IGCSE and GCSE Biology. Answers to questions

Section 3. Human physiology.

Chapter 13 Breathing

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1. Nasal cavity, trachea, bronchus, alveolus.
2. The absorbing surfaces are very large; thousands of alveoli, thousands of villi.
   The epithelium lining of both organs is very thin, consisting of a single-cell layer.
   Both organs are richly supplied with a network of capillaries which carry off digested food or allow rapid transport of oxygen.

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1. The diaphragm muscle contracts and so do the external intercostal muscles.
2. External intercostal muscles contract, ribs rise, thorax expands, lungs expand, air enters lungs.
3. The alveoli would expand most. The bronchioles would expand very little.

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1. Respiration is the production of energy from glucose. Ventilation is the process which refreshes the air supply in the lungs. Gaseous exchange refers to the output of carbon dioxide and intake of oxygen which takes place across the epithelium of the lungs.
   Ventilation ensures a constant replenishment of oxygen in the lungs and the removal of carbon dioxide. Gaseous exchange allows the oxygen to reach the blood vessels in the lungs and the carbon dioxide to leave. The oxygen absorbed by gaseous exchange reaches the cells and allows the production of energy in respiration.
2. The oxygen molecule is carried to the alveoli via the trachea, bronchus and bronchiole. It diffuses through the alveolar lining to reach a capillary where it combines with the haemoglobin in the red blood cell. The oxygenated blood is then carried from the lung to the right atrium of the heart in the pulmonary vein.
3. The direction of diffusion depends on the relative concentrations of the gases on each side of the alveolar lining. The oxygen concentration in the lungs is greater than that in the blood, so oxygen diffuses from the alveolar air into the capillaries. Conversely, the carbon dioxide concentration in the blood is greater than that in the alveoli. So CO_2 diffuses out of the blood into the alveoli.
4. Exhaled air still contains 16% oxygen which is quite enough to oxygenate the blood.
5. **a** At rest, you breathe about 16 times a minute and exchange $500cm^3$ with each breath. This amounts to 16 x 500 = 80,000 cm^3 (80 litres).
   b Similarly, during exercise, the breathing rate can be 20 - 30 times a minute and exchange 30 + 5 litres. So you might exchange between 20 x 35 = 700 and 30 x 35 = 1050 litres.

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1. **a** The immediate effects on the breathing system are constriction of the bronchioles, cessation of the ciliary movement and over-production of mucus.
   b The long-term effects are ‘smokers’ cough’, breakdown of the alveolar walls (emphysema), and chronic bronchitis.

2. The breakdown of the alveolar walls leads to a reduced surface for the absorption of oxygen. This means the breathing rate has to increase up to the point where it no longer meets the demands of the body for oxygen.
3. If you smoke 20 cigarettes a day, you are 13 times more likely to suffer from lung cancer than is a non-smoker.
4. Bronchitis, emphysema, heart disease, atheroma in the leg arteries, strokes, bladder cancer, gastric and duodenal ulcers, gum disease, tooth decay and tuberculosis.

Chapter 14 Excretion and the kidneys

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1. Carbon dioxide, urea, uric acid, water, salts, spent hormones, toxins, bile pigments.
2. Levels of urea, uric acid and breakdown products of hormones will give a clue as to how well the kidneys are working. Urine analysis will reveal substances that should not be there such as glucose, proteins, blood cells or drugs. These substances may lead to a diagnosis of a disease. (This information is not given in the text).

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1. It is the pressure of the blood which forces blood plasma (minus proteins) out of the capillaries of the glomerulus and into the renal capsule. With a fall in blood pressure, less fluid reaches the renal capsule. As a result, nitrogenous waste and other harmful substances remain circulating in the blood.
2. The renal vein will contain less urea, uric acid, salts, water and harmful substances than the renal artery. It will also contain less oxygen and more carbon dioxide.
3. Filtration; glomerulus. Reabsorption; renal tubule. Storage of urine; bladder. Transport of urine; ureter. Osmoregulation; collecting duct*.
   (*Not mentioned in text. ‘Renal tubule’ would be acceptable).
4. Loss of water during sweating causes an increase in the concentration of the blood so less water is reabsorbed by the kidney. This leads to a reduction in the volume of urine produced. This smaller volume still has to contain all the excretory products and so it becomes darker. When sweating ceases, there is more excess water to be removed by the kidneys, so urine production increases and dilutes the excretory products with the result that the urine is almost colourless.
5. The molecule of urea leaves the liver in the hepatic vein which joins the vena cava. The vena cava delivers its blood to the right atrium of the heart. The urea molecule then passes from the right atrium to the right ventricle and enters the pulmonary artery and, after passing through the lungs, enters the pulmonary vein which opens into the left atrium. It is pumped out by the left ventricle into the aorta which gives off a branch, the renal artery, which delivers the urea molecule to the kidneys. The molecule is filtered out of a glomerulus into a renal capsule which passes the urea molecule down the renal tubule to the pelvis of the kidney. From here the molecule passes down a ureter to the bladder, and to the outside world in the urine.
6. This question is flawed. The result does not give an answer compatible with the known figures. Apologies.

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1. **a** The kidneys. **b** The liver. **c** The skin. **d** The lungs.
2. **a** The dialysis machine resembles the kidney in that it filters unwanted substances through a membrane.
   b It differs from the kidney in the way that it prevents the loss of useful substances. In the kidney these are reabsorbed into the blood as they pass down the renal tubule. In the dialysis machine they are prevented from escaping by maintaining a solution outside the tube which carries the same concentration of these substances as in the blood, so that there is no diffusion gradient.

Chapter 15 The skin, and temperature control

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1. Principally; put on more or warmer clothing; take shelter in a warm environment. Minor actions; hot drinks, use external sources of heat, vigorous exercise.
2. Heat is one of the forms of energy produced by respiration both in active muscles and all other tissues. The heat is distributed round the body by the blood circulatory system.
3.

Gains	Losses	
Respiration	Conduction	to the environment
External sources e.g. sunlight	Convection	
central heating, hot food and drink	Radiation	
	Evaporation	

4. **a** The hairs **b** Vasoconstriction, cessation of sweating.
5. Your 'core' temperature changes very little. You feel cold when sensory organs in the skin detect and respond to heat loss. Similarly you feel hot when other receptors in the skin detect and respond to heat gain. These receptors send impulses to the brain which interprets them as 'feeling cold' or 'feeling hot'.
6. **a** Sweat will not evaporate if the air round the body is very (a) humid, (b) still.
   b Sweat will evaporate more rapidly if (a) the humidity is very low and (b) if there is air movement to carry the water vapour away.
7. Negative feedback triggers reactions which counteract the changes and restore the system to its steady state. Positive feed back would assist the changes and lead to an ever-increasing change in the system.

Chapter 16 Human reproduction

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1. Sperm cells are much smaller than ova. They have much less cytoplasm but they do have a long tail.
2. Epididymis, sperm duct, seminal vesicle and prostate gland, urethra.
3. Kidney, pelvic girdle, erectile tissue, foreskin, scrotum, rectum.
4. A zygote can give rise to any of the tissues in the body and can grow into a complete organism.

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1. a Ovulating once per month, a woman with a reproductive life of 37 years might release 12 x 37 = 444 ova.
   b In the developed world only two or three ova are likely to be fertilized. It could be many more. In the developing world, the numbers could be 5 or more.
2. Vagina, cervix, uterus, oviduct.
3. At the moment of fertilization, the male nucleus (from the sperm cell) fuses with the female nucleus (of the ovum).
4. **a** Sperms retain the ability to fertilize an ovum for two or three days. So, fertilization is possible if mating occurs 2 days before ovulation.
   b If the ovum survives for only 24 hours, mating 2 days after ovulation is unlikely to lead to fertilization.

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1. The umbilical vein will contain less oxygen, glucose, amino acids and salts, and more carbon dioxide and urea (nitrogenous waste) than the umbilical artery.
2. The embryo receives all the oxygen it needs from the blood reaching it from the umbilical artery (via the placenta).
3. If the twin boys are formed from a single fertilized ovum they will be identical twins. If they arise from two, separate fertilized ova, they will be fraternal twins.

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1. **a** Developing manual skills, animal and crop husbandry, adapting to seasonal changes but also reading and mathematics will be essential in modern farming.
   b Reading and mathematics will be essential as well as manual skills.
2. The onset of ovulation means that the woman could conceive a child. Widening of the hips gives more space and support for a developing embryo. Enlargement of the uterus is in preparation for the developing embryo. The enlargement of the breasts is a result of the development of the mammary glands in preparation for breast-feeding.
3. Menstruation results from a breakdown of the uterine epithelium as a result of a failure of fertilization. If fertilization has taken place, the uterine lining will be retained and developed.

Chapter 17 The skeleton, muscles and movement

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1. Upper arm bone; *humerus*. Upper leg bone; *femur*. Hip bone; *pelvic girdle*.
   Breastbone; *sternum*. 'Backbone'; *vertebral column*, (not labelled). Lower arm bones; *radius* and *ulna*.

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1. Jaw bone/skull, fingers, toes, ribs/spinal column. (These are 'like' hinge joints in their action but may be given other names).
2. The skeleton protects vital organs (e.g. brain, spinal cord, lungs).
3. The rib cage protects the heart and lungs; its movement results in breathing. The pelvis is essential for locomotion using the legs and also protects, to some extent, the organs of the abdomen particularly the uterus. The skull protects the brain but also allows the head to move.

Page 157 (left)

1. Walking to school. Regular training for a football team. These both involve sustained, repeated exercise over a long period of time. The others are short-lived exertions.
2. The benefits of a short burst of exercise cannot be retained. Only regular exercise is beneficial. Muscle growth, enlargement of the ventricles and increase in stroke volume, flexibility of joints, strengthening of ligaments and tendons are long-term changes induced by regular exercise.
3. If the supply of oxygen for the increased rate of respiration in active muscles is insufficient, some of the glucose is converted, anaerobically, to lactic acid. Even after exercise stops, there is a residue of lactic acid in the blood. This has to be oxidised to carbon dioxide and water so the demand for extra oxygen continues during a period of recovery.

Page 157 (right)

1. A tendon transmits the force produced by a contracting muscle to a bone, causing a movement at the joint.
   A ligament holds the bones together at a joint while still permitting movement.
2. The extensor and flexor muscles for the fingers are in the forearm attached to the radius and ulna.