Scheme of Work 2020-2021
Subject: Biology

Year Group: 13 Summer term
Specification: A2 Biology

Lesson No	Topic & Objectives	Big Question – What will students learn?	Key Activities & Specialist Terminology (Do Now Task / Starter/Tasks/Plenary	Planned Assessment	Homework or flipped learning resources DODDLE resources	Lit Num SMSC Codes
1 3.8.1 Alteration of the sequence of bases in DNA can alter the structure of proteins.	Gene mutations might arise spontaneously during DNA replication. They include addition, deletion, substitution, inversion, duplication and translocation of bases. The mutation rate is increased by mutagenic agents. Mutations affecting one triplet and those which cause frame shift.	• Describe what happens in substitution, addition, deletion, inversion, duplication and translocation mutations. • Explain how mutations can arise spontaneously, and the effect that mutagenic agents have on the rate of mutation. Relate the nature of a gene mutation to its effect on the encoded	**Learning activities:** • question students on what they recall from 3.4.3 on mutagenic agents and deletion and substitution mutations • provide students with a DNA sequence, a codon table and an instruction sheet on how to make one type of mutation to the sequence (give different types of mutations to different groups). The groups then work out the amino acid sequence produced from the wild type and mutated allele. Accept feedback from each group as to how different the mutated version was • teacher led explanation of mutations linked to protein structure and earlier knowledge of degeneracy • exam questions. **Skills developed by learning activities:** • AO1 – development of knowledge understanding of types of mutation and its consequences AO2 – application of knowledge to information/context of exam questions	**Specimen assessment material:** A-level Paper 3 (set 1) – Q10.3 **Past exam paper material**: BIOL5 June 2012 – Q1a-1c BIOL5 June 2014 – Q1 HBIO4 Jan 2013 – Q10b HBIO4 June 2011 – Q10c	**Rich questions:** • What is meant by a frame shift mutation? Explain why some types of mutation might not result in a change to the structure of the polypeptide that is produced.	C1,C3,Sp2

2 **3.8.2.1 Most of a cell's DNA is not translated.**	The characteristics and source of totipotent, pluripotent, multipotent and unipotent stem cells. The production of specialised cells from totipotent cells requires only part of the cell's DNA to be translated. Unipotent cells exemplified by formation of cardiomyocytes. Pluripotent cells and their use in treating human disorders.	• Define what a stem cell is. • Explain the characteristics of totipotent, pluripotent, multipotent and unipotent stem cells, and the sources of each type. • Explain how induced pluripotent cells can be produced and why they are of interest. Evaluate the use of stem cells in treating human disorders.	**Learning activities:** • introduce the idea of some plant cells being totipotent throughout their life (so a cutting can give rise to a new plant). Outline that this is not true with differentiated mammalian cells. Introduce stem cells • provide information sheets on totipotent (linking back to differentiation and translating only some of the cell's DNA), pluripotent, multipotent and unipotent cells (exemplified by formation of cardiomyocytes). Students circulate to find the answers to a series of questions • teacher explanation to reinforce • evaluation of use of stem cells in treating human disorders. This could be done as a debate • show students the video on IPS cells and get them to research IPS cells using selected websites. Ask them how IPS cells are made and whether this overcomes ethical objections around pluripotent embryonic stem cells • concept map • exam questions **Skills developed by learning activities:** • AO1 – development of understanding relating to the properties and uses of different types of stem cells	**Past exam paper material**: BIOL5 June 2010 – Q6 BIOL5 June 2011 – Q6a HBIO4 June 2014 – Q4	ncbe.reading.ac.uk/NCBE/SAFETY/tissuesafety.html earn.genetics.utah.edu/content/stemcells eurostemcell.org/factsheet/reprogramming-how-turn-any-cell-body-pluripotent-stem-cell **Rich questions:** • How do plants and mammals differ in relation to differentiation? Why is only a small proportion of a cell's DNA translated when it specialises?	C1,C3,Sp 2

	The production of Induced pluripotent cells (IPS cells).		• AO2/AO3 – application of knowledge and interpretation of, scientific data and evidence to evaluate the use of stem cells 8.4.2.5 – Research IPS cells.			
4 **3.8.2.2 Regulation of transcription and translation**	In eukaryotes, transcription of target genes can be stimulated or inhibited when specific transcriptional factors move from the cytoplasm into the nucleus. The role of the steroid hormone, oestrogen, in initiating transcription.	• Explain what a transcription factor is. • Describe the role of transcription factors in gene expression. • Describe the mechanism by which oestrogen is able to initiate transcription. Interpret data provided from investigations into gene expression.	**Learning activities:** • ask pupils to do a genetic cross of heterozygous peas eg for colour and to work out the 3:1 ratio. Provide numbers of pea plants which don't exactly match this ratio and ask students what possibilities exist to explain this difference in observed values • discuss the nature of probability and fertilisation events being unlinked and random • lead through students through a couple of worked examples of the chi-squared tests and how to interpret values – NB in written papers, students will not be expected to calculate a test statistic or find the value of P corresponding to the test statistic. They will be expected to interpret a value of P • provide further examples using simple dominant/recessive monohybrid crosses. **Skills developed by learning activities:** • AO1 – development of knowledge and understanding of the chi-squared test and how it is used • AO2 – application of knowledge to interpret chi-squared outcomes	**Past exam paper material**: BIOL5 June 2010 – Q5 BIOL5 June 2011 – Q8a	**Rich questions:** • Why is oestrogen able to directly enter the cell? • What is a transcriptional factor? • How does oestrogen stimulate/activate transcription factors? Suggest why oestrogen only has an effect in certain tissues?	C1,C3,Sp 2

			MS 1.9 – use the χ^2 test to investigate the significance of differences between expected and observed phenotypic ratios.			
5	Epigenetic control of gene expression in eukaryotes. Epigenetics involves heritable changes in gene function, caused by changes in the environment that inhibit transcription by: • increased methylation of the DNA • decreased acetylation of associated histones.	• Explain what epigenetics is, and what happens to the DNA or histone to modify gene expression. • Interpret data provided from investigations into gene expression. • Evaluate appropriate data for the relative influences of genetic and environmental factors on phenotype. • Explain how epigenetic control can cause disease, and how it could be used to treat diseases such as cancer.	**Learning activities:** • conduct a class vote on whether identical twins should have similar predispositions to diseases linked to gene expression • show video from the learn.genetics.utah.edu link (see resources). Follow this up with teacher elaboration on how methylation and acetylation affect gene expression as well as answering of any questions • analyse data on the relative influences of genetic and environmental factors on phenotype from twin studies, and draw conclusions • exam question • teacher led explanation of epigenetic causes of disease and epigenetic therapy (with reference to cancer). **Skills developed by learning activities:** • AO1 – development of understanding relating to epigenetics and its relevance to developing and treating disease AO2/AO3 – application of knowledge to explain trends in scientific data from studies of identical and fraternal twins.	**Past exam paper material**: HBIO4 Jan 2012 – Q6 HBIO4 June 2013 – Q7	scientificamerican.com/article/epigenetics-explained learn.genetics.utah.edu/content/epigenetics **Rich questions:** • Why is studying twins so useful when investigating the environmental effects on epigenetics? • What effect does DNA methylation have on gene expression? Why? What effect does histone acetylation have on gene expression. Why?	C1,C3,Sp 2

	The relevance of epigenetics on the development and treatment of disease, especially cancer.					
5	In eukaryotes and some prokaryotes, translation of the mRNA produced from target genes can be inhibited by RNA interference (RNAi).	• Explain how gene expression can be inhibited by RNA interference of translation. • Explain how siRNA interferes with translation. Interpret data provided from investigations into gene expression.Explain temporal, spatial summation, and inhibition by inhibitory synapses	**Learning activities:** • provide students with the materials (video and comprehension) from nature.com • get them to prepare a short presentation on what they have researched • peer evaluation of presentation and teacher explanation to address weaknesses and reinforce key points • provide data from investigations into RNAi and ask students to apply their knowledge • exam questions. **Skills developed by learning activities:** • AO1 – development of understanding of how RNA interference can inhibit gene expression AO2/AO3 – application of knowledge to, and interpretation of, scientific data from investigations into gene expression.	**Past exam paper material**: BIOL5 June 2013 – Q6 BIOL5 June 2011 – Q8b	nature.com/nrg/multimedia/rnai/animation/index.html nature.com/horizon/rna/background/interference.html **Rich questions:** • Why is RNA interference specific to mRNA from a particular gene? How is RNAi different from inhibition of gene expression by transcription factors?	C1,C3,Sp2
Specimen assessment material:	The main characteristics of benign and malignant tumours.	• Describe the characteristics of benign and malignant tumours. • Explain the role of oncogenes/tumour suppressor genes,	**Learning activities:** • teacher explanation of the main characteristics of benign and malignant tumours, and the role of tumour suppressor genes and oncogenes in cancer. The Nowgen video could support this but be	**Past exam paper material**: BIOL4 Jan 2012 – Q5 BIOL4 Jan 2013 – Q3	sanger.ac.uk/research/projects/cancergenome yourgenome.org/teachers/roleofcancergenes.shtml	

	The role of the following in the development of tumours: • tumour suppressor genes and oncogenes • abnormal methylation of tumour suppressor genes and • oncogenes increased oestrogen concentrations in the development of some breast cancers.	abnormal methylation and increased oestrogen concentrations in the development of cancer. • Evaluate evidence showing correlations between genetic and environmental factors and various forms of cancer. Interpret information relating to the way in which an understanding of the roles of oncogenes and tumour suppressor genes could be used in the prevention, treatment and cure of cancer.	aware that cancer may be a sensitive issue for some students • students could undertake the BRAF activity, identifying mutations in the BRAF proto-oncogene and compare against the COSMIC online database • discuss how this information could be used in the future to prevent, treat or cure cancer • teacher explanation of the role of abnormal DNA methylation, and increased oestrogen concentrations in the role of cancer development • exam questions. **Skills developed by learning activities:** • AO1 – development of understanding of tumours, and the possible reasons for developing tumours • AO2 – application of knowledge to exam questions • AO3/AT I – evaluation of scientific data showing correlations and comparison of data against bioinformatics database essay-writing skills.	BIOL4 June 2013 – Q3bii BIOL4 June 2014 – Q4a-4b BYA5 June 2008 – Q6 BYA5 June 2009 – Q4 **Exampro:** BYB4 Jan 2004 – Q5 BYB4 June 2004 – Q5 BYB4 June 2006 – Q6 BYB4 June 2005 – Q4	yourgenome.org/teachers/braf.shtml	
A-level Paper 3 (set 1) – Q4						

8 3.8.3 Using genome projects	Sequencing projects have read the genomes of a wide range of organisms. Determining the genome of simpler organisms allows the proteome to be determined. This may have many applications, including the identification of potential antigens for use in vaccine production. In more complex organisms, the presence of non-coding DNA and of regulatory genes means that knowledge of the genome cannot easily	• Explain the principles of gel electrophoresis in separating DNA fragments. • Explain how sequencing techniques have become automated and faster. Explain why it is harder to translate genomic sequences into the proteome for complex organisms than for simpler organisms.	**Learning activities:** • teacher explanation of the technique of electrophoresis • students could research the Human Genome project (and other genome projects) • show students the speed animation and ask them to highlight points which have allowed sequencing methods to become faster and more automated • exam questions. **Skills developed by learning activities:** • AO1 – development of understanding relating DNA sequencing techniques and genome projects AO2/AO3 – application of knowledge to, interpret sequences from gel patterns	**Past exam paper material**: BIOL5 June 2013 – Q8c **Exampro:** BYB2 June 2005 – Q6	wellcome.ac.uk/Education-resources/Education-and-learning/Resources/Animation/WTDV026689.htm yourgenome.org/teachers/sequencing.shtml yourgenome.org/teachers/speed.shtml yourgenome.org/teachers/hgp.shtml wellcome.ac.uk/Education-resources/Education-and-learning/Resources/Animation/WTX056051.htm.	So5,Sp2 M2

	be translated into the proteome. Sequencing methods are continuously updated and have become automated.					
9 **3.8.4.1 Recombinant DNA technology**	Recombinant DNA technology involves the transfer of fragments of DNA from one organism, or species, to another, resulting in translation within the recipient (transgenic organism) due to the universal nature of the genetic code. Fragments of DNA can be produced by several methods, including:	Recombinant DNA technology involves the transfer of fragments of DNA from one organism, or species, to another, resulting in translation within the recipient (transgenic organism) due to the universal nature of the genetic code. Fragments of DNA can be produced by several methods, including: • conversion of mRNA to cDNA, using reverse transcriptase • using restriction enzymes to cut a fragment containing the desired gene from DNA creating the gene in a 'gene machine'.	**Learning activities:** • teacher introduction to recombinant DNA technology • questioning to assess recall from GCSE • think, pair, share: how do we isolate a gene from the rest of the DNA to produce a DNA fragment? • teacher led explanation on the three methods required in the specification. Include an overview of how Type 2 restriction endonucleases cut to leave a sticky end • provide students with palindromic sequences and recognition site information for different Type 2 restriction endonucleases and ask them to draw the two pieces which would form when cut. This could be extended to look at how many pieces would be produced for an extended sequence with several restriction sites • exam questions. **Skills developed by learning activities:**	**Past exam paper material**: HBIO4 June 2014 – Q9bi HBIO4 Jan 2011 – Q9a **Exampro:** BYA2 Jan 2005 – Q2	highered.mheducation.com/olcweb/cgi/pluginpop.cgi?it=swf::640::480::/sites/dl/free/0073383074/811328/restriction_endonucleases.swf::Restriction%20Endonucleases **Rich questions:** • What is cDNA? • Why would it be inappropriate to produce cDNA of the human insulin gene by trying to find mRNA in a small intestine epithelial cell? • What is meant by the term palindromic recognition sequence?	So5,Sp2 M2

	• conversion of mRNA to cDNA, using reverse transcriptase • using restriction enzymes to cut a fragment containing the desired gene from DNA creating the gene in a 'gene machine'.		• AO1 – development of understanding relating to recombinant DNA technology and production of DNA fragments AO2 – application of knowledge of restriction endonuclease recognition sites to work out sticky ends produced			
10	The principles of the polymerase chain reaction (PCR) as an *in vitro* method to amplify DNA fragments.	• The principles of the polymerase chain reaction (PCR) as an *in vitro* method to amplify DNA fragments.predicted from genetic crosses. • Interpret P values from chi-squared tests in terms of probability and chance.	**Learning activities:** • get students to use the Virtual PCR lab (see resources) to work through the laboratory technique of PCR • teacher-led explanation of PCR and the stages involved. Use videos and animations to support your explanation • ask students to compare and contrast PCR to DNA replication • ask students to work out the number of copies you would have from one original	**Specimen assessment material:** A-level Paper 3 (set 1) – Q10.5 **Past exam paper material**: HBIO4 Jan 2013 – Q10c HBIO4 Jan 2011 – Q9b	sumanasinc.com/webcontent/animations/content/pcr.html dnalc.org/view/15475-The-cycles-of-the-polymerase-chain-reaction-PCR-3D-animation.html dnalc.org/resources/animations/pcr.html	So5,Sp2 M2

			DNA fragment after a specified number of cycles • card sort – order the stages and match up explanation cards to each • exam questions. **Skills developed by learning activities:** • AO1/PS4.1 – development of understanding of the process of PCR and its applications • AO2/AO3 – application of knowledge to, and interpretation of, scientific data and evidence to form reasoned arguments • AT l – computer modelling of PCR MS 0.5 and MS 2.5 – students could use calculators with exponential functions and a logarithmic scale to represent the increase in the number of copies of DNA fragments present after multiple cycles of PCR.		earn.genetics.utah.edu/content/labs/pcr **Rich questions:** • What is the purpose of adding DNA primers? • Why is Taq polymerase used in the PCR? How many fragments would you have after 20 cycles of PCR?	
11	The culture of transformed host cells as an *in vivo* method to amplify DNA fragments, involving: • the addition of promoter and terminator regions	• Explain what gene cloning is and why it is important in a range of applications. • Describe the stages involved in in vivo gene cloning. • Explain the importance of the addition of promoter and terminator regions. • Explain the importance of the use of restriction enzymes and sticky ends. • Explain the methods used for transformation.	**Learning activities:** • teacher explanation of how to clone in vivo (using videos and animations) • card sort of the stages • exam questions. **Skills developed by learning activities:** • AO1/PS 4.1 – development of understanding relating to the process of in vivo gene cloning • AO2/AO3 – interpretation of information in exam questions and application of knowledge about in vivo gene cloning	**Specimen assessment material:** A-level Paper 3 (set 1) – Q5 **Past exam paper material**: BIOL5 June 2012 – Q5 **Past exam paper material**: BIOL5 June 2012 – Q1 HBIO4 June 2014 – Q9bi	dnalc.org/resources/animations/restriction.html dnalc.org/resources/animations/transformation1.html highered.mheducation.com/sites/0072556781/student_view0/chapter14/animation_quiz_1.html **Rich questions:** Why is the percentage of cells successfully transformed with	So5,Sp2 M2

	to the fragments of DNA • the use of restriction endonucleases and ligases to insert fragments of DNA into vectors the use of marker genes to detect genetically modified (GM) cells or organisms.	• Explain the use of marker genes and replica plating. Interpret information provided in exam questions, to interpret which colonies have been successfully transformed with recombinant DNA.	MS 0.3 – use percentages when discussing/working out the proportion of cells which are successfully transformed.	HBIO4 Jan 2013 – Q6 HBIO4 June 2010 – Q9	recombinant DNA so low?	
12	The applications and implications of recombinant DNA technology	• Interpret information relating to the use of recombinant DNA technology. • Evaluate the ethical, financial and social issues associated with the use and ownership of recombinant DNA technology in agriculture, in industry and in medicine.	**Learning activities:** • continuum – who is in favour of transgenic/GM organisms? • jigsaw task: students work in groups of 4, with one going to become an expert in one of four areas. Provide materials on the use of recombinant DNA technology in agriculture, medicine, industry and the environment. For each area, provide case studies/data of how recombinant DNA technology has been used eg Bt Maize,	**Past exam paper material**: HBIO4 June 2014 – Q9biii HBIO4 June 2010 – Q5	bionetonline.org/English/Content/ff_intro.htm	So5,Sp2 M2

		Balance the humanitarian aspects of recombinant DNA technology with the opposition from environmentalists and anti-globalisation activists.	pharming, GM mustard plants removing excessive selenium • feedback and completion of summary table • repetition of continuum – have opinions changed • debate: should the UK allow the commercial growing of GM crops. Assign students viewpoints to reflect those who would benefit from humanitarian aspects against those who oppose GM. In addition to researcher applications, provide further information relating to risks. **Skills developed by learning activities:** • AO1 – development of understanding of how recombinant DNA technology is used • AO2/AO3 – application of knowledge to, and interpretation/evaluation of, scientific data and case studies to form reasoned arguments 8.4.2.5.			
13	Relate recombinant DNA technology to gene therapy.	• Explain the principles of gene therapy. • Explain the use of liposomes and viruses in delivering genes into cells. • Explain the difference between somatic and germ line therapy, and why germ line therapy is prohibited. (NB the first three bullet points are not required AO1 specification	**Learning activities:** • teacher-led explanation of gene therapy and the use of viruses and liposomes to deliver the gene to cells • students explore online gene therapy kit to determine pros and cons of using liposomes and viruses. Accept feedback and discuss • comprehension on possible applications of gene therapy in treating certain diseases • teacher-led explanation of the risks and issues surrounding effectiveness of liposomes and viruses. - exam questions.	**Past exam paper material**: BIOL5 June 2012 – Q6	learn.genetics.utah.edu/content/genetherapy **Rich questions:** • Why are viruses used in some forms of gene therapy? • Why does gene therapy become less effective with successive treatments?	So5,Sp2 M2

		knowledge but used to develop ideas). Evaluate the effectiveness and risks of gene therapy	**Skills developed by learning activities:** • AO1 – development of understanding relating to gene therapy, its effectiveness and its risks • AO2 – application of knowledge to evaluate gene therapy MS 0.3 – use percentages when discussing/working out the proportion of cells which take up and express the therapeutic gene.		• Describe a risk of using viruses? • What further challenges would be faced in using gene therapy to cure genetic diseases caused by mutations in multiple genes?	
14 **3.8.4.2 Differences in DNA between individuals of the same species can be exploited for identification and diagnosis of heritable conditions.**	The use of labelled DNA probes and DNA hybridisation to locate specific alleles of genes. The use of labelled DNA probes that can be used to screen patients for heritable conditions, drug responses or health risks. The use of this information in genetic counselling	• Explain how DNA probes and hybridisation are used to locate specific alleles. • Explain the benefits of screening for genetic diseases. • Explain some of the issues raised by screening, and the role of genetic counsellors. Evaluate information relating to screening individuals for genetically determined conditions and drug responses.	**Learning activities:** • ask students who would want to be screened for a genetic disease. Inform them that they were all screened at birth for PKU and why this was done • teacher explanation of DNA probes and hybridisation to screen for heritable conditions, drug responses or health risks • students could model this by being given a "DNA probe" with a short sequence and some DNA sequences from people – they have to find if the probe would hybridise and where • continuum line – Is genetic testing a good thing which we should all have done? • genome generation card scenarios – Students discuss all or some of the scenarios. Summarise the concerns eg should insurance companies have the right to know? • explanation of role of genetic counsellors • repeat the continuum – have opinions changed? • exam questions.	**Specimen assessment material:** A-level Paper 2 (set 1) – Q10.5 **Past exam paper material**: BIOL5 June 2012 – Q8 BIOL5 June 2013 – Q8a and 8b BIOL5 June 2014 – Q8 HBIO4 Jan 2013 – Q10e HBIO4 Jan 2011 – Q10 HBIO4 Jan 2010 – Q9a-c	yourgenome.org/teachers/genomegeneration.shtml earn.genetics.utah.edu/content/disorders/counselors bionetonline.org/English/content/gh_intro.htm **Rich questions:** • Explain how a radioactive DNA probe would be used in screening? • What is the value of genetic screening? • Why are some people concerned about having screening for a wide range of genetic diseases and predispositions?	So5,Sp2 M2

	and personalised medicine.		**Skills developed by learning activities:** • AO1 – development of understanding relating to genetic screening and counselling AO2 – application of knowledge to form reasoned arguments.		What can genetic counsellors provide advice on, and what can they not advise on?	

3.8.4.3 Genetic fingerprinting	An organism's genome contains many variable number tandem repeats (VNTRs). The probability of two individuals having the same VNTRs is very low. The technique of genetic fingerprinting in analysing DNA fragments that have been cloned by PCR, and its use in determining genetic relationships and in determining the genetic variability within a population.	• methodology involved in producing a genetic fingerprint. • Explain what variable number tandem repeats are, and how these allow the production of a virtually unique genetic fingerprint. • Explain the applications of genetic fingerprinting. • Interpret genetic fingerprint patterns and draw conclusions.	**Learning activities:** • questioning to establish recall from GCSE • teacher explanation of VNTRs and how they vary between people • students could use a computer model to model DNA fingerprinting (see resources) • teacher explanation to elaborate on learning so far (using animation) • information treasure hunt – find information to set questions about the applications of genetic fingerprinting by visiting information stations • accept feedback • model how to interpret genetic fingerprints eg in paternity cases and provide further examples for students to work through. **Skills developed by learning activities:** • AO1 – development of understanding relating to genetic fingerprinting and its applications • AO2/AO3 – interpretation of genetic fingerprints to draw valid conclusions • MS 1.4 – consider the probability of two people (not identical twins) having the same VNTRs essay-writing skills.	**Past exam paper material**: BIOL5 June 2011 – Q10a **Exampro:** BYA2 June 2005 – Q8	highered.mheducation.com/sites/dl/free/0072835125/126997/animation40.html pbslearningmedia.org/asset/tdc02_int_creatednafp2 **Rich questions:** • Why might PCR be used with DNA fingerprinting? • Why are forensics officers so careful to avoid contaminating a crime scene? What proportion of bands would you expect to match between a child and its father?	So5,Sp2 M2

	The use of genetic fingerprinting in the fields of forensic science, medical diagnosis, animal and plant breeding					