body. A minority thought that water is used in respiration.
- (b)(ii) Some students did not read the stem of the question carefully enough. They answered in terms of the environmental temperature increasing. However, many students were able to link an increase in food intake to heat or energy release for at least one mark. A minority of weaker students failed to gain a mark for poor expression. This was usually for stating that energy is released for respiration.
- (c) Nearly one third of students gained one mark. This was almost always for mentioning that increased sweating would result in less water being available for milk production, or that a decreased food intake would result in less nutrients or energy being available for milk production. Weaker students tended to focus on attempting to explain why, or how, cows need to lose heat as environmental temperature increases. They also frequently referred to enzyme denaturation, which was not credited.
- (d) Most students scored at least one mark. This was usually for stating that skin temperature is affected more by the environment or sweating. However, it was usually only better students who went on to relate this to skin temperature showing more variation or being further from core temperature.
- (e) Those students who failed to score usually referred to characteristics other than milk yield, such as body size, tolerance to heat stress and high sperm count. A worrying number of weaker students thought that bulls produce milk.
- (f) Almost all students appreciated that using percentages allows a comparison to be made but weaker students did not always link this to different countries having different population sizes.

- (g) Many students were well aware that the ability to digest lactose was a selective advantage and that these individuals would pass on their alleles to offspring. However, it was only better students who went on to give the final part of the story in terms of the frequency of this allele increasing in the population. Weaker students often expressed themselves poorly, in terms of individuals passing on ‘characteristics’ or ‘lactose tolerance’, without any reference to genes or alleles. Similarly, a minority conveyed the misconception that individuals would choose to not reproduce with lactose-intolerant individuals.

Question 10

In general, the standard of essays was better than last year with a greater proportion of scripts achieving a mark of 12 or more for scientific content and 3 for quality of written communication. It was also pleasing to see that many scripts showed evidence of a useful plan. This clearly helped to order students’ thoughts before starting, gave the essay a better flow and reducing the possibility of missing out important points. However, a number of misconceptions were seen by weaker students for both essay titles and these are described below.

Essay A

This was the more popular of the two essays. Although there was no evidence of misreading the essay title, a minority of weaker students simply described the shapes of different molecules or cells, without relating this to ‘fitting together’. Similarly, some students included examples of how the shapes or structures of different cells, such as palisade cells, red blood cells and myelinated neurons, are suited to their function.

Proteins & Enzymes

Students often started the essay with an account of enzymes. Many students stated that the active site and substrate have complementary shapes and this naturally led on to descriptions of the lock and key model and denaturation. Better students were able to also describe the induced fit model and could explain how both types of enzyme inhibitor reduce the rate of reaction. Similarly, there were some excellent, detailed accounts of protein structure and how a mutation can lead to the production of a non-functional enzyme. Unfortunately, some weaker students attributed the properties of enzymes to their quaternary structure and a minority placed the active site on the substrate. Surprisingly few students wrote about protein channels in the plasma membrane in the context of cell transport. However, in terms of awarding extra credit for material beyond the specification, there were some truly excellent accounts of how faulty chloride ion channels cause the production of thicker mucus in cystic fibrosis sufferers. The immune system was also frequently covered. However, responses were usually superficial. It was usually only better students who described the consequence of antigens and antibodies fitting together. Weaker students often let themselves down due to poor expression e.g. ‘antibodies fight disease’ and ‘memory cells remember the pathogen’. There was also confusion between the terms ‘antigen’, ‘antibody’ and ‘antibiotic’. Very few students mentioned vaccines.

Nucleic acids

Most students had no trouble in giving the complementary base pairings in DNA. However, only better students went on to explain their importance in terms of DNA replication, transcription or translation. Weaker students were often uncertain of the role of DNA polymerase. They thought that this enzyme is responsible for complementary base pairing during DNA replication, rather than joining nucleotides on the newly formed strand. Similarly,

a minority thought that DNA polymerase is involved in transcription. Many students appreciated the role of restriction enzymes in isolating genes, cutting plasmids and producing sticky ends. However, it was usually only better students who went further in terms of the production of complementary sticky ends, the role of DNA ligase and how bacteria can be made to take up recombinant plasmids. It was pleasing to see that many students understood the role of oestrogen in controlling transcription. However, references to siRNA were seen less frequently. A minority of students wrote about the polymerase chain reaction (PCR) and DNA hybridisation. These were not classed as relevant as they do not occur 'in cells and organisms'.

Physiology

The most popular topic in this section was the role of acetylcholine at a synapse. This was usually described well. However, weaker students often gave vague accounts of what happened after acetylcholine had bound to its complementary receptor. Similarly, some confused the roles of calcium and sodium ions. The best students had clearly done some independent study in this area and were well versed in the effects of a variety of drugs at a synapse. The control of blood glucose concentration was also frequently covered, with the best students including reference to cAMP or making the link to diabetes. However, other hormones, including those involved in controlling the mammalian oestrous cycle, were rarely mentioned. There were some excellent accounts of muscle contraction. Most students appreciated the importance of myosin heads fitting into binding sites on actin. However, better students were able to complete the story in terms of the 'power stroke' and detachment of the myosin heads. The best students described the role of calcium ions in removing tropomyosin from the actin binding sites to allow cross bridges to form. Haemoglobin was occasionally covered but this was usually superficial. Only the best students were able to link the partial pressure of oxygen or carbon dioxide to a change in shape of the molecule and relate this to its affinity for oxygen at the lungs or tissues.

Essay B

Bacteria and disease

Cholera was frequently covered and there were some truly excellent explanations of how the cholera toxin causes diarrhoea. Weaker students often stated that water moves into the intestine but the mechanism was often vague or confused. Unfortunately, some students wrote in unnecessary detail about the worldwide distribution of cholera and how the disease can be treated or avoided. Tuberculosis was less frequently covered and responses typically lacked detail. They amounted to little more than lung tissue being destroyed or the formation of scar tissue. Only the best students referred to the two phases of infection or the role of the immune response. Indeed, some students confused tuberculosis with emphysema. Antibiotic resistance was well covered and proved to be a good discriminator. Better students were able to describe horizontal gene transmission in detail and often went on to include how natural selection allows the proportion of resistant bacteria to increase. A common misconception seen by weaker students is that vertical gene transmission in bacteria is the same as mitosis. Similarly, some students gave long, unnecessary descriptions of how the immune system responds to a pathogen, without any context regarding how bacteria affect the lives of humans. Very few students mentioned vaccines.

Ecological importance

Most students appreciated the role of bacteria in the carbon cycle, although some weaker students described saprobiotic bacteria 'returning carbon to the soil', rather than returning carbon dioxide to the air by respiration. The nitrogen cycle proved to be a better discriminator. Better students had no trouble in giving full, accurate, detailed accounts. They

then often linked this to eutrophication. However, weaker students often focused on one part of the cycle or gave a muddled account. Such responses typically referred to plants taking up nitrogen, rather than nitrates. There was also the usual confusion regarding nitrogen fixation and nitrification. A common misconception that was seen is that nitrogen fixation is the first stage in nitrification, rather than a separate process in its own right. Similarly, a minority of students thought that bacteria can colonise bare rock and are therefore responsible for primary succession. These responses sometimes referred to lichens as bacteria.

Making use of bacteria

Many students focused primarily on how bacterial plasmids can be manipulated to produce genetically modified bacteria containing the human insulin gene. Weaker students appreciated the role of restriction enzymes to isolate the gene and cut the plasmid. However, it was usually only better students who explained the importance of producing complementary sticky ends and the role of DNA ligase in sealing the gene into the plasmid. They could usually also describe how bacteria can be treated in order to take up the recombinant plasmid. A number of misconceptions were seen in the work of weaker students. They included injecting bacteria containing the human insulin gene into diabetics and placing the plasmid into a virus. Indeed, some students thought that a bacteriophage and a bacterium are the same thing. Regarding gene therapy, there were some excellent accounts by the best students of how plasmids can be attached to liposomes in order to alleviate the symptoms of cystic fibrosis. These were awarded extra credit. Similarly, the roles of bacteria in producing vitamin K in the human digestive system, producing cellulase in the digestive system of cattle and breaking down oil spills were also seen. Finally, a number of weaker students confused bacteria with yeast and made references to the routine uses of bacteria in the brewing and baking industries.

Mark Ranges and Award of Grades

Grade boundaries and cumulative percentage grades are available on the [Results statistics](#) page of the AQA Website.