SNAB 2008 and 2015 specification comparison

Where the statement in the 2008 and 2015 column are identical they both appear in normal black font.

Any deletions to statements in the 2008 spec (words or whole statements) are shown as strike through in the 2008 column.

Any additions or wording changes to statements in the 2008 spec are shown in red italics on the 2015 draft column.

Criteria statements moved from A2 to AS (or vice versa) are shown in the 2008 column as blue underlined with details of their original location, they are also shown in the 2015 column as blue with any changes to the 2008 statements highlighted.

For the full specification see http://qualifications.pearson.com/en/qualifications/edexcel-a-levels/biology-a-2015.html

Topic 1: Lifestyle, health and risk

2008 specification	2015 specification
~~1 Demonstrate knowledge and understanding of the practical and investigative skills identified in numbers 4 and 5 in the table of How Science Works on page 13 of this specification.~~	
6 Explain why many animals have a heart and circulation (mass transport to overcome limitations of diffusion in meeting the requirements of organisms).	1.1 *Understand* why many animals have a heart and circulation (mass transport to overcome limitations of diffusion in meeting the requirements of organisms).
2 Explain the importance of water as a solvent in transport, including its dipole nature.	1.2 *Understand* the importance of water as a solvent in transport, including its dipole nature.
8 Explain how the structures of blood vessels (capillaries, arteries and veins) relate to their functions.	1.3 *Understand* how the structures of blood vessels (capillaries, arteries and veins) relate to their functions.
7 Describe the cardiac cycle (atrial systole, ventricular systole and diastole) and relate the structure and operation of the mammalian heart to its function, including the major blood vessels.	1.4 i) *Know* the cardiac cycle (atrial systole, ventricular systole and *cardiac* diastole) and relate the structure and operation of the mammalian heart, including the major blood vessels, to its function, ii) *Know how the relationship between heart structure and function can be investigated practically.*
11 Explain the course of events that leads to atherosclerosis (endothelial damage, inflammatory response, plaque formation, raised blood pressure).	1.5 *Understand* the course of events that leads to atherosclerosis (endothelial *dysfunction*, inflammatory response, plaque formation, raised blood pressure).
10 Describe the blood clotting process (thromboplastin release, conversion of prothrombin to thrombin and fibrinogen to fibrin) and its role in cardiovascular disease (CVD).	1.6 *Understand* the blood clotting process (thromboplastin release, conversion of prothrombin to thrombin and fibrinogen to fibrin) and its role in cardiovascular disease (CVD).
12 Describe the factors that increase the risk of CVD (genetic, diet, age, gender, high blood pressure, smoking and inactivity).	1.7 *Know how* factors *such as* genetics, diet, age, gender, high blood pressure, smoking and inactivity that increase the risk of cardiovascular disease CVD.

18 Analyse and interpret quantitative data on illness and mortality rates to determine health risks (including distinguishing between correlation and causation and recognising conflicting evidence).	1.8 *Be able to* analyse and interpret quantitative data on illness and mortality rates to determine health risks, including distinguishing between correlation and causation and recognising conflicting evidence.
19 Evaluate design of studies used to determine health risk factors (including sample selection and sample size used to collect data that is both valid and reliable).	1.9 *Be able to* evaluate design of studies used to determine health risk factors, including sample selection and sample size used to collect data that is both valid and reliable.
20 Explain why people's perceptions of risks are often different from the actual risks (including underestimating and overestimating the risks due to diet and other lifestyle factors in the development of heart disease).	1.10 *Understand* why people's perceptions of risks are often different from the actual risks, including underestimating and overestimating the risks due to diet and other lifestyle factors in the development of heart disease.
17 Analyse data on energy budgets and diet so as to be able to discuss the consequences of energy imbalance, including weight loss, weight gain, and development of obesity.	1.11 i) *Be able to* analyse data on energy budgets and diet. ii*) Understand* the consequences of energy imbalance, including weight loss, weight gain, and development of obesity.
3 Distinguish between monosaccharides, disaccharides and polysaccharides (glycogen and starch – amylose and amylopectin) and relate their structures to their roles in providing and storing energy (β -glucose and cellulose are not required in this topic).	1.12 *i) Know the difference* between monosaccharides, disaccharides and polysaccharides (glycogen and starch – amylose and amylopectin) *ii) be able to* relate the structures *of monosaccharides, disaccharides and polysaccharides* to their roles in providing and storing energy (β-glucose and cellulose are not required in this topic).
4 Describe how monosaccharides join to form disaccharides (sucrose, lactose and maltose) and polysaccharides (glycogen and amylose) through condensation reactions forming glycosidic bonds, and how these can be split through hydrolysis reactions.	1.13 *Know* how monosaccharides join to form disaccharides (sucrose, lactose and maltose) and polysaccharides (glycogen and amylose) through condensation reactions forming glycosidic bonds, and how these can be split through hydrolysis reactions.
5 Describe the synthesis of a triglyceride by the formation of ester bonds during condensation reactions between glycerol and three fatty acids and recognise differences between saturated and unsaturated lipids	1.14 i) *Know how* a triglyceride is synthesised by the formation of ester bonds during condensation reactions between glycerol and three fatty acids. ii) *Know the* differences between saturated and unsaturated lipids.
14 Analyse and interpret data on the possible significance for health of blood cholesterol levels and levels of high-density lipoproteins (HDLs) and low-density lipoproteins (LDLs). Describe the evidence for a causal relationship between blood cholesterol levels (total cholesterol and LDL cholesterol) and CVD.	1.15 i) *Be able to* analyse and interpret data on the possible significance for health of blood cholesterol levels and levels of high-density lipoproteins (HDLs) and low-density lipoproteins (LDLs). ii) *Know the* evidence for a causal relationship between blood cholesterol levels (total cholesterol and LDL cholesterol) and cardiovascular disease (CVD).
15 Discuss how people use scientific knowledge about the effects of diet (including obesity indicators), exercise and smoking to reduce their risk of coronary heart disease.	1.16 *Understand* how people use scientific knowledge about the effects of diet, including obesity indicators, *body mass index and waist-to-hip ratio*, exercise and smoking to reduce their risk of coronary heart disease.

9 Describe how the effect of caffeine on heart rate in Daphnia can be investigated practically, and discuss whether there are ethical issues in the use of invertebrates.	**CORE PRACTICAL 1: *Investigate* the effect of caffeine on heart rate in Daphnia can be investigated practically.**
	1.17 Be able discuss the potential ethical issues regarding the use of invertebrates in research.
16 Describe how to investigate the vitamin C content of food and drink.	**CORE PRACTICAL 2: *Investigate* the vitamin C content of food and drink.**
13 Describe the benefits and risks of treatments for CVD (antihypertensives, plant statins, anticoagulants and platelet inhibitory drugs).	1.19 *Know* the benefits and risks of treatments for CVD (antihypertensives, plant statins, anticoagulants and platelet inhibitory drugs).

Topic 2: Genes and health	
2008 specification	**2015 specification**
~~1 Demonstrate knowledge and understanding of the practical and investigative skills identified in numbers 4 and 5 in the table of How Science Works on page 13 of this specification.~~	
6 Describe the properties of gas exchange surfaces in living organisms (large surface area to volume ratio, thickness of surface, difference in concentration) and explain how the structure of the mammalian lung is adapted for rapid gaseous exchange.	2.1 i) Know the properties of gas exchange surfaces in living organisms (large surface area to volume ratio, thickness of surface, difference in concentration). ii) *Understand how the rate of diffusion is dependent on these properties and can be calculated using Fick's Law of Diffusion.* iii) Understand how the structure of the mammalian lung is adapted for rapid gaseous exchange.
2 Explain how models such as the fluid mosaic model of cell membranes are interpretations of data used to develop scientific explanations of the structure and properties of cell membranes.	2.2 i) *Know the structure and properties of cell membranes.* ii) *Understand* how models such as the fluid mosaic model of cell membranes are interpretations of data used to develop scientific explanations of the structure and properties of cell membranes.
5 Describe how membrane structure can be investigated practically, eg by the effect of alcohol concentration or temperature on membrane permeability.	CORE PRACTICAL 3: *Investigate* membrane structure, including the effect of alcohol concentration or temperature on membrane permeability.
3 Explain what is meant by osmosis in terms of the movement of free water molecules through a partially permeable membrane (consideration of water potential is not required).	2.3 *Understand* what is meant by osmosis in terms of the movement of free water molecules through a partially permeable membrane (consideration of water potential is not required).
4 Explain what is meant by passive transport (diffusion, facilitated diffusion), active transport (including the role of ATP), endocytosis and exocytosis and describe the involvement of carrier and channel proteins in membrane transport.	2.4 i) *Understand* what is meant by passive transport (diffusion, facilitated diffusion), active transport (including the role of ATP *as an immediate source of energy*), endocytosis and exocytosis. ii) *Understand* the involvement of carrier and channel proteins in membrane transport.
10 Describe the basic structure of mononucleotides (as a deoxyribose or ribose linked to a phosphate and a base, ie thymine, uracil, cytosine, adenine or guanine) and the structures of DNA and RNA (as polynucleotides composed of mononucleotides linked through condensation reactions) and describe how complementary base pairing and the hydrogen bonding between two complementary strands are involved in the formation of the DNA double helix.	2.5 i) *Know* the basic structure of mononucleotides (deoxyribose or ribose linked to a phosphate and a base, including thymine, uracil, cytosine, adenine or guanine) and the structures of DNA and RNA (polynucleotides composed of mononucleotides linked through condensation reactions). ii) Know how complementary base pairing and the hydrogen bonding between two complementary strands are involved in the formation of the DNA double helix.

14 Outline the process of protein synthesis, including the role of transcription, translation, messenger RNA, transfer RNA and the template (antisense) DNA strand (details of the mechanism of protein synthesis on ribosomes are not required at AS). From Topic 6 due to protein synthesis moved from A2 to AS in the core criteria so all detail now required in AS 3 Explain the process of protein synthesis (transcription, translation messenger RNA, transfer RNA, ribosomes and the role of start and stop codons) and explain the roles of the template (antisense) DNA strand in transcription, codons on messenger RNA, anticodons on transfer RNA.	2. 6 i) *Understand* the process of protein synthesis (transcription including the *role of RNA polymerase,* translation, messenger RNA, transfer RNA, *ribosomes and the role of start and stop codons*). ii) *Understand* the roles of the template (antisense) DNA strand in transcription*, codons on messenger RNA and anticodons on transfer RNA.*
12 Explain the nature of the genetic code (triplet code ~~only;~~ nonoverlapping and degenerate ~~not required at AS~~). From Topic 6 due to move of protein synthesis in the core ciriteria 2 Explain the nature of the genetic code (triplet code, non-overlapping and degenerate).	2.7 Understand the nature of the genetic code (triplet code, non-overlapping and degenerate).
13 Describe a gene as being a sequence of bases on a DNA molecule coding for a sequence of amino acids in a polypeptide chain.	2.8 *Know that* a gene is a sequence of bases on a DNA molecule that codes for a sequence of amino acids in a polypeptide chain.
7 Describe the basic structure of an amino acid (structures of specific amino acids are not required) and the formation of polypeptides and proteins (as amino acid monomers linked by peptide bonds in condensation reactions) and explain the significance of a protein's primary structure in determining its three-dimensional structure and properties (globular and fibrous proteins and types of bonds involved in three dimensional structure).	2.9 i*) Know* the basic structure of an amino acid (structures of specific amino acids are not required). ii) *Understand* the formation of polypeptides and proteins (amino acid monomers linked by peptide bonds in condensation reactions). iii) *Understand* the significance of a protein's primary structure in determining its three-dimensional structure and properties (globular and fibrous proteins and the types of bonds involved in its three-dimensional structure). iv) *Know the molecular structure of a globular protein and a fibrous protein and understand how their structures relate to their functions (including haemoglobin and collagen).*
8 Explain the mechanism of action and specificity of enzymes in terms of their three-dimensional structure and explain that enzymes are biological catalysts that reduce activation energy, catalysing a wide range of intracellular and extracellular reactions	2.10 i) *Understand* the mechanism of action and the specificity of enzymes in terms of their three-dimensional structure. ii) *Understand* that enzymes are biological catalysts that reduce activation energy. iii) *Know that there are intracellular enzymes catalysing reactions inside cells and extracellular enzymes produced by cells catalysing reactions outside of cells.*
9 Describe how enzyme concentrations can affect the rates of reactions and how this can be investigated practically by measuring the initial rate of reaction.	**CORE PRACTICAL 4:** ***Investigate*** **the effect of enzyme and substrate concentrations on the initial rates of reactions.**

11 Describe DNA replication (including the role of DNA polymerase), and explain how Meselson and Stahl's classic experiment provided new data that supported the accepted theory of replication of DNA and refuted competing theories.	2.11 i) *Understand the process of* DNA replication, including the role of DNA polymerase. ii) *Understand* how Meselson and Stahl's classic experiment provided new data that supported the accepted theory of replication of DNA and refuted competing theories.
15 Explain how errors in DNA replication can give rise to mutations and explain how cystic fibrosis results from one of a number of possible gene mutations	2.12 i) *Understand* how errors in DNA replication can give rise to mutations. ii) *Understand* how cystic fibrosis results from one of a number of possible gene mutations.
16 Explain the terms: gene, allele, genotype, phenotype, recessive, dominant, homozygote and heterozygote; and explain monohybrid inheritance, including the interpretation of genetic pedigree diagrams, ~~in the context of traits such as cystic fibrosis, albinism, thalassaemia, garden pea height and seed morphology~~	2.13 i) *Know the meaning* of the terms: gene, allele, genotype, phenotype, recessive, dominant, incomplete dominance, homozygote and heterozygote. ii) *Understand patterns of inheritance,* including the interpretation of genetic pedigree diagrams, in the context of monohybrid inheritance.
17 Explain how the expression of a gene mutation in people with cystic fibrosis impairs the functioning of the gaseous exchange, digestive and reproductive systems.	2.14 *Understand* how the expression of a gene mutation in people with cystic fibrosis impairs the functioning of the gaseous exchange, digestive and reproductive systems.
~~18 Describe the principles of gene therapy and distinguish between somatic and germ line therapy.~~	
19 Explain the uses of genetic screening: identification of carriers, preimplantation genetic diagnosis and prenatal testing (amniocentesis and chorionic villus sampling) and discuss the implications of prenatal genetic screening.	2.15 i) *Understand* the uses of genetic screening, including the identification of carriers, pre-implantation genetic diagnosis (PGD) and prenatal testing, including amniocentesis and chorionic villus sampling. ii) *Understand* the implications of prenatal genetic screening.
20 Identify and discuss the social and ethical issues related to genetic screening from a range of ethical viewpoints.	2.16 *Be able to* identify and discuss the social and ethical issues related to genetic screening from a range of ethical viewpoints.

Topic 3: Voice of the genome	
2008 specification	**2015 specification**
~~1 Demonstrate knowledge and understanding of the practical and investigative skills identified in the table of How Science Works on page 12 of this specification.~~	
	3.1 *Know that all living organisms are made of cells, sharing some common features.*
3 Describe the ultrastructure of an animal (eukaryotic) cell (nucleus, nucleolus, ribosomes, rough and smooth endoplasmic reticulum, mitochondria, centrioles, lysosomes, and Golgi apparatus) ~~and recognise these organelles from EM images.~~ Moved to separate statement (3.5)	3.2 *Know* the ultrastructure of eukaryotic cells, including nucleus, nucleolus, ribosomes, rough and smooth endoplasmic reticulum, mitochondria, centrioles, lysosomes, and Golgi apparatus.
4 Explain the role of the rough endoplasmic reticulum (rER) and the Golgi apparatus in protein transport within cells and including its role in formation of extracellular enzymes.	3.3 *Understand* the role of the rough endoplasmic reticulum (rER) and the Golgi apparatus in protein transport within cells, including their role in the formation of extracellular enzymes.
2 Distinguish between eukaryotic and prokaryotic cells in terms of their structure and ultrastructure.	3.*4 Know the ultrastructure of prokaryotic cells, including cell wall, capsule, plasmid, flagellum, pili, ribosomes, mesosomes and circular DNA.*
	3.5 *Be able to recognise the organelles in 3.2 from electron microscope (EM) images.*
9 Explain how mammalian gametes are specialised for their functions.	3.6 *Understand* how mammalian gametes are specialised for their functions *(including the acrosome in sperm and the zona pellucida in the egg*).
10 Describe the process of fertilisation in mammals ~~and flowering plants~~ (starting with the acrosome reaction in mammals ~~and pollen tube growth in plants~~ and ending with the fusion of the nuclei) and explain the importance of fertilisation in sexual reproduction.	3.7 *Know* the process of fertilisation in mammals, including the acrosome reaction, the cortical reaction and the fusion of nuclei.
	3.*8 i) Know that a locus (loci) is the location of genes on a chromosome.* *ii) Understand the linkage of genes on a chromosome and sex linkage.*
8 Explain the role of meiosis in the production of gametes and genetic variation through recombination of alleles and genes including independent assortment and crossing over (details of the stages of meiosis are not required).	3.9 *Understand* the role of meiosis in ensuring genetic variation through the production of non-identical gametes as a consequence of independent assortment of chromosomes and crossing over of alleles *between chromatids* (details of the stages of meiosis are not required).
6 Explain the role of mitosis and the cell cycle for growth and asexual reproduction	3.10 *Understand* the role of mitosis and the cell cycle *in producing identical daughter cells f*or growth and asexual reproduction.
7 Describe the stages of mitosis and how to prepare and stain a root tip squash in order to observe them practically.	**CORE PRACTICAL 5:** **Prepare and stain a root tip squash to observe the stages of mitosis**.

11 Explain what is meant by the terms stem cell, pluripotency and totipotency and discuss the way society uses scientific knowledge to make decisions about the use of stem cells in medical therapies ~~(eg regulatory authorities relating to human embryo research, ability of stem cells to develop into specialised tissues, potential sources of stem cells, who could benefit from the therapies, procedures to obtain stem cells and their risks).~~	3.11 i) *Understand* what is meant by the terms 'stem cell, pluripotency and totipotency'. ii) *Be able to* discuss the way society uses scientific knowledge to make decisions about the use of stem cells in medical therapies.
~~**12 Describe how totipotency can be demonstrated practically using plant tissue culture techniques.**~~	
13 Explain how cells become specialised through differential gene expression, producing active mRNA leading to synthesis of proteins. which in turn control cell processes or determine cell structure in animals and plants (details of transcription factors are not required at AS).	3.12 Understand how cells become specialised through differential gene expression, producing active mRNA leading to synthesis of proteins, which in turn control cell processes or determine cell structure in animals and plants, including the lac operon.
5 Describe how the cells of multicellular organisms can be organised into tissues, tissues into organs and organs into systems.	3.13 Understand how the cells of multicellular organisms are organised into tissues, tissues into organs and organs into systems.
14 Explain how phenotype is the result of an interaction between genotype and the environment ~~(eg animal hair colour, human height, monoamine oxidase A (MAOA) and cancers), but the data on the relative contributions of genes and environment is often difficult to interpret.~~	3.14 i) *Understand* how phenotype is the result of an interaction between genotype and the environment. *ii) Know how epigenetic changes, including DNA methylation and histone modification, can modify the activation of certain genes.* *iii) Understand how epigenetic changes can be passed on following cell division.*
15 Explain how some phenotypes are affected by alleles at many loci (polygenic inheritance) as well as the environment (eg height) and how this can give rise to phenotypes that show continuous variation.	3.15 Understand how some phenotypes are affected by multiple alleles for the same gene at many loci (polygenic inheritance) as well as the environment and how this can give rise to phenotypes that show continuous variation.

Topic 4: Biodiversity and natural resources	
2008 specification	**2015 specification**
~~1 Demonstrate knowledge and understanding of the practical and investigative skills identified in the table of How Science Works on page 12 of this specification.~~	
	4.1 Know that over time the variety of life has become extensive but is now being threatened by human activity.
13 Explain the terms biodiversity and endemism and describe how biodiversity can be measured within a habitat using species richness and within a species using genetic diversity, ~~eg variety of alleles in a gene pool.~~	4.2 i) Understand the terms biodiversity and endemism. ii) Know how biodiversity can be measured within a habitat using species richness and within a species using genetic diversity *by calculating the heterozygosity index (H)=* $\frac{\text{number of heterozygotes}}{\text{number of individuals in the population}}$ *iii) Understand how biodiversity can be compared in different habitats using a formula to calculate an index of diversity (D)=* $\frac{N(N-1)}{\Sigma n\,(n-1)}$
14 ~~Describe~~ the concept of niche and discuss examples of adaptation of organisms to their environment (behavioural, physiological and anatomical).	4.3 *Understand* the concept of niche and discuss examples of adaptation of organisms to their environment (behavioural, physiological and anatomical).
15 Describe how natural selection can lead to adaptation and evolution.	4.4 *Understand* how natural selection can lead to adaptation and evolution.
	4.*5 i) Understand how the Hardy-Weinberg equation can be used to see whether a change in allele frequency is occurring in a population over time.* *ii) Understand that reproductive isolation can lead to accumulation of different genetic information in populations, potentially leading to the formation of new species.*
16 Discuss the process and importance of critical evaluation of new data by the scientific community, which leads to new taxonomic groupings (ie three domains based on molecular phylogeny).	4.6 *i) Understand that classification is a means of organising the variety of life based on relationships between organisms using differences and similarities in phenotypes and in genotypes, and is built around the species concept.* ii) Understand the process and importance of critical evaluation of new data by the scientific community, which leads to new taxonomic groupings, including the three domains of life based on molecular phylogeny*, which are Bacteria, Archaea, Eukaryota.*
2 Compare the ultrastructure of plant cells (cell wall, chloroplasts, amyloplasts, vacuole, tonoplast, plasmodesmata, pits and middle lamella) with that of animal cells.	4.7 *Know* the ultrastructure of plant cells (cell walls, chloroplasts, amyloplasts, vacuole, tonoplast, plasmodesmata, pits and middle lamella) and *be able to* compare it with animal cells.
	4.8 Be able to recognise the organelles in 4.7 from electron microscope (EM) images.

3 Compare the structure and function of the polysaccharides starch and cellulose including the role of hydrogen bonds between β-glucose molecules in the formation of cellulose microfibrils.	4.9 *Understand* the structure and function of the polysaccharides starch and cellulose, including the role of hydrogen bonds between β-glucose molecules in the formation of cellulose microfibrils.
4 Explain how the arrangement of cellulose microfibrils in plant cell walls and secondary thickening contribute to the physical properties of plant fibres, which can be exploited by humans	4.10 *Understand* how the arrangement of cellulose microfibrils and secondary thickening in plant cell walls contributes to the physical properties of *xylem vessels and sclerenchyma fibres* in plant fibres that can be exploited by humans.
7 Identify sclerenchyma fibres and xylem vessels as seen through a light microscope.	CORE PRACTICAL 6: Identify sclerenchyma fibres, *phloem sieve tubes* and xylem vessels and *their location within stems* through a light microscope.
5 Compare the structures, position in the stem and function of sclerenchyma fibres (support) and xylem vessels (support and transport of water and mineral ions).	4.11 *Know the similarities and differences* between the structures, position in the stem and function of sclerenchyma fibres (support), xylem vessels (support and transport of water and mineral ions) and *phloem (translocation of organic solutes)*.
9 Explain the importance of water and inorganic ions (nitrate, calcium ions and magnesium ions) to plants	4.12 *Understand* the importance of water and inorganic ions (nitrate, calcium ions and magnesium ions) to plants.
10 **Describe how to investigate plant mineral deficiencies practically.**	CORE PRACTICAL 7: *Investigat*e plant mineral deficiencies.
8 ~~**Describe how to**~~ **determine the tensile strength of plant fibres practically.**	CORE PRACTICAL 8: Determine the tensile strength of plant fibres.
12 Compare historic drug testing with contemporary drug testing protocols, eg William Withering's digitalis soup; double blind trials; placebo; three-phased testing	4.13 *Understand the development of drug testing from historic to contemporary protocols*, including William Withering's digitalis soup, double blind trials, placebo, three-phased testing.
	4.14 Understand the conditions required for bacterial growth.
11 ~~**Describe how to**~~ **investigate the antimicrobial properties of plants**.	CORE PRACTICAL 9: Investigate the antimicrobial properties of plants, including aseptic techniques for the safe handling of bacteria.
6 Describe how the uses of plant fibres and starch may contribute to sustainability, eg plant-based products to replace oil-based plastics.	4.15 *Understand* how the uses of plant fibres and starch may contribute to sustainability, including plant-based products to replace oil-based plastics.
17 Discuss and evaluate the methods used by zoos and seedbanks in the conservation of endangered species and their genetic diversity (eg scientific research, captive breeding programmes, reintroduction programmes and education).	44.16 *Be able to* evaluate the methods used by zoos and seed banks in the conservation of endangered species and their genetic diversity, including scientific research, captive programmes, reintroduction programmes and education.

Topic 5 On the wild side	
2008 specification	**2015 specification**
~~1 Demonstrate knowledge and understanding of the How Science Works areas listed in the table on page 13 of the specification.~~	
11 Describe how to carry out a study on the ecology of a habitat ~~to produce valid and reliable data~~ (including the use of quadrats and transects to assess abundance and distribution of organisms and the measurement of abiotic factors, ~~eg solar energy input, climate, topography, oxygen availability and edaphic factors).~~	**CORE PRACTICAL 10:** ***Carry out a study on the ecology of a habitat, such as using quadrats, transects to determine distribution and abundance of organisms, and measuring abiotic factors appropriate to the habitat.***
	5.1 Understand the terms of ecosystems, communities, populations, habitats
10 Explain that the numbers and distribution of organisms in a habitat are controlled by biotic and abiotic factors.	5.2 *Understand* that the numbers and distribution of organisms in a habitat are controlled by biotic and abiotic factors.
12 Explain how the concept of niche accounts for distribution and abundance of organisms in a habitat.	5.3 *Understand* how the concept of niche accounts for distribution and abundance of organisms in a habitat.
13 Describe the concept of succession to a climax community.	5.4 *Understand* the concept of succession *from colonisation* to a climax community.
3 Describe the overall reaction of photosynthesis as requiring energy from light to split apart the strong bonds in water molecules, storing the hydrogen in a fuel (glucose) by combining it with carbon dioxide and releasing oxygen into the atmosphere.	5.5 *Understand* the overall reaction of photosynthesis as requiring energy from light to split apart the strong bonds in water molecules, storing the hydrogen in a fuel (glucose) by combining it with carbon dioxide and releasing oxygen into the atmosphere.
5 Describe how phosphorylation of ADP requires energy and how hydrolysis of ATP provides an immediate supply of energy for biological processes.	5.6 *Understand* how phosphorylation of ADP requires energy and *that* hydrolysis of ATP provides an immediate supply of energy for biological processes.
4 Describe the light-dependent reactions of photosynthesis including how light energy is trapped by exciting electrons in chlorophyll and the role of these electrons in generating ATP, and reducing NADP in photophosphorylation and producing oxygen through photolysis of water.	5.7 *Understand* the light-dependent reactions of photosynthesis including how light energy is trapped by exciting electrons in chlorophyll and the role of these electrons in generating ATP, reducing NADP in photophosphorylation and producing oxygen through photolysis of water.
6 Describe the light-independent reactions as reduction of carbon dioxide using the products of the light-dependent reactions (carbon fixation in the Calvin cycle, the role of GP, GALP, RuBP and RUBISCO) and describe the products as simple sugars that are used by plants, animals and other organisms in respiration and the synthesis of new biological molecules (including polysaccharides, amino acids, lipids and nucleic acids).	5.8 i*) Understand* the light-independent reactions as reduction of carbon dioxide using the products of the light-dependent reactions (carbon fixation in the Calvin cycle, the role of GP, GALP, RuBP and RUBISCO) *ii) know that* the products as simple sugars that are used by plants, animals and other organisms in respiration and the synthesis of new biological molecules (including polysaccharides, amino acids, lipids and nucleic acids).
	CORE PRACTICAL 11: ***Be able to investigate photosynthesis using isolated chloroplasts (the Hill reaction)***

2 Describe the structure of chloroplasts in relation to their role in photosynthesis.	5.9 *Understand* the structure of chloroplasts in relation to their role in photosynthesis.
7 ~~Carry out~~ calculations of net primary productivity and explain the relationship between gross primary productivity, net primary productivity and plant respiration.	5.10 i) *Be able to* calculate of net primary productivity ii) *Understand* the relationship between gross primary productivity, net primary productivity and plant respiration.
8 Calculate the efficiency of energy transfers between trophic levels.	5.11 *Know how to* calculate the efficiency of energy transfers between trophic levels.
18 Analyse and interpret different types of evidence for ~~global warming~~ and its causes (including records of carbon dioxide levels, temperature records, pollen in peat bogs and dendrochronology) recognising correlations and causal relationships.	5.12 *Understand the* different types of evidence for *climate change* and its causes (including records of carbon dioxide levels, temperature records, pollen in peat bogs and dendrochronology) recognising correlations and causal relationships.
14 Outline the causes of ~~global warming~~ — including the role of greenhouse gases (carbon dioxide and methane, CH4) in the greenhouse effect.	5.13 *Understand* the causes of *anthropogenic climate change* — including the role of greenhouse gases (carbon dioxide and methane) in the greenhouse effect.
19 ~~Describe~~ that data can be extrapolated to make predictions, that these are used in models of future global warming, and that these models have limitations.	5.14 i) *Understand* that data can be extrapolated to make predictions and that these are used in models of future climate change. ii) *Understand* that models for climate change have limitations.
15 ~~Describe~~ the effects of global warming (~~rising temperature,~~ changing rainfall patterns and changes in seasonal cycles) on plants and animals (distribution of species, development and life cycles).	5.15 *Understand* the effects of climate change (changing rainfall patterns and changes in seasonal cycles) on plants and animals (distribution of species, development and life cycles).
	CORE PRACTICAL 12: *Investigate the effect of temperature on the initial rate of an enzyme-catalysed reaction, to include Q10.*
16 Explain the effect of increasing temperature on the rate of enzyme activity in plants, animals and micro-organisms.	5.16 *Understand* the effect of temperature on the rate of enzyme activity and its impact on plants, animals and micro-organisms.
17 Describe how to investigate the effects of temperature on the development of organisms (eg seedling growth rate, brine shrimp hatch rates).	**CORE PRACTICAL 13:** **Investigate the effects of temperature on the development of organisms (eg seedling growth rate, brine shrimp hatch rates).**
21 Describe how evolution (a change in the allele frequency) can come about through gene mutation and natural selection.	5.17 *Understand* how evolution (a change in the allele frequency) can come about through gene mutation and natural selection.
23 Describe the role of the scientific community in validating new evidence (including molecular biology, eg DNA, proteomics) supporting the accepted scientific theory of evolution (scientific journals, the peer review process, scientific conferences).	*5.18* Understand *the role of the scientific community (scientific journals, the peer review process, scientific conferences) in validating new evidence (including proteomics and genomics) supporting the accepted scientific theory of evolution.*
22 Explain how ~~r~~eproductive isolation can lead to speciation.	5.19 *Understand* how isolation *reduces gene flow between populations leading to allopatric or sympatric speciation.*

20 Discuss the way in which scientific conclusions about controversial issues, such as what actions should be taken to reduce ~~global warming~~ or the degree to which humans are ~~affecting global warming,~~ can sometimes depend on who is reaching the conclusions.	5.20 *Understand* the way in which scientific conclusions about controversial issues, such as what actions should be taken to reduce *climate change* or the degree to which humans are affecting *climate change*, can sometimes depend on who is reaching the conclusions.
9 Discuss how understanding the carbon cycle can lead to methods to reduce atmospheric levels of carbon dioxide (~~including the use of biofuels and reforestation~~).	5.21 *Understand* how *knowledge* of the carbon cycle can *be applied* to methods to reduce atmospheric levels of carbon dioxide.
	5.22 Understand how reforestation and the use of sustainable resources including biofuels are examples of the effective management of the conflict between human needs and conservation

Topic 6 Immunity, infection and forensics	
2008 specification	**2015 specification**
~~1 Demonstrate knowledge and understanding of the How Science Works areas listed in the table on page 13 of the specification.~~	
20 ~~Describe~~ how to determine the time of death of a mammal by examining the extent of decomposition, stage of succession, forensic entomology, body temperature and degree of muscle contraction.	6.1 *Understand* how to determine the time of death of a mammal by examining the extent of decomposition, stage of succession, forensic entomology, body temperature and degree of muscle contraction.
9 Describe the role of micro-organisms in the decomposition of organic matter and the recycling of carbon.	6.2 *Know* the role of micro-organisms in the decomposition of organic matter and the recycling of carbon.
5 Describe how DNA profiling is used for identification and determining genetic relationships between organisms (plants and animals).	6.3 *Know* how DNA profiling is used for identification and determining genetic relationships between organisms (plants and animals).
6 Describe how DNA can be amplified using the polymerase chain reaction (PCR).	6.4 *Know* how DNA can be amplified using the polymerase chain reaction (PCR). *Note: no longer core practical*
7 Describe how gel electrophoresis can be used to separate DNA fragments of different length.	**CORE PRACTICAL 14:** *Understand* **how to use gel electrophoresis to separate DNA fragments of different.**
8 Distinguish between the structure of bacteria and viruses.	6.5 *Know the* structure of bacteria and viruses.
11 Explain how bacterial and viral infectious diseases have a sequence of symptoms that may result in death, including the diseases caused by Mycobacterium tuberculosis (TB) and Human Immunodeficiency Virus (HIV).	6.6 *Understand how* Mycobacterium tuberculosis *(TB) and* Human Immunodeficiency Virus *(HIV) infect human cells,* causing a sequence of symptoms that may result in death.
12 Describe the non-specific responses of the body to infection, including inflammation, lysozyme action, interferon, and phagocytosis.	6.7 *Understand* the non-specific responses of the body to infection, including inflammation, lysozyme action, interferon, and phagocytosis.
13 Explain the roles of antigens and antibodies in the body's immune response including the involvement of plasma cells, macrophages and antigen-presenting cells.	6.8 *Understand* the roles of antigens and antibodies in the body's immune response including the involvement of plasma cells, macrophages and antigen-presenting cells.
14 Distinguish between the roles of B cells (including B memory and B effector cells) and T cells (T helper, T killer and T memory cells) in the body's immune response.	6.9 *Understand the difference* between the roles of B cells (including B memory and B effector cells) and T cells (T helper, T killer and T memory cells) in the body's immune response.
~~3 Explain the process of protein synthesis (transcription, translation messenger RNA, transfer RNA, ribosomes and the role of start and stop codons) and explain the roles of the template (antisense) DNA strand in transcription, codons on messenger RNA, anticodons on transfer RNA.~~	Moved to AS however a revisit will be required to link to statement 6.11
~~2 Explain the nature of the genetic code (triplet code, nonoverlapping and degenerate).~~	
4 Explain how one gene can give rise to more than one protein through post-transcriptional changes to messenger RNA.	6.10 *Understand* how one gene can give rise to more than one protein through post-transcriptional changes to messenger RNA (mRNA).

10 Describe the major routes pathogens may take when entering the body and explain the role of barriers in protecting the body from infection, including the roles of skin, stomach acid, gut ~~and skin~~ flora.	6.11 *Understand* the major routes pathogens may take when entering the body and explain the role of barriers in protecting the body from infection, including the roles of skin, stomach acid, and gut flora.
15 Explain how individuals may develop immunity (natural, artificial, active, passive).	6.12 *Understand* how individuals may develop immunity (natural, artificial, active, passive).
16 Discuss how the theory of an 'evolutionary race' between pathogens and their hosts is supported by the evasion mechanisms as shown ~~by Human Immunodeficiency Virus (HIV) and Mycobacterium tuberculosis (TB).~~	6.13 *Understand* how the theory of an 'evolutionary race' between pathogens and their hosts is supported by the evasion mechanisms shown by *pathogens*
17 Distinguish between bacteriostatic and bactericidal antibiotics.	6.14 *Understand the growth of bacteria in ideal conditions and the* difference between bacteriostatic and bactericidal antibiotics
18 Describe how to investigate the effect of different antibiotics on bacteria.	**CORE PRACTICAL 15:** ***Investigate*** **the effect of different antibiotics on bacteria**
19 Describe how an understanding of the contributory causes of hospital acquired infections have led to codes of practice relating to antibiotic prescription and hospital practice relating to infection prevention and control.	6.15 *Know* how an understanding of the contributory causes of hospital acquired infections have led to codes of practice relating to antibiotic prescription and hospital practice relating to infection prevention and control.

Topic 7 Run for your life	
2008 specification	**2015 specification**
~~1 Demonstrate knowledge and understanding of the How Science Works areas listed in the table on page 13 of the specification.~~	
4 Recall the way in which muscles, tendons, the skeleton and ligaments interact to enable movement, including antagonistic muscle pairs, extensors and flexors.	7.1 *Know* the way in which muscles, tendons, the skeleton and ligaments interact to enable movement, including antagonistic muscle pairs, extensors and flexors.
3 Explain the contraction of skeletal muscle in terms of the sliding filament theory, including the role of actin, myosin, troponin, tropomyosin, calcium ions (Ca^{2+}), ATP and ATPase.	7.2 *Understand* the *process of* contraction of skeletal muscle in terms of the sliding filament theory, including the role of actin, myosin, troponin, tropomyosin, calcium ions (Ca^{2+}), ATP and ATPase.
5 Describe the overall reaction of aerobic respiration as splitting of the respiratory substrate (eg glucose) to release carbon dioxide as a waste product and reuniting of hydrogen with atmospheric oxygen with the release of a large amount of energy.	7.3 i) *Understand* the overall reaction of aerobic respiration as splitting of the respiratory substrate, to release carbon dioxide as a waste product and reuniting of hydrogen with atmospheric oxygen with the release of a large amount of energy. ii) *Understand that respiration is a many-stepped process with each step controlled and catalysed by a specific intracellular enzyme*
7 Recall how phosphorylation of ADP requires energy and how hydrolysis of ATP provides an accessible supply of energy for biological processes.	Included in AS but needs to be revisited here
8 Describe the roles of glycolysis in aerobic and anaerobic respiration, including the phosphorylation of hexoses, the production of ATP, reduced coenzyme and ~~pyruvate acid~~ (details of intermediate stages and compounds are not required).	7.4 *Understand* the roles of glycolysis in aerobic and anaerobic respiration, including the phosphorylation of hexoses, the production of ATP, reduced coenzyme, *pyruvate and lactate* (details of intermediate stages and compounds are not required).
9 Describe the role of the Krebs cycle in the complete oxidation of glucose and formation of carbon dioxide (CO2), ATP, reduced NAD and reduced FAD (names of other compounds are not required) ~~and that respiration is a many-stepped process with each step controlled and catalysed by a specific intracellular enzyme~~ (moved).	7.5 *Understand* the role of the *link reaction and* the Krebs cycle in the complete oxidation of glucose and formation of carbon dioxide (CO_2), ATP, reduced NAD and reduced FAD (names of other compounds are not required) *and why these steps take place in the mitochondria, unlike glycolysis which occurs in the cytoplasm.*
10 Describe the synthesis of ATP by oxidative phosphorylation associated with the electron transport chain in mitochondria, including the role of chemiosmosis and ~~ATPase.~~	7.6 *Understand how* ATP *is synthesised* by oxidative phosphorylation associated with the electron transport chain in mitochondria, including the role of chemiosmosis and *ATP synthase.*
11 Explain the fate of lactate after a period of anaerobic respiration in animals.	7.7 *Understand what happens to* lactate after a period of anaerobic respiration in animals.
6 ~~Describe how to~~ investigate rate of respiration practically.	CORE PRACTICAL 16: Investigate rate of respiration practically.

12 ~~Understand that cardiac muscle is myogenic~~ and describe the normal electrical activity of the heart, including the roles of the sinoatrial node (SAN), the atrioventricular node (AVN) and the bundle of His, ~~and~~ how the use of electrocardiograms (ECGs) can aid the diagnosis of cardiovascular disease (CVD) and other heart conditions.	7.8 i) *Know the myogenic nature* of cardiac muscle ii) *know about* the normal electrical activity of the heart, including the roles of the sinoatrial node (SAN), the atrioventricular node (AVN) and the bundle of His *and the Purkyne fibres*. iii) *Understand* how the use of electrocardiograms (ECGs) can aid the diagnosis of cardiovascular disease (CVD) and other heart conditions.
13 Explain how variations in ventilation and cardiac output enable rapid delivery of oxygen to tissues and the removal of carbon dioxide from them, including how the heart rate and ventilation rate are controlled and the roles of the cardiovascular control centre and the ventilation centre.	7.9 i) *Be able to calculate cardiac output* *ii) Understand* how variations in ventilation and cardiac output enable rapid delivery of oxygen to tissues and the removal of carbon dioxide from them, including how the heart rate and ventilation rate are controlled and the roles of the cardiovascular control centre and the ventilation centre *in the medulla oblongata.*
14 Describe how to investigate the effects of exercise on tidal volume and breathing rate using data from spirometer traces.	**CORE PRACTICAL 17:** **Investigate the effects of exercise on tidal volume, breathing rate, *respiratory minute ventilation and oxygen consumption* using data from spirometer traces.**
2 Describe the structure of a muscle fibre and explain the structural and physiological differences between fast and slow twitch muscle fibres.	7.10 i) *Know* the structure of a muscle fibre ii) *Understand* the structural and physiological differences between fast and slow twitch muscle fibres.
15 Explain the principle of negative feedback in maintaining systems within narrow limits.	7.11 *i) Understand what is meant by negative and positive feedback.* *ii) Understand* the principle of negative feedback in maintaining systems within narrow limits.
16 Discuss the concept of homeostasis and its importance in maintaining the body in a state of dynamic equilibrium during exercise, including the role of the hypothalamus and the mechanisms of thermoregulation.	7.12 *Understand* homeostasis and its importance in maintaining the body in a state of dynamic equilibrium during exercise, including the role of the hypothalamus and the mechanisms of thermoregulation.
18 Analyse and interpret data on possible disadvantages of exercising too much (wear and tear on joints, suppression of the immune system) and exercising too little (increased risk of obesity, coronary heart disease (CHD) and diabetes), recognising correlation and causal relationships.	7.13 *Understand the analysis* and interpretation data *relating* to possible disadvantages of exercising too much (wear and tear on joints, suppression of the immune system) and exercising too little (increased risk of obesity, *cardiovascular disease (CVD)* and diabetes), recognising correlation and causal relationships.
19 Explain how medical technology, including the use of keyhole surgery and prostheses, is enabling those with injuries and disabilities to participate in sports, ~~eg cruciate ligaments repair using keyhole surgery and knee joint replacement using prosthetics.~~	7.14 *Understand* how medical technology, including the use of keyhole surgery and prostheses, is enabling those with injuries and disabilities to participate in sports.
20 Outline two ethical positions relating to whether the use of performance-enhancing substances by athletes is acceptable.	7.15 *Be able to discuss* two ethical positions relating to whether the use of performance-enhancing substances by athletes is acceptable.
17 Explain how genes can be switched on and off by DNA transcription factors including hormones.	7.16 *Understand* how genes can be switched on and off by DNA transcription factors including hormones.

Topic 8 Grey matter	
2008 specification	**2015 specification**
~~1 Demonstrate knowledge and understanding of the How Science Works areas listed in the table on page 13 of this specification.~~	
3 Describe the structure and function of sensory, relay and motor neurones including the role of Schwann cells and myelination.	8.1 *Know* the structure and function of sensory, relay and motor neurones including the role of Schwann cells and myelination.
7 Explain how the nervous systems of organisms can cause effectors to respond ~~as exemplified~~ by pupil dilation and contraction.	8.2 i) *Understand* how the nervous systems of organisms can cause effectors to respond to a stimulus. *ii) Understand how the* pupil dilates and contracts.
4 Describe how a nerve impulse (action potential) is conducted along an axon including changes in membrane permeability to sodium and potassium ions and the role of the nodes of Ranvier.	8.3 *Understand* how a nerve impulse (action potential) is conducted along an axon including changes in membrane permeability to sodium and potassium ions and the role of *myelination in saltatory conduction*.
2 ~~Describe how plants detect light using photoreceptors and how they respond to environmental cues.~~	(see 8.6 below)
5 Describe the structure and function of synapses, including the role of neurotransmitters, such as acetylcholine.	8.4 *Know* the structure and function of synapses in nerve impulse transmission, including the role of neurotransmitters, e.g.acetylcholine.
6 Describe how the nervous systems of organisms can detect stimuli with reference to rods in the retina of mammals, the roles of rhodopsin, opsin, retinal, sodium ions, cation channels and hyperpolarisation of rod cells in forming action potentials in the optic neurones.	8.5 *Understand* how the nervous systems of organisms can detect stimuli with reference to rods in the retina of mammals, the roles of rhodopsin, opsin, retinal, sodium ions, cation channels and hyperpolarisation of rod cells in forming action potentials in the optic neurones.
8 Compare mechanisms of coordination in plants and animals, ie nervous and hormonal, including the role of IAA in phototropism (details of individual mammalian hormones are not required).	8.6 *Understand* how phytochrome and IAA bring about responses in plants to environmental cues including their effects on transcription.
	8.7 *Understand how co-ordination is brought about through nervous and hormonal control* in animals.
9 ~~Locate and state~~ the functions of the regions of the human brain's cerebral hemispheres ~~(ability to see, think, learn and feel emotions)~~, hypothalamus ~~(thermoregulate),~~ cerebellum ~~(coordinate movement)~~ and medulla oblongata ~~(control the heartbeat).~~	8.8 *know the location* and functions of ~~the regions of the human brain's~~ cerebral hemispheres, hypothalamus, cerebellum and medulla oblongata *in the human brian*
10 Describe the use of magnetic resonance imaging (MRI), functional magnetic resonance imaging (fMRI) and computed tomography (CT) scans in medical diagnosis and investigating brain structure and function.	8.9 *Understand how* magnetic resonance imaging (MRI), functional magnetic resonance imaging (fMRI), *positron emission tomography (PET)* and computed tomography (CT) scans are used in medical diagnosis and the investigati~~ng~~on of brain structure and function.
11 Discuss whether there exists a critical 'window' within which humans must be exposed to particular stimuli if they are to develop their visual capacities to the full.	8.10 *Understand what happens during the critical period so that mammals can develop their visual capacities to the full.*

12 Describe the role animal models have played in developing explanations of human brain development and function, including Hubel and Wiesel's experiments with monkeys and kittens.	8.11 *Understand* the role animal models have played in *the research into* human brain development and function, including Hubel and Wiesel's experiments with monkeys and kittens.
16 Discuss the moral and ethical issues relating to the use of animals in medical research from two ethical standpoints.	8.12 *Be able to discuss* the moral and ethical issues relating to the use of animals in medical research from two ethical standpoints.
	8.13 Understand how animals, including humans, can learn by habituation.
15 Describe how to investigate habituation to a stimulus.	**CORE PRACTICAL 18:** **Investigate habituation to a stimulus.**
17 Explain how imbalances in certain, naturally occurring, brain chemicals can contribute to ill health (eg dopamine in Parkinson's disease and serotonin in depression) and to the development of new drugs.	8.14 *Understand* how imbalances in certain, naturally occurring, brain chemicals can contribute to ill health (e.g. dopamine in Parkinson's disease and serotonin in depression) and to the development of new drugs.
18 Explain the effects of drugs on synaptic transmissions, including the use of L-Dopa in the treatment of Parkinson's disease and the action of MDMA in ecstasy.	8.15 *Understand* the effects of drugs on synaptic transmissions, including the use of L-Dopa in the treatment of Parkinson's disease and the action of MDMA in Ecstasy.
19 Discuss how the outcomes of the ~~Human Genome Project~~ are being used in the development of ~~new drugs~~ and the social, moral and ethical issues this raises.	8.16 *Understand* how the outcomes *of genome sequencing projects* are being used in the development of *personalised medicine* and the social, moral and ethical issues this raises.
20 Describe how drugs can be produced using genetically modified organisms (plants and animals and microorganisms).	8.17 *Know* how drugs can be produced using genetically modified organisms (plants, animals and microorganisms).
21 Discuss the risks and benefits associated with the use of genetically modified organisms.	8.18 *Understand* the risks and benefits associated with the use of genetically modified organisms.
13 Consider the methods used to compare the contributions of nature and nurture to brain development, including evidence from the abilities of new born babies, animal experiments, studies of individuals with damaged brain areas, twin studies and cross-cultural studies.	8.19 *Understand* the methods used to *investigate* ~~compare~~ the contributions of nature and nurture to brain development, including evidence from the abilities of new born babies, animal experiments, studies of individuals with damaged brain areas, twin studies and cross cultural studies.