EDUQAS: Biology GCSE specification For GCSE exams 2018 onwards **Higher Tier content in bold**	**Revision Guide page reference** **ISBN 9781407176864**	**Exam Practice Book page reference** **ISBN 9781407176871**	**Revision and Practice Book page reference** **ISBN 9781407176888**
1. CELL BIOLOGY			
1.1 PROKARYOTIC AND EUKARYOTIC CELLS *Learners should be able to:*			
(a) draw and label animal and plant cells	9	9	11, 165
(b) describe the differences between eukaryotic and prokaryotic cells	8	8	10, 164
(c) explain how the following sub-cellular structures of eukaryotic cells (plants and animals) and prokaryotic cells (bacteria) are related to their functions: nucleus/DNA, plasmids, mitochondria, chloroplasts, cell membranes, cytoplasm, vacuole, cell wall	8, 9	8, 9	10, 11, 164, 165
(d) explain how the development of the microscope (light, electron, laser imaging) increased the understanding of the sub cellular structure of organisms and the proposal that the cell is the basic unit of life	8, 12	11	10, 14, 167
SPECIFIED PRACTICAL WORK · SP1.1 Examination of plant and animal cells using a light microscope and production of labelled scientific drawings from observation	15	13	17, 169
1.2 GROWTH AND DEVELOPMENT OF CELLS *Learners should be able to:*			
(a) describe the process of mitosis in growth, including the cell cycle; cell division by mitosis enables organisms to grow, replace worn out cells and repair damaged tissues	18	15	20, 171
(b) explain the importance of cell differentiation to produce specialised cells for greater efficiency	10, 11	10	12, 13, 166
(c) describe cancer as the result of changes in cells that lead to uncontrolled growth and division	43	30	45, 186

(d) describe the function of stem cells in embryonic and adult animals and meristems in plants; some cells, both plant and animal, do not lose the ability to differentiate and are called stem cells	19, 20	16	21, 22, 172
(e) discuss the potential benefits, risks and ethical issues surrounding stem cell technology in medicine including the implications for society e.g. the use of embryonic stem cells	19, 20	16	21, 22, 172
(f) explain the role of meiotic cell division in halving the chromosome number to form gametes; each meiotic division produces four cells that are genetically different because genes separate and are reshuffled during the process of gamete formation	100	66	102, 222
1.3 CELL METABOLISM *Learners should be able to:*			
(a) explain that chemical reactions in cells are controlled by enzymes. Enzymes are proteins made by living cells. Different proteins are composed of different amino acids linked together to form a chain which is then folded to form a specific shape held by chemical bonds. The specific shape of an enzymes active site enables it to function. This is called the 'lock and key' hypothesis. Enzymes function by the formation of the enzyme-substrate complex at the active site	30, 31	21, 22	32, 33, 177, 178
(b) explain that enzymes speed up/catalyse the rate of chemical reactions. Each enzyme has its own optimum pH and temperature. Interpret enzyme activity in terms of molecular collisions. Boiling denatures most enzymes by altering their shape	30, 31	21, 22	32, 33, 177, 178
(c) describe cellular respiration as an exothermic reaction which is continuously occurring in all living cells, enabling cells to carry out cell processes. Aerobic respiration occurs in cells when oxygen is available. It is a series of chemical reactions within the cell, controlled by enzymes. Glucose and oxygen are used and carbon dioxide, water and energy are produced. The energy released is in the form of ATP. Recall the word equation for aerobic respiration	67, 68, 69, 71	46	69, 70, 71 ,73, 202

(d) explain that in the absence of oxygen, anaerobic respiration may occur. This is less efficient than aerobic respiration. In humans energy is released from glucose and lactic acid is produced. An oxygen debt may occur. In yeast, glucose is broken down and ethanol and carbon dioxide are produced. Recall the word equation for anaerobic respiration in human cells and fermentation in yeast. Explain that there is less ATP released per molecule of glucose in anaerobic respiration than in aerobic respiration because of the incomplete breakdown of glucose	68, 69, 70	46, 47	70, 71, 72, 202, 203
(e) compare the processes of aerobic and anaerobic respiration	68, 69, 70	46, 47	70, 71, 72, 202, 203
(f) explain that fats, made up of fatty acids and glycerol, proteins, made up of amino acids, and starch (a carbohydrate), made up of a chain of glucose molecules, in our food are insoluble. They are broken down during digestion into soluble substances so that they can be absorbed	28, 29	21, 22	30, 31, 177, 178
(g) explain the importance of the digested products of fats, carbohydrates and proteins. Fatty acids and glycerol from the breakdown of lipids and glucose from the breakdown of carbohydrate are needed for respiration. Amino acids from digested proteins are needed to synthesise proteins in the body	29	21, 22, 23	31, 177, 178, 179
SPECIFIED PRACTICAL WORK · SP1.3A Investigation into factors affecting enzyme action · SP1.3B Qualitative identification of starch (iodine), glucose (Benedict's) and protein (biuret)	32, 33	23, 24	34, 35, 179, 180
2. TRANSPORT SYSTEMS			
2.1 TRANSPORT IN CELLS *Learners should be able to:*			
(a) explain that diffusion is a passive process and that only certain substances pass through the cell membrane in this way	21, 22	17	23, 24, 173
(b) explain that diffusion is the movement of substances down a concentration gradient including the use of Visking tubing as a model of living material. Explain the role of the cell membrane in diffusion	21, 22	17	23, 24, 173
(c) explain the process of osmosis as the diffusion of water through a selectively permeable membrane, from a region of high water (low solute) concentration to a region of low water (high solute) concentration	23, 24	18	25, 26, 174

(d) explain that active transport allows substances to enter cells against a concentration gradient and requires energy	26	20	28, 176
(e) explain the need for exchange surfaces and a transport system in multicellular organisms in terms of surface area:volume ratio	10, 22	17	12, 24, 173
(f) describe how oxygen, carbon dioxide, water, dissolved food molecules, mineral ions and urea maybe transported into and out of humans, green plants and single celled organisms	22	17, 18, 20	24, 173, 174, 176
SPECIFIED PRACTICAL WORK · SP2.1 Investigation into the effect of solute concentration on osmosis in potato chips	25	19	27, 175
2.2 TRANSPORT SYSTEMS IN HUMANS *Learners should be able to:*			
(a) describe the human circulatory system as a double circulatory system and its relationship with the gaseous exchange system. The blood passes through the heart twice in every complete circulation. The right side of the heart pumps the blood to the lungs and the left hand side pumps it around the rest of the body	34	25	36, 181
(b) label on a given diagram of the heart: the left and right atria and ventricles, semi-lunar, bicuspid and tricuspid valves, pulmonary artery, pulmonary vein, aorta and vena cava	34	25	36, 181
(c) explain how the structure of the heart is adapted to its function	34	25	36, 181
(d) describe the passage of blood through the heart including explaining the functions of the valves in preventing backflow of blood	34	25	36, 181
(e) describe and be able to compare the structure of arteries and veins	36	27	38, 183
(f) explain how arteries and veins are adapted to their functions	36	27	38, 183
(g) describe that in the organs blood flows through very small blood vessels called capillaries which allow exchange of substances. Explain that the thin walls of the capillaries are an advantage for diffusion and that capillaries form extensive networks so that every cell is near to a capillary carrying blood	36	27	38, 183

(h) describe the functions of the four main parts of the blood: plasma (transport of water, nutrients, hormones, urea, antibodies), red cells (carry oxygen), white cells (defence) and platelets (clotting). Explain how red blood cells, white blood cells, platelets and plasma are adapted to their functions in the blood	37	27	39, 183
SPECIFIED PRACTICAL WORK · SP2.2 Examination of artery and vein using a light microscope and production of labelled scientific drawings of these from observation	36	27	38, 183
2.3 TRANSPORT SYSTEMS IN PLANTS *Learners should be able to:*			
(a) explain that xylem tissue contains tubes of dead cells called xylem vessels and explain how the vessels are adapted to their role in the transport of water and minerals from the roots upwards within plants	44, 45, 46	31, 32	46, 47, 48, 187, 188
(b) explain how phloem is adapted to carry sugar from the photosynthetic areas to other parts of the plant. Sugar is moved to other parts of the plant for use in respiration and converted into starch for storage. This is called translocation	44, 45, 46	31, 32	46, 47, 48, 187, 188
(c) explain the significance of root hairs in increasing the area for absorption, the role of osmosis in the uptake and movement of water through a plant and how mineral salts are taken up by root hairs by active transport	22, 23, 44, 45	20, 32	24, 25, 46, 47, 176, 188
(d) describe the structure of a leaf and be able to label the following structures on a diagram of a T.S. leaf: cuticle, epidermis, stomata, palisade layer, spongy layer, xylem and phloem	44	31	46, 187
(e) describe the structure of stomata to include guard cells and stoma and how stomata can open and close to regulate transpiration	45, 46	32	47, 48, 188
(f) describe the process of transpiration resulting in the movement of water through a plant	45	32	47, 188
(g) explain the environmental factors that can affect transpiration, including light intensity, air movement and temperature and that this can be investigated with the use of a simple potometer	46	32	48, 188
3. HEALTH, DISEASE AND THE DEVELOPMENT OF MEDICINE			

3.1 HEALTH AND DISEASE *Learners should be able to:*			
(a) describe the relationship between health and disease	40, 41	29	42, 43, 185
(b) describe diseases as being communicable and non-communicable diseases as exemplified by influenza and cardiovascular disease	38, 39, 40, 41, 42	28, 29	40, 41, 42, 43, 44, 184, 185
(c) describe the interactions between different types of disease, as exemplified by the increased risk of developing skin cancer when HIV positive and the increased risk of cardiovascular disease in diabetes patients	40	29	42, 185
3.2 COMMUNICABLE DISEASE *Learners should be able to:*			
(a) explain the means by which communicable diseases caused by viruses, bacteria, protists and fungi can be spread in animals and plants. This should include by contact, aerosol, body fluids, water, insects, contaminated food.	48, 49, 50, 51, 52, 59, 60	34, 35	50, 51, 52, 53, 54, 61, 62, 190, 191
(b) describe the following diseases, this should include the causative agent, the effect on the infected organism and how they can be prevented from spreading · HIV/ AIDS · Chlamydia · Ash die back · Malaria	48, 49, 50, 51, 52	34, 35	50, 51, 52, 53, 54, 190, 191
(c) describe the non-specific defence systems of the human body against pathogens, including intact skin forming a barrier against microorganisms and blood clots sealing wounds to seal the skin	53	36	55, 192
(d) explain the role of the immune system of the human body in defence against disease. This should include the roles of lymphocytes in secreting antibodies and antitoxins and phagocytes which ingest and digest micro-organisms. Explain the process by which antigens from micro-organisms trigger lymphocytes to release antigen specific antibodies and that antibodies activate phagocytes	53	27, 37	55, 183, 193

(e) describe how monoclonal antibodies are produced from activated lymphocytes which are able to divide continuously. Consequently very large numbers of identical antibodies, specific to one antigen, are produced continuously in very large numbers	57	40	59, 196
(f) describe some of the ways in which monoclonal antibodies can be used including: **· diagnosis of diseases including Chlamydia and HIV** **· tissue typing for transplants** **· monitoring the spread of malaria** **· supporting chemotherapy for cancers**	57	40	59, 196
(g) describe the following as physical defence responses in plants forming a barrier to pathogens: · cellulose cell walls, which may be strengthened by other chemical substances · leaf cuticle, which forms a waxy layer on the outside of the leaf Physical defences to herbivores include: · specialised hardened cells · specialised structures including stinging cells and trichomes	61	41	63, 197
(h) describe chemical plant defence responses, including that many plants produce enzymes or toxic chemicals which attack insects and disease causing bacteria and fungi	61	41	63, 197
(i) describe different ways plant diseases can be detected and identified, in the lab and in the field. In the field, diseased plants can be identified by abnormal growth or by signs of the disease-causing organism, such as bacterial slime or eggs of insects. In the laboratory, pathogens can be grown on agar plates and viruses can be cultured in controlled conditions	13, 59, 60	41	15, 61, 62, 197
3.3 TREATING, CURING AND PREVENTING DISEASE *Learners should be able to:*			
(a) explain that a vaccine contains antigens derived from a disease-causing organism. A vaccine will protect against infection by that organism by stimulating the white blood cells to produce antibodies to that antigen. Vaccines may be produced which protect against bacteria and viruses	54	37	56, 193

(b) discuss the factors influencing parents in decisions about whether to have children vaccinated or not, including the need for sound scientific evidence and the effect of the media and public opinion. Understand that science can only provide a statistically based 'balance of probability' answer to such issues	54	37	56, 193
(c) explain that antibiotics, including penicillin, were originally medicines produced by living organisms, such as fungi. Explain that antibiotics help to cure bacterial disease by killing the infecting bacteria or preventing their growth	55	38	57, 194
(d) explain that antibiotics may kill some bacteria but not viruses. Some resistant bacteria, such as MRSA, can result from the over use of antibiotics. Explain effective control measures for MRSA	55	38	57, 194
(e) explain and understand the safe use of basic aseptic techniques involved in inoculating, plating and incubating microorganisms	13, 14	12	15, 16, 168
(f) describe the process of discovery and development of potential new medicines, including preclinical and clinical testing. New drug treatments may have side effects and extensive, large scale, rigorous testing is required including risk management. Preclinical stages involve testing on human cells grown in the laboratory, then on animals and finally a group of healthy volunteers. The new medicines are then taken for clinical testing using small groups of patients	56	39	58, 195
SPECIFIED PRACTICAL WORK · SP3.3 Investigation into the effect of antibiotics on bacterial growth	17	14	19, 170
3.4 NON-COMMUNICABLE DISEASES IN HUMANS *Learners should be able to:*			
(a) recall that many non-communicable human diseases, including cardiovascular disease, lung cancer, skin cancer, emphysema, type 2 diabetes and cirrhosis can be caused by the interaction of a number of life style factors	38, 39, 43, 84	28, 29, 30, 56	40, 41, 45, 86, 184, 185, 186, 212
(b) explain the effect of the following lifestyle factors on the incidence of non-communicable diseases at local, national and global levels: exercise, diet, alcohol, smoking and exposure to UV radiation	42	28, 29, 30, 56	44, 184, 185, 186, 212

(c) evaluate the advantages and disadvantages of the following treatments for cardiovascular disease · statins · angioplasty · changes to lifestyle diet/exercise	38, 39	28	40, 41, 184
4. COORDINATION AND CONTROL			
4.1 NERVOUS COORDINATION AND CONTROL IN HUMANS *Learners should be able to:*			
(a) describe sense organs as groups of receptor cells, which respond to specific stimuli: light, sound, touch, temperature, chemicals, and then relay this information as electrical impulses along neurones to the central nervous system	73, 74	49	75, 76, 205
(b) describe the structure of the nervous system, including the brain, spinal cord, sensory neurones, motor neurones and sensory receptors and the central nervous system consisting of the brain and spinal cord	74, 78	49	76, 80, 205
(c) explain how the structure of the nervous system (including CNS, sensory and motor neurones and sensory receptors) is adapted to its functions	74, 75	49	76, 77, 205
(d) describe the properties of reflex actions. These reactions are fast and automatic and some are protective, as exemplified by the withdrawal reflex, blinking and pupil size	75	49	77, 205
(e) explain how the structure of a reflex arc is related to its function and be able to label a diagram to show: receptor, sensory neurone, relay neurone in spinal cord, motor neurone, effector and synapses	74, 75	49	76, 77, 205
(f) explain the functions of the following parts of the eye: sclera, cornea, pupil, iris, lens, choroid, retina, blind spot and optic nerve recognise and be able to label these parts on a diagram of a vertical section through the eye	79	51	81, 207
(g) describe common defects of the eye and explain how some of these problems may be overcome as exemplified by long-sightedness, short-sightedness and cataracts	80	51	82, 207
(h) describe the structure and function of the following parts of the brain: the cerebral hemispheres, cerebellum and medulla	78	51	80, 207

(i) explain that brain function is difficult to study and involves the use of brain scans, such as MRI and electrical stimulation. Discuss the ethical implications of studying patients with brain damage.	78	51	80, 207
(j) explain some of the limitations in treating damage and disease in the brain and other parts of the nervous system as exemplified by Parkinson's disease and multiple sclerosis	78	51	80, 207
SPECIFIED PRACTICAL WORK · SP4.1 Investigation into factors affecting reaction times	77	50	79, 206
4.2 HORMONAL COORDINATION AND CONTROL IN HUMANS *Learners should be able to:*			
(a) describe and be able to label the positions of the following glands on a diagram of the human body: pituitary, adrenal, thyroid, pancreas, ovaries and testes	82	54	84, 210
(b) describe hormones as chemical messengers, produced by glands and carried by the blood, which control many body functions	82	54	84, 210
(c) describe the principles of negative feedback mechanisms in maintaining optimum conditions inside the body	83	62	85, 218
(d) explain the role of thyroxine in the body as an example of negative feedback. Description should be limited to effects of TRH and TSH in the release of thyroxine.	94	62	96, 218
(e) explain the role of adrenaline in the body. Description should be limited to the effects of adrenaline on the heart, breathing and muscles. Adrenaline is converted into a less active compound by the liver.	94	62	96, 218
(f) describe the roles of hormones in human reproduction, including the menstrual cycle	90, 91	59	92, 93, 215
(g) explain the interactions of FSH, LH, oestrogen and progesterone in the control of the menstrual cycle	90, 91	59	92, 93, 215
(h) explain the use of hormones in contraception and evaluate hormonal and non-hormonal methods of contraception	92	60	94, 216
(i) explain the use of hormones in modern reproductive technologies to treat infertility	93	61	95, 217

4.3 HOMEOSTASIS IN HUMANS *Learners should be able to:*			
(a) explain the importance to animals of maintaining a constant internal environment in response to internal and external change	73	48	75, 204
(b) explain why and how glucose levels need to be kept within a constant range. When the blood glucose level rises, the pancreas releases the hormone insulin, a protein, into the blood. This causes the liver to reduce the glucose level by converting glucose to insoluble glycogen and then storing it	83	55	85, 211
(c) explain how glucagon interacts with insulin to control blood sugar levels in the body	83	55	85, 211
(d) compare type 1 and type 2 diabetes and explain how they can be treated. Diabetes is a common disease in which a person has a high blood sugar (glucose) level. In Type 1 diabetes this is because the body does not produce enough insulin. In Type 2 diabetes the body cells do not properly respond to the insulin that is produced	84, 85	56	86, 87, 212
(e) describe the function of the skin in the control of body temperature. Label a diagram of a vertical section through the skin to show: hair, erector muscle, sweat gland, sweat duct, sweat pore, blood vessels. Explain the role of these structures in temperature regulation: change in diameter of blood vessels, sweating, erection of hairs; shivering as a means of generating heat	81	53	83, 209
(f) describe and be able to label a diagram of the human excretory system to show kidneys, renal arteries, renal veins, aorta, vena cava, ureters, bladder, urethra and be able to indicate the direction of blood flow in the blood vessels associated with the kidney	86, 87	57	88, 89, 213
(g) describe the function of the kidneys in maintaining the water balance of the body and remove waste products from the blood and explain why this is necessary. The waste, a solution containing urea and excess salts called urine, passes from the kidneys in the ureters to the bladder where it is stored before being passed out of the body. The presence of blood or cells in the urine indicates disease in the kidney	86, 87	57	88, 89, 213

(h) label a section through a kidney to include: renal artery, renal vein, cortex, medulla, pelvis, ureter	86	57	88, 213
(i) label a diagram of a nephron and its associated blood supply to show: capillary knot, Bowman's capsule, tubule, collecting duct, capillary network, arteriole to and from capillary knot	86	57	88, 213
(j) explain the process of filtration under pressure and that selective reabsorption of glucose, some salts, and much of the water takes place in the tubule	86	57	88, 213
(k) describe the effect of ADH on the permeability of the kidney tubules. The kidneys regulate the water content of the blood by producing dilute urine if there is too much water in the blood or concentrated urine if there is a shortage of water in the blood. ADH increases the permeability of the collecting duct walls to water. More ADH is produced if there is a shortage of water in the blood, more water is reabsorbed and so a more concentrated urine is produced	88	57	90, 213
(l) explain the effect on cells of osmotic changes in body fluids	23, 86, 87, 88	57	25, 88, 89, 90, 213
(m) explain the response of the body to different temperature and osmotic challenges	81, 88	53, 57	83, 90, 209, 213
SPECIFIED PRACTICAL WORK · SP4.3 Dissection of mammalian kidney	86	57	88, 213
4.4 PLANT HORMONES *Learners should be able to:*			
(a) explain how auxins are important in the control and coordination of plant growth and development, including the positive response of plant shoots to light, phototropism, and plant roots to gravity, gravitropism	95, 96	63	97, 98, 219
b) describe some of the effects of plant hormones, relating to auxins, **gibberellins** and **ethene**	95	63	97, 219
(c) describe some of the different ways in which people use plant hormones to control plant growth	95	63	97, 219
5. PHOTOSYNTHESIS *Learners should be able to:*			

(a) describe the process of photosynthesis and describe photosynthesis as an endothermic reaction, whereby green plants and other photosynthetic organisms use chlorophyll and light to convert carbon dioxide and water into glucose, producing oxygen as a by-product. Recall the word equation for photosynthesis	63	42	65, 198
(b) explain the effect of temperature, light intensity and carbon dioxide concentration on the rate of photosynthesis	64, 65	43	66, 67, 199
(c) explain the interaction of these factors in limiting the rate of photosynthesis, understand and use inverse proportion – the inverse square law and light intensity in the context of factors affecting photosynthesis	64, 65	43	66, 67, 199
SPECIFIED PRACTICAL WORK · SP5 Investigation into factors affecting the rate of photosynthesis	66	44	68, 200
6. ECOSYSTEMS			
6.1 LEVELS OF ORGANISATION WITHIN AN ECOSYSTEM *Learners should be able to:*			
(a) describe different levels of organisation in an ecosystem from individual organisms through populations and communities to the whole ecosystem	125, 126	79	127,128, 235
(b) explain how some abiotic factors affect communities as exemplified by pH, light, temperature and salinity	127	80, 81	129, 236, 237
(c) explain how some biotic factors affect communities as exemplified by predation, disease and food availability	128	80, 81	130, 236, 237
(d) describe the importance of interdependence and competition in a community	126	79	128, 235
(e) describe photosynthetic organisms as the main producers of food and therefore biomass for life on Earth. Green plants, and other photosynthetic organisms such as algae use the light from the sun to produce organic materials	130	93	132, 249
(f) describe the differences between the trophic levels of organisms within an ecosystem including producers; first, second and third stage consumers; herbivores and carnivores	130, 142	93	132, 144, 249

(g) investigate data about food chains and food webs and explain that they show the transfer of biomass between organisms	130, 142	83	132, 144, 239
(h) use data to construct and interpret pyramids of numbers	143	93	145, 249
(i) describe pyramids of biomass and explain, with examples, how biomass is lost between the different trophic levels. At each stage in the food chain biomass is used in repair and in the maintenance and growth of cells whilst biomass is lost in waste materials and respiration which is exothermic	142, 143	93	144, 145, 249
(j) calculate the efficiency of biomass transfers between trophic levels and explain how this affects the number of organisms at each trophic level	143	93	145, 249
6.2 THE PRINCIPLE OF MATERIAL CYCLING *Learners should be able to:*			
(a) recall that many different materials cycle through the abiotic and biotic components of an ecosystem. Nutrients are released in decay, e.g. nitrates and phosphates and these nutrients are then taken up by other organisms resulting in nutrient cycles. In a stable community the processes which remove materials are balanced by processes which return materials	127, 128, 136	86, 87	129, 130, 138, 242, 243
(b) explain why it is important that carbon is constantly cycled in nature by the carbon cycle via photosynthesis which incorporates it and respiration which releases it	134	86, 87	136, 242, 243
(c) explain that microorganisms, bacteria and fungi, feed on waste materials from organisms and that when plants and animals die their bodies are broken down by microorganisms bringing about decay. These micro-organisms respire and release carbon dioxide into the atmosphere. Burning fossil fuels releases carbon dioxide	136	87	138, 243
(d) explain the importance the water cycle to living organisms	135	86	137, 242
(e) explain the effects of factors such as temperature and water content on rate of decomposition in aerobic and anaerobic environments	136, 137	87	138, 139, 243
(f) evaluate the evidence for the impact of environmental changes on the distribution of organisms, with reference to water and atmospheric gases	138	89	140, 245
SPECIFIED PRACTICAL WORK · SP6.2 Investigation into factors affecting decomposition	137	88	139, 244

6.3 BIODIVERSITY *Learners should be able to:*			
(a) describe how to use quadrats to investigate the abundance of species e.g. a comparison of different sides of a hedge or mown and unmown grassland	131, 132,133	84	133, 134, 135, 240
(b) describe how transects can be used to measure changes in the abundance and distribution of species e.g. seashore	131, 132, 133	84, 85	133, 134, 135, 240, 241
(c) describe the principles of sampling, the need to collect sufficient data and use of appropriate statistical analysis. (Details of statistical tests are not required.) Describe the principles of capture/recapture techniques including simple calculations on estimated population size	131, 132, 133	84, 85	133, 134, 135, 240, 241
(d) explain what is meant by biodiversity, the variety and number of different species in an area, and why it is important. Explain that indicator species are an important set of organisms whose numbers and changing population can tell us a lot about the changing state of ecosystems	139	90	141, 246
(e) describe both positive and negative human interactions within ecosystems and explain their impact on biodiversity	141	91, 92	143, 247, 248
(f) describe the ways in which biodiversity and endangered species can be protected locally and globally, including issues surrounding the use of legislation. Explain the need for and issues associated with the collection of reliable data and ongoing environmental monitoring	141	92	143, 248
(g) explain the use of biological control agents and the introduction of alien species and their effects on local wildlife. Explain the issues surrounding the use of biological control agents and how the approach to using this method of control has changed as requirements for detailed research and scientifically based trials and analysis are now more fully understood	144	94	146, 250
(h) explain some of the benefits and challenges of maintaining local and global biodiversity	141	92	143, 248
SPECIFIED PRACTICAL WORK · SP6.3 Investigation into factors affecting the abundance and distribution of a species	133	84, 85	135, 240, 241

6.4 SOME OF THE BIOLOGICAL CHALLENGES OF INCREASING FOOD YIELDS USING FEWER RESOURCES *Learners should be able to:*			
(a) describe the issues surrounding the need to balance the human requirements for food and economic development with the needs of wildlife. Discuss how the collection of detailed, reliable scientific information and monitoring by biologists could help to inform, manage and reduce the impact of development on the environment e.g. the role of the Environment Agency	144	94	146, 250
(b) describe some of the biological factors affecting levels of food security including increasing human population, changing diets in wealthier populations, new pests and pathogens, environmental change, sustainability and cost of agricultural inputs	144, 145	94	146, 147, 250
(c) describe and explain some possible biotechnological and agricultural solutions, including genetic modification, to the demands of the growing human population	145	94	147, 250
7. INHERITANCE, VARIATION AND EVOLUTION			
7.1 THE GENOME AND GENE EXPRESSION *Learners should be able to:*			
(a) describe chromosomes as linear arrangements of genes. Chromosomes that are found in pairs in body cells are strands of DNA	101	67	103, 223
(b) describe DNA as a polymer made up of two strands forming a double helix	102	67, 68	104, 223, 224
(c) describe DNA as a polymer made from four different nucleotides; each nucleotide consisting of a common sugar and phosphate group with one of four different bases attached to the sugar	102	67, 68	104, 223, 224
(d) recall a simple description of protein synthesis. There are four bases, A, T, C and G within DNA and that it is the order of these bases which forms a code to produce proteins	103	69	105, 225
(e) explain simply how the structure of DNA affects the proteins made in protein synthesis. There is complementary base pairing between adenine and thymine, cytosine and guanine. The order of bases determines the	102, 103	69	104, 105, 225

order in which different amino acids are linked together to form different proteins. The bases are read in groups of three, this is called the triplet code			
(f) describe how the genes for a particular protein may occur in different forms (alleles or variants) which have different sequences of bases in their DNA. These variants, therefore, will give rise to differences in the order of amino acids in the protein and change its activity, affecting a characteristic of an organism	105	69	107, 225
(g) describe that a large amount of DNA does not occur in genes and the bases do not form part of the genetic code for producing proteins. Instead, this non-coding DNA coordinates and controls how and when particular genes become active and produce proteins	104	69	106, 225
(h) describe how an organism's DNA can be analysed by 'genetic profiling' and how this can be used to show the similarity between two DNA samples. The process involves cutting the DNA into short pieces which are then separated into bands. The pattern of the bands produced can be compared to show the similarity between two DNA samples	101	67	103, 223
(i) describe the genome as the entire genetic material of an organism	101	67	103, 223
(j) discuss the potential importance for medicine of our increasing understanding of the human genome	101	67	103, 223
SPECIFIED PRACTICAL WORK · SP7.1 Simple extraction of DNA from living material	101	67	103, 223
7.2 INHERITANCE *Learners should be able to:*			
(a) explain the following terms: gamete, chromosome, gene, allele/variant, dominant, recessive, homozygous, heterozygous, genotype, phenotype	105	70	107, 226
(b) describe genes as sections of DNA molecules that determine inherited characteristics and that are in pairs. Genes have different forms, called alleles	105	70	107, 226
(c) explain single gene inheritance and be able to complete Punnett squares to show this	107, 108	71	109, 110, 227
(d) predict the outcomes of monohybrid crosses including ratios	107, 108	71	109, 110, 227

(e) recall that most phenotypic features are the result of multiple genes rather than single gene inheritance	105	70, 71	107, 226, 227
(f) describe sex determination in humans. In human body cells, one of the pairs of chromosomes, XX or XY, carries the genes which determine sex. These separate and combine randomly at fertilisation	111	70, 71	113, 226, 227
(g) describe the development of our understanding of genetics including the work of Gregor Mendel. Discuss why the significance of his work was not recognised and validated by scientists for many years	119	77	121, 233
7.3 VARIATION AND EVOLUTION *Learners should be able to:*			
(a) explain some of the advantages and disadvantages of asexual and sexual reproduction in a range of organisms	98, 99	65	100, 101, 221
(b) describe simply how the genome, and its interaction with the environment, influence the development of the phenotype of an organism. Variation may be due to environmental or genetic causes or a combination of the two	110	70	112, 226
(c) state that there is usually extensive genetic variation within a population of a species	110	72	112, 228
(d) recall that all variants result from changes, mutations, in existing genes and that mutations occur at random. Most mutations have no effect on the phenotype but some influence phenotype and very few determine phenotype. Mutation rates can be increased by ionising radiation	104	72	106, 228
(e) describe evolution as a change in the inherited characteristics of a population over time through a process of natural selection which may result in the formation of new species. Genes which enable better adapted individuals to survive are passed on to the next generation. This may results in new species being formed. The process of natural selection is sometimes too slow for organisms to adapt to new environmental conditions and so organisms may become extinct	111, 117	73	113, 119, 229
(f) explain how individuals with characteristics adapted to their environment are more likely to survive and breed successfully. This results in evolution	111	73	113, 229

(g) describe that evolution is ongoing as shown by the development of resistance to antimicrobial chemicals by bacteria or Warfarin resistance in rats and that evolution can also be evidenced by fossils	120, 121	38, 73	122, 123, 194, 229
(h) describe the impact of developments in biology on classification systems; biological classification systems continue to be modified in the light of ongoing research. Recently, the three Domain system (based on differences in RNA) proposes two Domains of prokaryotes and one further Domain containing four main eukaryote kingdoms – Protists, Fungi, Plants and Animals	122, 123	78	124, 125, 234
(i) describe the work of Darwin and Wallace in the development of the theory of evolution by natural selection and explain the impact of these ideas on modern biology	117, 118	76	119, 120, 232
7.4 SELECTIVE BREEDING AND GENE TECHNOLOGY *Learners should be able to:*			
(a) explain the impact of the selective breeding of food plants and domesticated animals	112	74	114, 230
(b) describe genetic engineering as a process which involves modifying the genome of an organism to introduce desirable characteristics	113	75	115, 231
(c) describe the main steps in the process of genetic engineering	113, 114	75	115, 116, 231
(d) explain some of the possible benefits and risks, including practical and ethical considerations, of using gene technology in modern agriculture and medicine	114, 115	75	116, 117, 231