SK277 Human Biology

Are you ready for SK277?

Contents

WEB 04508 7
1.1

1 Introduction

If you are intending to study SK277 *Human Biology*, you will want to make sure that you have the necessary background knowledge and skills to be able to enjoy the module fully. This will give you the best possible chance of completing it successfully. This material is designed to help you do just that.

SK277 addresses the question of human health, and the ways in which social, psychological and particularly biological factors interact to produce a healthy individual. The module contains material from three disciplines: the first is biology (the largest component of the module), which is the study of living organisms, their body structures and functions and their interrelationships; second, psychology, which is concerned with the study of human behaviour and mental states; and third, sociology, which is the study of human interactions and social relationships, their organisation, functions, development and significance.

As with students on many other modules in human biology, you will spend much of your time learning about the biology of organ systems, but the approach of this module, where possible, is holistic. This means we have tried to keep in mind the 'whole', when trying to give explanations of particular topics or issues. With this aim we have, as a distinctive feature of this module, developed a series of relevant *case reports* that have been integrated within each chapter. These accounts are of individuals' experiences associated with particular disease states. They should serve to remind you of the 'knock-on' effect of malfunction in one system or part of a system to the functioning of the rest of the body. More than that though, because we are social beings, the approach is extended to interactions with other persons as well as interactions with society, because disease almost always affects an individual's social life and interpersonal relationships.

2 Previous study for SK277

It is important to realise that SK277 is a Level 2 science module, and that it makes intellectual demands commensurate with this. Some of you will already have taken modules in science, social science or from the health studies area, while others may be new to study at The Open University. If you are in the latter category, you should prepare yourself for a particularly challenging and exciting year of study. Although SK277 is designed to be accessible to students who have studied Level 1 modules and are from a broad range of educational backgrounds, experience has shown that some people find it difficult to cope with learning new study skills at the same time as tackling a Level 2 university module. If you get into difficulties, you will find helpful advice in *The Sciences Good Study Guide* by A. Northedge, J. Thomas, A. Lane and A. Peasgood, published by the Open University Press in 2005 (ISBN 0749259744).

3 Module profile and demands

SK277 is a 30 credit module and involves about 300 hours of study and work spread over 31 weeks. There are four Books which are supported with online activities.

The module has two main themes:

1 The interaction between, and interdependence of, components in a healthy individual and the demonstration that malfunctions can lead to disease. This is manifested (i) at the whole-body level, looking at individuals, their relations with each other and with their environments; (ii) at the system level, where different sets of organs and tissues cooperate to maintain a healthy body; and (iii) at a metabolic level, where molecular components interact to maintain function both in health and during disease processes.

2 The variability between individuals and across an individual's lifespan. This is manifested in the dynamic nature of life processes, across generations, within a whole lifespan as well as moment by moment.

The aims of the module are summarised by the following statements:

1 To place human biology in an interdisciplinary context that will appeal to students from a variety of backgrounds, whether in science, technology, the humanities or the paramedical professions.

2 To enable students to appreciate how such knowledge is relevant to issues in health and healing as well as disease.

4 Assessment

The assessments in SK277 are designed to assess how you have fulfilled the learning outcomes for the module. There are two components: three formative tutor-marked assignments (TMAs), which you are expected to complete at intervals throughout the academic year and a final examination, which you will sit at the end of your study of SK277. The three assignments will be marked by your tutor but won't count towards your overall module grade – though you have to achieve an overall score of at least 30% in your TMAs to pass the module. Your final grade for SK277 is determined by your performance in the exam.

The format of the three TMAs and exam are broadly similar which ensures that your progress can easily be measured within a standard framework, and you are not faced with major surprises in the exam. You will be tested on factual recall, on your ability to interpret, analyse and present experimental data, to extract information from scientific literature, and your ability to write extended answers that synthesise material from several parts of the module. Initially, you will probably not be able to produce written material on very wide-ranging topics; but, over the course of the year, we will expect your answers to become increasingly wide ranging, using material from more than one book, as well as other sources of information, such as the multimedia resources and any text provided as part of the TMA assignments.

The following self-assessment questions are designed to make you aware of some of the skills you will need to master in order to make the most of SK277.

5 Self-assessment questions (SAQs)

SAQ 1

Identical twins have identical genes. What would a person who believes in biological determinism predict about the growth and development of identical twins who were separated at birth and brought up by different families?

SAQ 2

Suppose a friend of yours who is pregnant and also a heavy smoker has heard that smoking tends to reduce the baby's weight thus making the delivery easier and safer. What would be your advice to her?

SAQ 3

(a) What is the body mass index?

(b) Calculate the body mass indexes for Sarah, 1.65 m tall and 55 kg, and Ian, 1.84 m tall and 88 kg. What do the values indicate about the health of these individuals?

SAQ 4

Name and briefly describe the two structural specializations of the intestinal epithelium that facilitate absorption of nutrients.

SAQ 5

For the following statements say whether they are true or false and justify your answer.

(a) Phantom limb pain is all in the mind.

(b) If you sustain an injury to the right half of the spinal cord in the region of the thoracic vertebrae you will subsequently feel neither touch nor pain from the right leg.

SAQ 6

Design and draw a flow chart that summarizes the role of glucagon in increasing blood glucose and ketone levels during starvation.

SAQ 7

Assume that your heart rate is 70 beats per minute and your stroke volume is 70 ml.

(a) Calculate your cardiac output (in litres per hour).

(b) What factors affect cardiac output?

SAQ 8

What changes occur in the cardiovascular and respiratory systems in response to the onset of exercise and how are these changes brought about?

SAQ 9

Explain why infectious diseases common among children in some countries (such as measles, which is caused by a viral infection) do not generally occur twice in the same person. Explain your answer in terms of clonal selection theory.

SAQ 10

Distinguish between the restorative and ecological theories for the function of sleep.

SAQ 11

It has been suggested that people in lower occupational positions have poorer health because of greater stress.

(a) How would you test this hypothesis?

(b) What recommendations would you make for employers to improve the health of their lower-grade employees?

SAQ 12

Explain why taking combined oral contraceptive pills (COCs) suppresses follicular growth and development and secretions of oestrogens by the ovary.

6 Answers to self-assessment questions

SAQ 1

The twins should show identical features of growth and development, despite their different environments, since, to a biological determinist, every aspect of their biology is determined by their identical genes.

SAQ 2

You could confirm that heavy smoking does tend to reduce the baby's birth weight, but that it does so by reducing the amount of oxygen and nutrients that the baby receives from the mother. You could point out that this could have long-term consequences for the person's future health, as suggested by epidemiological studies. You might then explain how this could happen through the effects on the blood vessels of the body: reduced oxygen and nutrients for the fetus result in preferential blood flow to the brain, so the body experiences reduced blood pressure and the vessels may then fail to develop normal elasticity, which could be irreversible. Finally, to reassure her, you could add that there are many built-in protective factors for the fetus, and that reasonable care is all that is required for a successful childbirth.

SAQ 3

(a) The body mass index (BMI) of an individual can be calculated to determine whether they are within the healthy range for their height:

$$\text{BMI} = \frac{\text{weight/kg}}{(\text{height/m})^2}$$

(b)

$$\text{Sarah: BMI} = \frac{55}{1.65^2} = \frac{55}{2.7225} = 20.2$$

$$\text{Ian: BMI} = \frac{88}{1.84^2} = \frac{88}{3.3856} = 25.99 = 26$$

Sarah is classified as within the healthy weight range, although she needs to take care not to lose any weight as she is near the bottom of the range.

Ian is classified as overweight and should be advised to try and lose weight. He is only just in the overweight classification and it would be sensible to lose the small amount of weight necessary to put him in the healthy range.

SAQ 4

The epithelium has many finger-like projections, called villi, and the absorptive cell membrane of individual epithelial cells has many small projections, called microvilli, which form the brush border. These specialisations greatly increase the surface area through which absorption can take place.

SAQ 5

(a) False. Although phantom limb pain is ‘in the mind’ to the extent that it is ‘felt’ as pain coming from an area that no longer exists, currently it is believed that what is being detected is activity in damaged nociceptors and the activity in tensed up muscles in the stump area of the missing limb. Pathways from this area may also be overly sensitive to stimulation (hyperexcitable).

(b) Partially true. A key point here is where the tracts cross the midline of the spinal cord. The injury (lesion) will cut through all tracts on the right side of the spinal cord. The right dorsal columns receive input from the right leg, where there will be a loss of touch, but pain sense in the right leg will be unaffected. The right spinothalamic tract contains the axons of neurons in the left dorsal horn, and so there will be a loss of pain sense in the left leg. Touch sense in the left leg will be normal. Award yourself a bonus mark if you also mentioned that there will be paralysis of the muscles in the right leg, due to damage to motor nerves in the spinocortical tract on the right side of the spinal cord!

SAQ 6

There are a number of ways of drawing the flow chart and Figure 1 demonstrates one way of doing so:

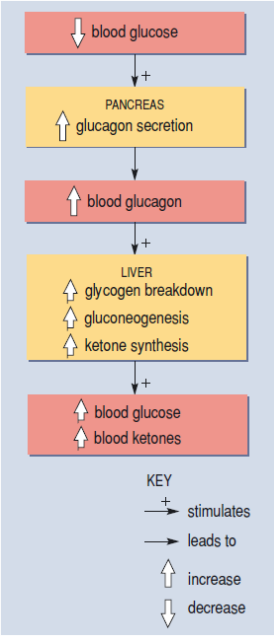

Figure 1 A flow diagram that shows the factors that affect the release of glucagon and the effects of the hormone on blood glucose and ketone levels.

SAQ 7

(a) Using the relationship:

cardiac output = heartrate × stroke volume

cardiac output = 70 beats per min × 70 ml

= 4900 ml per min

= 4.9 litres per min

= 4.9 litres × 60 min = 294 litres per hour

(b) Cardiac output can be altered by changes in heart rate or stroke volume or both, as given by the equation used in (a). Heart rate is the major controlling factor and it is increased by increased sympathetic (noradrenergic) nervous activity stimulating the sinoatrial node (SAN); it is decreased by parasympathetic (cholinergic) innervation of the SAN derived from the vagus nerve. The heart rate can also be influenced by humoral factors (e.g. circulating adrenalin and noradrenalin – the 'fright, fight and flight' hormones). Stroke volume is dependent on the venous return (Starling's law), so an increase in venous return (pre-load) will increase stroke volume. Contraction of the smooth muscle in the walls of the veins and venules increases the venous pressure and forces a greater volume of blood back towards the heart, so increasing venous return.

SAQ 8

During exercise, the working muscles require an increased supply of oxygen, which demands simultaneous increases in cardiac output and ventilation. An increase in heart rate and stroke volume increases cardiac output. The heart rate is increased by a reduction in the tonic inhibition of the sinoatrial node. Stimulation by the sympathetic nervous system and the action of circulating adrenalin and noradrenalin cause vasoconstriction, which increases the peripheral resistance and venous return, which by Starling's law results in increased stroke volume and thus cardiac output.

Sympathetic nerve activity also increases ventilation by stimulating the contraction of the inspiratory muscles. Metabolic autoregulation in the muscle capillary beds increases the local blood supply through active tissues. A build-up of lactate during exercise shifts the oxygen-haemoglobin dissociation curve to the right with the result that oxygen is released from haemoglobin more easily. After cessation of exercise, the alterations in ventilation and cardiac output persist until the post-exercise oxygen consumption caused by lactate acid build-up is returned to a normal level.

SAQ 9

When a child becomes infected with (say) the virus that causes measles for the first time, members of any clones of small lymphocytes in the adaptive immune system which have *antigen receptors* or the correct shape bind to *epitopes* on the virus (*antigen recognition* lead to *clonal selection*). Clonal expansion follows and various types of defensive cells differentiate and initiate a primary immune response directed specifically against the measles virus epitopes. After the virus has been eliminated, the immune system remains permanently adapted to mount a faster, more effective *secondary response* against the measles virus if the same epitopes are ever encountered again. This ability (*immunological memory*) relies on the differentiation of long-lived memory cells during the *primary response*, which form an expanded clone of cells ready to react quickly and effectively to a second exposure to the measles epitopes. It is unusual to have measles twice because the person usually becomes *immune* to the virus after the first exposure.

SAQ 10

The restorative theory proposes that sleep has a short-term effect, allowing the body and the brain to recover from daytime activity. The ecological theory suggests that sleep is an adaptive pattern of behaviour by keeping animals 'out of harm's way' during certain times of day.

SAQ 11

(a) There are many possibilities. You could measure levels of hormones such as cortisol when people arrived for work, or monitor people's heart rate or adrenalin levels in response to talking about their jobs.

(b) If people were given greater control, for example, of the hours they worked, the order in which they did their tasks, or the way they worked together, their levels of stress would be expected to reduce. By giving employees information about future plans, and including them in company decisions, you could give them a greater sense of predictability. Finally, you could provide sports facilities and other outlets for stress.

SAQ 12

Combined oral contraceptive pills contain oestrogens and progestins. High blood progesterone depresses levels of plasma FSH and LH by negative feedback, supressing secretion of these hormones by the anterior pituitary. High blood progesterone levels also supress the positive feedback response of the pituitary to oestrogen, so that there is no LH surge and ovulation is blocked. Normally in the luteal phase of the menstrual cycle, high progesterone suppresses FSH preventing the initiation of growth of primordial follicles and a new menstrual cycle.