

HSC Trial Examination 2006

Biology

Solutions and marking guidelines

Section I

Part A

Answer and explanation		Syllabus content and course outcomes
Question 1 When carbon dioxide is added to water the pH is lowered (< pH 6) and therefore the water becomes acidic.	B	9.2.3 H6
Question 2 Xylem vessels have tracheids with pits. A is schlerenchyma, B is phloem and C is collenchyma.	D	9.2.2 H6
Question 3 Sodium chloride and antibody are not hormones. Aldosterone acts on the kidney, promoting the reabsorption of sodium ions into the blood.	D	9.2.3 H6
Question 4 The line on the graph flattens because the substrate concentration no longer increases the rate of the reaction.	C	9.2.1 H6, 14
Question 5 The fish would have to excrete small quantities of concentrated urine from the kidneys.	A	9.2.3 H6
Question 6 In humans, diploid number $2n = 46$, haploid number $n = 23$.	C	9.3.3 H6, H9
Question 7 Beadle and Tatum worked with the bread mould <i>Neurospora</i> to establish the link that one gene codes for one enzyme (later refined to one gene – one polypeptide).	B	9.3.4 H2, H9
Question 8 Common bone structure suggests that all pentadactyl limbs have developed from a common ancestor.	A	9.3.1 H10, H14
Question 9 Since the donor cell's nucleus contributed the genetic material to the new individual, the new individual will be genetically identical to the donor cell organism.	B	9.3.5 H9, H14
Question 10 Circular symbol represents female; must be heterozygous since she passes a recessive gene on to her offspring in generation III (individual 6), and she must have received a recessive copy from her father, who was homozygous recessive.	D	9.3.2 H9, H14
Question 11 Malaria is caused by a group of protozoans, one example is <i>Plasmodium falciparum</i> . The <i>Anopheles</i> mosquito is the vector of the disease.	C	9.4.3 H8
Question 12 Health is often defined as the absence of disease and vice-versa. A is a correct statement but does not answer the question.	B	9.4.1 H6
Question 13 B, C and D apply to some infectious diseases but not to all.	A	9.4.3 H6
Question 14 D is the only correct combination.	D	9.4.2, 9.4.6 H6, H12
Question 15 The graph only gives us information about estimated rates of detection and interception, so more information would be needed to reach conclusion A or B. C is an incorrect conclusion.	D	9.4.7 H4, H14

Part B

Sample answer	Syllabus content, course outcomes and marking guide									
Question 16 (a) Let G = green (dominant) and g = blue (recessive) <table><tr><td></td><td>G</td><td>G</td></tr><tr><td>g</td><td>Gg</td><td>Gg</td></tr><tr><td>g</td><td>Gg</td><td>Gg</td></tr></table>		G	G	g	Gg	Gg	g	Gg	Gg	9.3.2 H6, H9, H13, H14 - Correctly assigns appropriate symbols to dominant and recessive alleles. - Correctly constructs an appropriate Punnett square. - Correctly fills in Punnett square with all possible allele combinations 3 - Any TWO of above criteria done correctly. 2 - Any ONE of above criteria done correctly. 1
	G	G								
g	Gg	Gg								
g	Gg	Gg								
(b) Genotypes: 100% Gg Phenotypes: 100% green	9.3.2 H9, H13 - Correctly states proportions of both genotypes and phenotypes 2 - Correctly states proportions of either genotypes OR phenotypes 1									
(c) If the offspring birds from the above cross were mated together, you would expect the proportion of blue birds in the next generation to be 25%.	9.3.2 H9, H13 Correctly predicts the proportion of blue birds in the offspring 1									
Question 17 Cells need oxygen (O₂) in order to respire. O₂ is a reactant in the reaction, whereas carbon dioxide (CO₂) is a waste product of respiration. Glucose + O₂ → CO₂ + Water + ATP Cause: When CO₂ dissolves in water it forms carbonic acid. Therefore, CO₂ must be removed to maintain the cells' normal pH balance as well as the normal pH balance of the blood. <i>[Note: Also, at normal levels (after excess removal of CO₂) the CO₂/HCO₃³⁻ equilibrium is an important mechanism for buffering the blood to maintain a constant pH.]</i> Effect: Removing excess CO₂ prevents a build-up of carbonic acid, which causes a lower pH. This would lead to increased breathing rates.	9.2.2 H6 - Correctly outlines the need for oxygen and the removal of carbon dioxide in cells. - Correctly states a cause of low pH in cells. - Correctly states the effect of removing carbon dioxide from cells 3 - Two of the above are correct 2 - One of the above is correct 1									

Part B (Continued)

Sample answer	Syllabus content, course outcomes and marking guide
Question 18 The theory of evolution by natural selection and isolation can account for both convergent and divergent evolution. Divergent evolution is when an ancestral species gives rise to a variety of different species over time. These changes can occur through isolation: suppose an ancestral population becomes separated for a length of time. Natural selection acts on each separate population, gradually making them different to each other as favourable mutations occur in each population. A similar process to this is thought to have given rise to the variety of marsupials in Australia from one ancestral species. Conversely, convergent evolution is the phenomenon of two different organisms gradually becoming more and more alike over time. For example, sharks and dolphins are superficially similar creatures, although one is a fish and the other is a mammal. By natural selection acting on each organism's ancestors in a similar environment and ecological niche, the two organisms developed similar body shapes and appearances.	9.3.1 H7, H10 - Provides issues and/or points for and against for BOTH divergent and convergent evolution, including reference to examples and reference to natural selection and isolation..... 4 - Explains BOTH divergent and convergent evolution, without providing a link to natural selection and isolation. OR - Provides issues and/or points for and against for BOTH divergent and convergent evolution, some important points omitted, some reference to examples absent 3 - Provides limited explanation of convergent and divergent evolution in terms of natural selection and isolation 2 - States features of convergent or divergent evolution. 1
Question 19 (a) Pasteur's experiment showed that something from the air causes meat broth to go bad. This experiment contributed to the rejection of the idea of 'spontaneous generation'. (b) As the swan-necked flasks used by Pasteur were difficult to construct, we replaced them with two identical conical flasks, each fitted with a one-holed stopper. Glass tubing bent into an S-shape was inserted into one stopper. A piece of straight glass tubing was inserted into the stopper of the other flask as a control. A clear nutrient broth as used by Pasteur was made. Equal volumes of this broth were placed into the flasks then boiled gently for 15 minutes. Pasteur left his flask for months but it was only practicable for us to leave the flasks for several weeks. Every three days the contents of the two flasks were compared and observations such as cloudiness, scum etc. were recorded.	9.4.3 H2, H6 - Correctly states how Pasteur's experiment contributed to our understanding of decay 1 - Justifies procedure followed by: H6, H11, H12 - making comparisons of an appropriate procedure with Pasteur's experiment AND (if appropriate) - stating why changes needed to be made - identifying (stated or implied) variables controlled 3 - Justifies procedure followed by: - outlining or drawing a diagram of an appropriate procedure - making comparisons with Pasteur's experiment - AND (if appropriate) - stating why changes needed to be made - OR - identifying (stated or implied) variables controlled 2 - Outlines or draws a diagram of an appropriate procedure 1

Part B (Continued)

Sample answer		Syllabus content, course outcomes and marking guide
Question 20		
(a)	Nephron	9.2.3 H6 States the correct name 1
(b)	Cause: Filtration is a non-selective process that takes place in the Bowman's capsule. Water, electrolytes, glucose, amino acids and nitrogenous wastes move into the convoluted tubules. Reabsorption takes place selectively at various points along the convoluted tubules. Water is reabsorbed in all parts of the tubule and returned to the blood, except the ascending Loop of Henle. All the glucose and amino acids are recovered. Some electrolytes are reabsorbed at different rates and points along the convoluted tubules depending on feedback from the body. In some cases, active transport is required. Effect: If body fluid composition was not regulated, metabolic and physiological functions would cease to function effectively due to chemical and volume imbalances.	9.2.3 H6, H13 - Correctly states the selectivity and location of both filtration and reabsorption in the mammalian nephron. - Correctly explains what occurs during the processes of both filtration and reabsorption in the mammalian nephron. - Correctly explains the effects of the processes of filtration and reabsorption in the mammalian nephron. 4 - Correctly states the selectivity and location of both filtration and reabsorption in the mammalian nephron. - Correctly explains what occurs during the processes of either filtration OR reabsorption in the mammalian nephron. - Correctly explains the effects of the processes of filtration and reabsorption in the mammalian nephron. 3 - Correctly states the selectivity and location of either filtration OR reabsorption in the mammalian nephron. - Correctly explains what occurs during the processes of either filtration OR reabsorption in the mammalian nephron. 2 - Correctly states the selectivity and location of either filtration OR reabsorption in the mammalian nephron. OR - Correctly explains what occurs during the processes of either filtration OR reabsorption in the mammalian nephron. 1

Part B (Continued)

Sample answer		Syllabus content, course outcomes and marking guide
Question 21		
(a)	Light microscope	9.2.2 H11 • Correctly states the name of the instrument. 1
(b)	1. Collect a light microscope and prepared blood slides (as well as other materials such as slide grids or rulers, laptops, pencil, light source etc.). 2. Place the slide on the stage and focus using low power (LP). 3. Using the conversion $1\text{ mm} = 1000\text{ }\mu\text{m}$, the diameter of the LP and high power (HP) field of view is calculated. (Ruler, grid slide or microscopy software could be used). 4. Focus on some red blood cells, estimate their size by counting the number across the field of view and dividing into field of view diameter, then measure the cells using software OR use secondary sources to check the size of red blood cells and see if you agree with the estimate. 5. Browse over the field looking for some white blood cells. Look for larger cells with clearly defined and stained nuclei and, using the same technique outlined in step 4, estimate and check the size of white blood cells. 6. Carefully remove the slide from the microscope and return the microscope and slides in an orderly manner so as to limit damage to the microscope, slides and to others in the laboratory.	9.2.2 H11, H12, H15 - Identifies the main features of the method for an appropriate investigation. - States an appropriate method for estimating the size of red and white blood cells and states a method for checking the reliability of the size estimates. - Identifies a suitable way of minimising risks to equipment and/or humans 4–5 - Identifies some of the main features of the investigation with reference to the method for estimating the size of red and white blood cells 2–3 - Makes some correct statements relating to the method 1
(c)	Fresh human blood is a potentially hazardous biological agent due to its ability to harbour pathogens and infectious diseases such as HIV and Hepatitis B. Given the difficulties involved in testing and screening fresh blood, prepared slides that have been sourced from safe, reputable distributors are used instead. This reduces the risk of catching/spreading diseases in this investigation to no/zero risk.	9.2.2 H12, H16 - Explains that the use of fresh blood is a biological hazard. - States that the use of prepared blood slides minimises the risk considerably. 2 - States that blood is a potential biological hazard/risk 1
Question 22		
(a)	ONE of: adenine, cytosine, guanine, thymine.	9.3.3 H9 • Correctly names ONE of the DNA bases. 1
(b)	The process is transcription.	9.3.4 H6 • Correctly names the process of transcription. 1
(c)	If the DNA code is changed, the polypeptide may be affected, since the DNA codes for the formation of the RNA, which in turn determines the sequence of amino acids that make up the polypeptide. If the changes to the polypeptide sequence are sufficiently detrimental, the polypeptide that is formed may not function properly.	9.3.4 H6, H13 - Clearly establishes the link between changes in the DNA and changes in the amino acid structure of the polypeptide 2 - States a correct feature of changes. 1
Question 23		
Sexual reproduction greatly increases the variability in offspring. As can be seen in the table, the chances of two humans (46 chromosomes) receiving the same chromosome set from their two parents is an astronomically small number. This is due to the independent assortment of chromosomes at meiosis, but also due to the fact that this happens in each parent. The inheritance of different genetic material from each parent means that the variability is high for sexual reproduction.		9.3.2 H6, H9, H14 - Clearly establishes the link between increased genetic variability in offspring and sexual reproduction, with reference to the information in the table 2 - States some correct features of increased variability 1

Part B (Continued)

Sample answer	Syllabus content, course outcomes and marking guide
Question 24	
(a) To produce a transgenic species, the following processes need to occur: 1. Identification of the desired gene in the donor organism. 2. Cutting out the desired gene from donor organism's genome. 3. Inserting the desired gene into a vector such as a virus to transport into the host organism. 4. The insertion of the desired gene into the host organism's genome.	9.3.5 H4, H6 Provides steps and processes required to produce transgenic species, including: • desired gene cut out from donor DNA AND • desired gene inserted into host DNA 2 • States a feature of processes required to produce transgenic species. 1
(b) Transgenic species are produced for a variety of reasons. Most have applications in agriculture. For instance, a variety of cotton has been developed that produces a pesticide from a gene sourced from a bacterium. Other crop species that are susceptible to frost might have an antifreeze gene from Arctic fish inserted into their genome. Another area of application for transgenic species is in medicine. For instance, the human insulin gene has been inserted into a bacterium so that insulin for diabetes sufferers is produced in great quantities by the bacterium.	9.3.5 H4, H6, H7 • Provides reasons why transgenic species are developed 2 • States a reason why transgenic species are developed 1
Question 25	
(a) The human body has the ability to recognise a transplanted animal organ as foreign (particularly if the organ is from an individual of a different species). This triggers an immune response, leading to likely rejection of the new organ.	9.4.4 H6, H12 • Makes a correct inference from the information given, including mention of the immune response and possible rejection of the new organ 2 • Makes a correct inference from the information given, including mention of the immune response OR possible rejection of the new organ 1
(b) Due to the presence of 'non-self' proteins on the surface of the transplant, the following may occur: 1. Phagocytosis – white blood cells move to the area and attempt to engulf the foreign cells. 2. B cells will be produced. They form antibodies that bind to the foreign tissue. 3. A variety of different types of T cells will be produced; e.g. cytotoxic ('killer') T cells bind to the antigen, releasing an enzyme that destroys the cell membranes of the foreign tissue.	9.4.4, 9.4.5 H6 • Describes three of the body's responses to the introduction of a transplanted organ . . 3 • Describes two of the body's responses to the introduction of a transplanted organ 2 • Describes one of the body's responses to the introduction of a transplanted organ 1
(c) Bacteria or prion.	9.4.3 H6 • Correctly names a pathogen. 1
(d) For xenotransplantation to work, researchers must find a way to block the human body's immune response. Future research may result in the production of more effective immunosuppressive drugs, or ways of preparing the body more effectively to receive the new organ. Scientists must also develop methods to keep viruses, possibly carried by these organs, from entering the human population. Xenotransplantation is likely to be replaced eventually by a new biological technique that allows tissues to be grown from a host's own cells, e.g. In June 2006 new beating heart tissue was grown successfully in rats by Australian medical scientists.	9.4.4 H5, H14 • Identifies two appropriate future directions for research 2 • Identifies one appropriate future direction for research 1

Part B (Continued)

Sample answer	Syllabus content, course outcomes and marking guide
Question 26 Endotherms have the ability to regulate their body temperature. In order to do this, endotherms have higher metabolic rates at lower environmental temperatures (approx. 5 to 20°C) and lower metabolic rates at higher temperatures (above 35°C) in order to counter the effects of changing temperatures. Ectotherms do not have the ability to regulate their own body temperature and so the rates at which they can metabolise increases as environmental temperature increases.	9.2.1 H6 • Recognises that endotherms have the ability to regulate their body temperature. • Recognises that ectotherms do not have the ability to regulate their own body temperatures. • Correctly explains the relationship between environmental temperature and metabolic rate of the endotherm. • Correctly explains the relationship between environmental temperature and metabolic rate of the ectotherm 4 • Three of the above are correct 3 • Two of the above are correct 2 • One of the above is correct 1
Question 27 A vaccine is a preparation containing dead or attenuated pathogens or toxins. Vaccines help prevent infection by triggering the body's own immune response. Vaccinations are used in immunisation programs, often as a public health measure. Professor Frazer's newly developed vaccine has the potential to prevent thousands of deaths from cervical cancer every year, revolutionising women's health across the globe. Other vaccination programs have been incredibly successful in reducing the occurrence of disease across the world. Smallpox has been eradicated worldwide. Since the 1930s, the number of children dying from whooping cough, diphtheria, tetanus, polio and measles in Australia has decreased enormously, largely as a result of government-subsidised immunisation programs. While it costs millions of dollars to administer these campaigns, it is a cost-effective way to spend the health budget. Hospitalisation and treatment are more expensive than vaccination. There are some problems with the use of vaccines, however, which occasionally result in groups within the community speaking out against their use. Some people develop side-effects such as nausea, fever and swelling at the site of the infection. Some vaccines only provide short-term immunity and have to be re-administered at regular intervals. In the case of the vaccine for cervical cancer, some people have expressed concern about the intention to administer it to girls before they become sexually active. There is a belief that it may encourage promiscuity. While acknowledging these concerns, it is difficult to deny the major contribution vaccination programs have made and will continue to make towards limiting the spread of human disease.	9.4.5 H4, H6, H13, H14 • States what is meant by vaccination. • Outlines the effectiveness of named vaccination programs. • Describes a number of logical points for and/or against the use of vaccination in controlling the spread of disease. • The argument follows a logical sequence, with the use of appropriate biological terminology. • Includes a value judgement 7–8 • States what is meant by vaccination. • Outlines the effectiveness of named vaccination programs. • Outlines a number of logical points for and/or against the use of vaccination in controlling the spread of disease 5–6 • States what is meant by vaccination. • Outlines the effectiveness of a named vaccination program. • Outlines at least one logical point for and/or against the use of vaccination in controlling the spread of disease 3–4 • Identifies an appropriate issue or argument relevant to the question 1–2

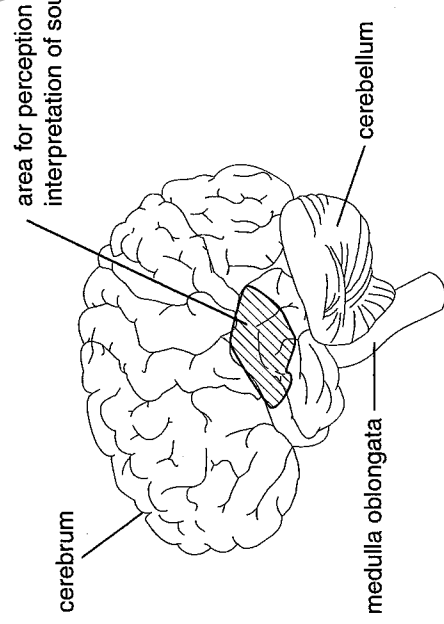
Section II

Question 28

Communication

Sample answer

Syllabus content, course outcomes and marking guide	
(a) (i) Organ of Corti in the cochlea.	9.5.6, 9.5.1 H6 • Identifies specific location 1
(ii) Sound travels through all substances, so an animal, whether aquatic or terrestrial, is always surrounded by a medium that transmits sound. Sound can be used for communication both day and night and over distances too great for other forms of communication; e.g. smell or touch. Sound can generally be produced and detected by most humans and other animals so messages can be sent between them.	9.5.5 H6, H13 • Explains clearly the relationship between the characteristics of sound and its usefulness and versatility in communication, using three points 3 • Explains the relationship between the characteristics of sound and its usefulness and versatility in communication, using two points 2 • Identifies why sound is useful or versatile as a form of communication. 1
(b) (i) If an actual mammalian brain is not available for examination and/or dissection, a physical or computer-generated model could be very useful, as it represents the real organ in three dimensions and enables the relationship between parts to be determined. Use of a model may result in reduced risk to the observer, as living tissue does not need to be handled or dissecting equipment used. A 3D model may be taken apart more easily to study individual parts.	9.5.7 H6, H12, H14 • Assesses the usefulness of a model of the brain by making a judgement about its value or outcomes with two reasons for the judgement 2 • Assesses the usefulness of a model of the brain by making a judgement about its value or outcomes with a reason for the judgement . . 1
(ii)	9.5.7 H6, H12 • Draws a clear diagram of the brain, correctly labelling cerebrum, cerebellum and medulla oblongata, and the regions involved in the perception and interpretation of sound . . 4 • Draws a clear diagram of the brain, correctly labelling THREE of the parts requested. . . 3 • Draws a diagram of the brain, correctly labelling TWO of the parts requested . . . 2 • Draws a diagram of the brain, correctly labelling ONE of the parts requested . . . 1



Question 28 Communication (Continued)

Sample answer	Syllabus content, course outcomes and marking guide
(c) One of the causes of blindness in humans is the clouding of the lens or cataract. A recent technological advance used to prevent blindness due to this condition is the intraocular lens implant. The newest technology involves breaking the affected lens up with a small vibrating probe, after which the lens is removed by suction then replaced with an artificial lens. The incision into the eye may be so small that no stitches are needed. This results in faster recovery time and thus people return to work earlier. Older people who have had the surgery can lead more independent, productive lives with less reliance on welfare. The surgery can be performed in developing countries as it is relatively easy to train surgeons and manufacture the lenses locally. The positive impact on society of this technology is thus evident. A recent technology used to correct hearing loss is the cochlear implant. This device performs the function of damaged hair cells, stimulating nerve fibres in the inner ear, bypassing the auditory pathway. It is useful for profoundly deaf children and adults, and it can be programmed to an individual's requirements. Miniaturisation of the components of this device and improvements in the quality of the sounds received have resulted in the device becoming more widely available. Children, in particular, receive significant gains in sound awareness, speech understanding and speech production. This has resulted in them being more likely to be integrated into mainstream education with consequent benefits to the individual and to the community. Lack of acceptability by certain members of the deaf community and the cost of insertion and maintenance of this device are problems that society needs to address.	9.5.3, 9.5.6 H4, H8, H14 - Makes judgements based on criteria using well-developed argument that makes the link between the advantages of recent technologies and their impacts on society. Includes evaluation of both types of technologies. Sequences arguments logically and uses correct biological terminology. 6–7 - Attempts to make a judgement, identifying appropriate technologies and related impacts. Makes the link between the advantages of ONE recent technology and its impact on society. Makes limited use of correct biological terminology. 4–5 - Identifies both types of technologies and some related impacts on society 2–3 - Identifies a technology to correct sight or hearing and its impact on society. 1
(d) (i) Cell A is a cone cell; cell B is a rod cell. (ii) Cones are concentrated in the centre of the retina whereas rods are evenly distributed across most of the retina (apart from the fovea). Rods detect light and shade whereas cones are responsible for colour vision.	9.5.4 H6 - Identifies cells A and B correctly 1 9.5.4 H6 - Outlines the difference in distribution and function of cones and rods. 2 - Outlines the difference in distribution OR function of cones and rods. 1

Question 28

Communication (Continued)

Sample answer	Syllabus content, course outcomes and marking guide
(iii) The human eye uses the cornea, lens and other refractive media to focus light produced or reflected by the object viewed. This focused light forms a normally clear, inverted image on the retina at the back of the eye. Focus is achieved by the changing shape of the lens. The image produced by an insect eye on the other hand, is in the form of a mosaic and is relatively blurry. The differences in these images can be attributed to differences in structure and function of the two organs. Unlike the human eye which is a single structure, the insect eye is made up of thousands of separate units called ommatidia. Each ommatidium only forms an image of part of an object. A transparent cornea and a crystalline cone refract light rays down to the retinal cells. The crystalline cone is unable to change its shape, unlike the lens of a human eye. However, the insect eye is more efficient at detecting slight movement over a wide range as it has a high rate of 'flicker fusion' and the multiple ommatidia detect images from every direction.	9.5.4 H6, H7, H14 - Shows clearly how the images are different and analyses why the images are different in terms of the differences in structure and/or function of the human and insect eyes. .4-5 - Identifies ONE difference in the images and relates it to ONE aspect of the difference in structure or function of the human and insect eyes2-3 - Identifies ONE difference in the images OR the structure of the human and insect eyes.1