Scheme of Work 2020-2021
Subject: Biology

Year Group: 13 Spring term 2
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 **3.7.1 Inheritance**	The genotype is the genetic constitution of an organism. The phenotype is the expression of this genetic constitution and its interaction with the environment. There may be many alleles of a single gene. In a diploid organism, the alleles at a specific	Explain the meaning of the key terms: • gene • allele • genotype • phenotype • homozygous • heterozygous.	**Learning activities:** • diagnostic question to assess GCSE understanding – is it possible for two brown eyed parents to have a blue eyed child? Explain your answer • teacher-led explanation of the concepts of genes and alleles and the key terms required in the specification • card match – terms to definitions • exam questions. **Skills developed by learning activities:** • AO1 – development of knowledge and understanding of key terms and concepts relating to inheritance ATh – ethical and safe use of organisms.		**Rich question:** What is wrong with this statement: "he had two blue eyed genes which meant he had blue eyes"? **<u>Flipped learning opportunity</u>** PiXL Independence: Biology – Student Booklet KS5 – Genetics and evolution	C1,C3,Sp 2

	locus may be either homozygous or heterozygous					
2	Alleles may be dominant or recessive. The use of fully labelled genetic diagrams to interpret, or predict, the results of monohybrid crosses involving dominant and recessive alleles	• Define what is meant by dominant and recessive alleles and describe how to represent these. • Draw genetic diagrams of dominant/recessive monohybrid crosses to predict offspring genotypes and phenotypes. Apply knowledge to calculate the	**Learning activities:** • stimulus: survey those in the class who can roll their tongue. Introduce the idea of this being controlled by two alleles of one gene – a dominant and a recessive one • teacher explanation of the principle of dominant and recessive alleles (related back to protein synthesis) and how these are symbolically represented • work through some examples, using Punnet squares to represent the inheritance of characteristics. Relate back to meiosis • students work through further examples independently • teacher-led explanation of how to interpret pedigree analysis diagrams to prove whether a characteristic is dominant or recessive. **Skills developed by learning activities:** • AO1 – development of understanding of dominant and recessive alleles, and their inheritance • AO2 – application of knowledge to unfamiliar contexts • MS 0.3 – use information to represent phenotypic ratios in monohybrid crosses MS 1.4 – understand simple probability associated with inheritance.	**Past exam paper material**: BIOL4 June 2013 – Q3a–b HBIO4 June 2013 – Q4 HBIO4 June 2010 – Q6	kscience.co.uk/animations/drosophila2.htm kscience.co.uk/animations/inheritance.htm **Rich questions:** • Define what is meant by dominant and recessive alleles. • Why is it not correct to think of a cell ignoring the recessive allele if a dominant one is present? Two heterozygous parents who can roll their tongue have 3 children. All 3 offspring can roll their tongue. They then fall pregnant with a 4th child. Does this mean that this one will be unable to roll their tongue?	C1,C3,Sp 2

3	Use of the chi-squared ($\chi 2$) test to compare the goodness of fit of observed phenotypic ratios with expected ratios..	• Explain what the chi-squared test is used for. • Set a null hypothesis. • Use the chi-squared test to compared observed values against those predicted from genetic crosses. • Interpret chi-squared tests in terms of probability and chance.	**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 MS 1.9 – use the $\chi 2$ test to investigate the significance of differences between expected and observed phenotypic ratios.	**Past exam paper material**: BYA5 Jan 2003 – Q8a–8b	**Rich questions:** • Why should you use chi-squared for inheritance investigations? • What is the null hypothesis for this? • How many degrees of freedom? • Interpret your results in terms of chance and probability.	
4	Alleles may also be codominant. The use of fully labelled genetic	• Define what is meant by codominant alleles, and describe how to represent these. • Draw genetic diagrams of codominant	**Learning activities:** • teacher explanation of the principle of co-dominant alleles and how these are symbolically represented	**Past exam paper material**: BIOL4 June 2014 – Q4c	**Rich question:** Ask students to interpret or predict the offspring when provided with parental genotypes for examples involving	C1,C3,Sp 2

	diagrams to interpret, or predict, the results of monohybrid crosses involving codominant alleles..	monohybrid crosses to predict offspring genotypes and phenotypes. • Apply knowledge to calculate the predicted ratios of genotypes and phenotype of offspring, using fully labelled diagrams, when supplied with appropriate information. • Use the chi-squared test to compare observed values against those predicted from genetic crosses. Interpret P values from chi-squared tests in terms of probability and chance.	• work through some examples, using Punnet squares to represent the inheritance of characteristics. Relate back to meiosis • students work through further examples independently, including chi-squared questions as well. **Skills developed by learning activities:** • AO1 – development of understanding of co-dominant alleles, and their inheritance. • AO2 – application of knowledge to unfamiliar contexts. • MS 0.3 – use information to represent phenotypic ratios in monohybrid crosses. • MS 1.4 – understand simple probability associated with inheritance. MS 1.9 – use the $\chi 2$ test to investigate the significance of differences between expected and observed phenotypic ratios		codominance eg pink snapdragons, Tabby cats, Palamino horses, Human haemoglobin, orange moths.	
5	• The use of fully labelled genetic diagrams to interpret, or predict, the results of multiple allele crosses.unidirectionality	• Describe how to represent alleles in crosses involving multiple alleles. • Draw genetic diagrams to predict offspring genotypes and phenotypes. • Apply knowledge to calculate the predicted ratios of genotypes and phenotype of offspring, using fully labelled diagrams, when supplied with appropriate information.	**Learning activities:** • introduce the concept of blood groupings. Ask students to do a simple monohybrid cross for Rhesus blood groupings (antigen D gene) as a recap of dominant/recessive crosses) • introduce the ABO blood grouping system and the fact it is controlled by one gene. Ask students to suggest how this is possible • teacher explanation of the principle multiple allele inheritance and how these alleles are symbolically represented • work through some examples, using Punnet squares to represent the inheritance of characteristics	**Past exam paper material**: BIOL4 June 2012 – Q2a–c BIOL4 Jan 2011 – Q2a–b BIOL4 June 2011 – Q5 **Exampro:** BYA5 Jan 2007 – Q3 BYA5 June 2006 – Q7	**Rich question:** Ask students to interpret or predict the offspring when provided with parental genotypes for examples involving multiple alleles eg ABO blood groups, coat colour in rabbits.	C1,C3,Sp 2

	• temporal and spatial summation • inhibition by inhibitory synapses.	• Use the chi-squared test to compared observed values against those predicted from genetic crosses. • Interpret P values from chi-squared tests in terms of probability and chance.. Explain temporal, spatial summation, and inhibition by inhibitory synapses	• students work through further examples independently, including chi-squared questions. **Skills developed by learning activities:** • AO1 – development of understanding of multiple alleles and their inheritance • AO2 – application of knowledge to unfamiliar contexts • MS 0.3 – use information to represent phenotypic ratios in monohybrid crosses • MS 1.4 – understand simple probability associated with inheritance MS 1.9 – use the $\chi 2$ test to investigate the significance of differences between expected and observed phenotypic ratios			
6	The use of fully labelled genetic diagrams to interpret, or predict, the results of crosses involving sex linkage.	• Explain what is meant by sex-linked genes, and describe how to represent these. • Draw genetic diagrams of sex-linked crosses to predict offspring genotypes and phenotypes. • Apply knowledge to calculate the predicted ratios of genotypes and phenotype of offspring, using fully labelled diagrams, when supplied with appropriate information. • Use the chi-squared test to compared observed values against those	**Learning activities:** • ask students to suggest why some characteristics eg red-green colour blindness, DMD are more common in men • teacher explanation of the principle sex linkage and how these alleles are symbolically represented • work through some examples, using Punnet squares to represent the inheritance of characteristics students work through further examples independently, including chi-squared questions as well. **Skills developed by learning activities:** • AO1 – development of understanding of co-dominant alleles, and their inheritance • AO2 – application of knowledge to unfamiliar contexts	**Past exam paper material**: BIOL4 Jan 2012 – Q5 BIOL4 Jan 2013 – Q3 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	kscience.co.uk/animations/drosophila2.htm **Rich question:** Ask students to interpret or predict the offspring when provided with parental genotypes for examples involving sex linkage eg Duchenne muscular dystrophy, Haemophilia, Red/green colour blindness.	C1,C3,Sp 2

		predicted from genetic crosses. Interpret P values from chi-squared tests in terms of probability and chance.	• MS 0.3 – use information to represent phenotypic ratios in monohybrid crosses • MS 1.4 – understand simple probability associated with inheritance MS 1.9 – use the $\chi 2$ test to investigate the significance of differences between expected and observed phenotypic ratios.			
7	The use of fully labelled genetic diagrams to interpret, or predict, the results of dihybrid crosses involving dominant, recessive and codominant alleles.	• Draw genetic diagrams of dihybrid crosses to predict offspring genotypes and phenotypes. • Apply knowledge to calculate the predicted ratios of genotypes and phenotype of offspring, using fully labelled diagrams, when supplied with appropriate information. • Use the chi-squared test to compare observed values against those predicted from genetic crosses. Interpret P values from chi-squared tests in terms of probability and chance.	**Learning activities:** • teacher explanation of dihybrid crosses as looking at the inheritance of two characteristics controlled by two unlinked genes, which are inherited independently of each other • work through some examples, using Punnet squares to represent the inheritance of characteristics • students work through further examples independently, including chi-squared questions as well. **Skills developed by learning activities:** • AT h – ethical and safe use of organisms • AO1 – development of understanding of dihybrid crosses • AO2 – application of knowledge to unfamiliar contexts • MS 0.3 – use information to represent phenotypic ratios in dihybrid crosses • MS 1.4 – understand simple probability associated with inheritance MS 1.9 – use the $\chi 2$ test to investigate the significance of differences between expected and observed phenotypic ratios.	**Exampro:** BYA5 Jan 2005 – Q7 BYA5 Jan 2009 – Q6 BYB4 June 2006 – Q6 BYB4 June 2007 – Q5 BYB4 June 2009 – Q3	kscience.co.uk/animations/drosophila2.htm **Rich question:** Ask students to interpret or predict the offspring when provided with parental genotypes for examples involving dihyrbid inheritance eg coat colour and hair length in guinea pigs, wing size and body colour in Drosophila.	

8	The use of fully labelled genetic diagrams to interpret, or predict, the results of crosses involving autosomal linkage.	• Apply knowledge to calculate the predicted frequencies of genotypes and phenotype of offspring, using fully labelled diagrams, when supplied with appropriate information. • Use the chi-squared test to compared observed values against those predicted from genetic crosses. • Interpret P values from chi-squared tests in terms of probability and chance.	**Learning activities:** • provide data on the work of Bateson, Saunders and Punnet in 1905, showing the F1 and F2 generation results. Ask them to apply chi-squared to this, assuming it was a simple dihybrid cross (ie 9:3:3:1) to prove there was a significant difference between observed and expected • teacher explanation of autosomal linkage. Make it clear that this is investigating two genes on the same chromosome pair, unlike other examples studied so far • work through some examples, using Punnet squares to represent the inheritance of characteristics when supplied with the frequency of gametes with each combination of alleles • students work through further examples independently. **Skills developed by learning activities:** • AO1 – development of understanding of epistasis • AO2 – application of knowledge to unfamiliar contexts • MS 0.3 – use information to represent phenotypic ratios in crosses involving epistasis • MS 1.4 – understand simple probability associated with inheritance MS 1.9 – use the χ^2 test.	**Specimen assessment material**: A-level Paper 2 (set 1) – Q3	kscience.co.uk/animations/drosophila2.htm **Rich question:** Ask students to interpret or predict the offspring when provided with parental genotypes for examples involving autosomal linkage eg linkage in flower colour and type of pollen in sweet peas, linkage of wing and eye colour.	C1,C3,Sp 2
9	The use of fully labelled genetic diagrams to interpret, or	• Apply knowledge to calculate the predicted ratios of genotypes and phenotype of offspring, using fully labelled	**Learning activities:** • teacher explanation of the gross structure teacher explanation of epistasis (the interference of one gene's expression of another)	**Exampro:** BYB4 June 2005 – Q7 BYB4 Jan 2005 – Q5 BYB4 Jan 2006 – Q6	**Rich questions:** Ask students to interpret or predict the offspring when provided with parental genotypes	C1,C3,Sp 2

	predict, the results of crosses involving epistasis.	diagrams, when supplied with appropriate information. • Use the chi-squared test to compare observed values against those predicted from genetic crosses. • Interpret P values from chi-squared tests in terms of probability and chance.	• work through some examples using Punnet squares to represent the inheritance of characteristics • students work through further examples independently. **Skills developed by learning activities:** • AO1 – development of understanding of epistasis • AO2 – application of knowledge to unfamiliar contexts • MS 0.3 – use information to represent phenotypic ratios in crosses involving epistasis MS 1.4 – understand simple probability associated with inheritance.	BYA4 Jan 2006 – Q6a	for examples involving epistasis eg coat colour in rodent, fruit colour in summer squashes, flower colour in sweet peas, comb shape in chickens.	
10 3.7.2 Populations	Species exist as one or more populations. A population as a group of organisms of the same species occupying a particular space at a particular time that can potentially interbreed. The concepts of gene pool	• Define what is meant by the term 'population'. • Explain what is meant when we refer to allele frequencies and a gene pool. • Explain why some genotypes cannot be determined by looking at phenotypes.Explain the role of phosphocreatine in muscle fibres.	**Learning activities:** • ask students the rich questions to expose common misconceptions • define the concept of a population. Introduce the concept of gene pools and the limitations of Mendel's crosses • provide students with photocopied pictures of animals with the genotypes for one feature written on them (have a mixture of homozygous dominant, heterozygous and homozygous recessive individuals). Ask students to work out the frequency of genotypes and allele frequencies within the gene pool • summarise their findings as p+q=1. **Skills developed by learning activities:**	**Past exam paper material**: BYA5 Jan 2005 – Q8a BYA5 June 2003 – Q4a	**Rich questions:** • Is the dominant allele more common in a population than the recessive allele? Explain your answer. Is it possible to work out the genotypes of everyone in a population for a particular feature? Explain your answer.	So5,Sp2 M2

	and allele frequency		• AO1 – development of understanding of population and gene pools • AO2/AO3 – analyse information and apply knowledge to work out allele frequencies MS 0.3 – use percentages and decimals.			

11	The The Hardy-Weinberg principle provides a mathematical model, which predicts that allele frequencies will not change from generation to generation. The conditions under which the principle applies.
	
	The frequency of alleles, genotypes and phenotypes in a population can be calculated
		• Explain what the Hardy-Weinberg principle predicts.
		• Explain the conditions under which Hardy-Weinberg principle is valid.
		• Describe and explain the mathematical equations used to express allele and genotype frequencies.
		• Apply knowledge of the Hardy-Weinberg equation to the data given in a question to calculate the frequency of an allele or genotype.
			Learning activities:
			
			• recap findings from last lesson that p + q =1
			• teacher explanation of Hardy-Weinberg principle and the conditions under which it applies
			• worked examples of calculations using the Hardy-Weinberg equation as a class
			• students investigate the frequency of observable phenotypes within a population:
			  • make observations of observable phenotypes
			  • select and calculate an appropriate statistical test
			  • interpret the results of the stats tests to draw conclusions
			  • apply knowledge of inheritance and Hardy-Weinberg to explain your results and other data.
			• students follow the practical method from BIO6T P13 ISA, carry out the stats test and then do the ISA paper
			• exam questions.
			
			Skills developed by learning activities:
			
			• AO1 – development of understanding of Hardy–Weinberg principle
			• AO2 – application of knowledge to unfamiliar contexts
			• MS 0.3 – use percentages and decimals
				Specimen assessment material:
				
				A-level Paper 2 (set 1) – Q6.1
				
				Past exam paper material:
				
				BIOL4 June 2012 – Q2d
				
				BIOL4 June 2013 – Q3c
				
				BIOL4 Jan 2011 – Q2c
				
				BIOL4 June 2010 – Q3
				
				BIOL4 June 2011 – Q6a–bi
					Rich questions:
					
					• What assumptions does the Hardy-Weinberg principle make?
					• Do these principles apply in practice?
					
					Why must both equations be equal to 1?
						C1,C3,Sp 2

	using the Hardy-Weinberg		• MS 2.4 – students should be able to calculate allele, genotype and phenotype frequencies from appropriate data using the Hardy–Weinberg equation • MS 3.1 – translate information between numerical and algebraic forms • AT k – collect data about the frequency of observable phenotypes within a single population • PS 3.2/MS 1.9 – select and use an appropriate statistical test 8.4.2.4.			
12 **3.7.3 Evolution may lead to speciation**	Individuals within a population may show a wide range of variation in phenotype. This is due to genetic and environmental factors. The primary source of genetic variation is mutation. Meiosis and the random fertilisation of gametes during	• Explain why individuals within a population of a species may show a wide range of variation in phenotype. • Describe variation based on trends in graphs and link this to the causes of variation.	**Learning activities:** • students could measure variation within the group • plot results using spreadsheets • teacher-led discussion of trends in data and the types/causes of variation. Link genetic variation back to work done in Year 1 on meiosis and mutation **Skills developed by learning activities:** • AT l – use software to process (eg calculate standard deviation) and plot data • MS 1.10 – understand and calculate standard deviation and range • AO1 – development of knowledge of variation and its causes • AO2/AO3 – application of knowledge to identify types of variation and causes from experimentally derived data MS1.6 – calculate mean, median and mode for measured values.	**Past exam paper material:** HBIO4 Jan 2013 – Q3 HBIO4 June 2011 – Q4 and Q10e	learn.genetics.utah.edu/content/variation/sources **Rich questions:** • What do we mean by continuous and discontinuous variation? • What causes discontinuous and continuous variation? Explain why siblings are so varied, even though they have the same parents.	C1,C3,Sp2

13	Predation, disease and competition for the means of survival result in differential survival and reproduction, ie natural selection. Those organisms with phenotypes providing selective advantages are likely to produce more offspring and pass on their favourable alleles to the next generation.	• Explain what is meant by selection. • Explain how natural selection is linked to inheritance of alleles by the next generation and adaptation. • Explain the concept of differential reproductive success. • Apply your knowledge to explain data.	**Learning activities:** • set up cards around the room with factors which animals might compete for eg food. Make sure that some factors are in short supply and that they are well hidden and inaccessible to some students • give students five minutes to collect a full set of cards • discuss the principle of competition and the fact that those without a full set would not have survived and reproduced. You can also link the model into variation and adaptation eg tallest reach the highest cards • teacher led explanation of predation, disease and competition linked to survival. Link to Darwin's observations. Contextualise with information on the factors eg facial tumour disease in Tazmanian devils • students use peppered moths simulation to model effects of natural selection or work through peppered moths student sheet (see resources) • exam questions. **Skills developed by learning activities:** • AO1/AO2/AO3 – development of knowledge of natural selection and selection pressures, and application to data	**Specimen assessment material**: A-level Paper 2 (set 1) – Q6.2 **Past exam paper material:** BIOL4 Jan 2011 – Q4	nuffieldfoundation.org/practical-biology/selection-action-%E2%80%93-peppered-moths nuffieldfoundation.org/practical-biology/selection-action-%E2%80%93-banded-snails peppermoths.weebly.com learn.genetics.utah.edu/content/selection arkive.org/education/teaching-resources-16-18	C1,C3,Sp 2

			AT I – use computer programs to model the effects of natural selection.			
14	The effect of differential reproductive success on the allele frequencies within a gene pool. The effects of stabilising, directional and disruptive	• Recall what is meant by allele frequency. • Explain what is meant by stabilising, directional and disruptive selection in the context of the effect that each has on phenotypes and allele frequencies.	**Learning activities:** • questioning to recall directional and stabilising selection from 3.4.4 • teacher-led explanation of disruptive selection (alongside recap of other forms of selection if required). Use animation of the selection of finches on the Galapagos islands • card sort with examples of disruptive, directional and stabilising selection described. Students have to categorise • ask students to work in groups to explain the evolution of characteristics in a species eg a single hoof in horses, long necks in giraffes including the type of selection and reference to allele frequencies • presentation of explanation and peer assessment • exam questions. **Skills developed by learning activities:** • AO1 – development of understanding relating to forms of natural selection and their effect on allele frequencies AO2/AO3 – application of knowledge to experimentally derived data (in exam questions).	**Past exam paper material:** BIOL4 June 2011 – Q6bii; BIOL4 Jan 2010 – Q1d; BIOL4 June 2014 – Q5	wps.pearsoncustom.com/wps/media/objects/3014/3087289/Web_Tutorials/17_A02.swf bcs.whfreeman.com/thelifewire/content/chp23/2302001.html nortonbooks.com/college/biology/animations/ch16a02.htm learn.genetics.utah.edu/content/selection **Rich question:** What kind of selection is shown in the example of *Biston betularia*? Justify your answer.	C1,C3,Sp 2
15	Reproductive separation of two populations can result in the	• Explain what is meant by allopatric and sympatric speciation. • Explain how natural selection and isolation may result in change in	**Learning activities:** • teacher led explanation of the concept of reproductive separation preventing gene flow as a precursor to speciation	**Past exam paper material**: BIOL4 Jan 2013 – Q8c Q4 BIOL4 June 2013 – Q6	wps.pearsoncustom.com/wps/media/objects/3014/3087289/Web_Tutorials/18_A01.swf	C1,C3,Sp 2

	accumulation of difference in their gene pools. New species arise when these genetic differences lead to an inability of members of the populations to interbreed and produce fertile offspring, resulting in speciation. Allopatric speciation and sympatric speciation.	the allele and phenotype frequency and lead to the formation of a new species by allopatric speciation and sympatric speciation. • Explain possible mechanisms for sympatric speciation. • Apply knowledge to unfamiliar contexts. Explain how evolutionary change over a long period of time has resulted in a great diversity of species	• provide information stations eg videos, animations, textbook, comprehensions and websites for students to find out about allopatric and sympatric speciation • accept feedback. Question students about the mechanisms of reproductive isolation for sympatric speciation • think, pair, share: what could constitute a geographical barrier to some species, for allopatric speciation to occur? • use knowledge and teacher input to derive a model class answer • apply that answer to an example as a class • exam questions • link speciation to species diversity and what is shown by fossils. An example could be the evolution of lizards or whales. **Skills developed by learning activities:** • AO1 – development of understanding relating to forms of natural selection and their effect on allele frequencies and species diversity • AO2 – application of knowledge to unfamiliar contexts in exam questions extended exam answers.	BIOL4 Jan 2011 – Q8c	media.hhmi.org/biointeractive/films/OriginSpecies-Lizards.html youtube.com/watch?v=H6IrUUDboZo **Rich questions:** • Explain what happens to cause speciation. How do the mechanisms of reproductive separation differ in allopatric and sympatric speciation?	
16	The importance of genetic drift in causing changes in allele frequency in small populations	• Explain the process of genetic drift and its impact on allele frequencies. • Explain how genetic drift differs from natural selection.	**Learning activities:** • provide students with photocopied pictures of animals with the genotypes for one feature written on them (used previously in the section 3.7.2) but limit the number to 10 animals in total. Get students to work out allele frequencies in the gene pool. Then ask students to close their eyes and randomly eliminate 4 cards from the 10.	Assessment of students' written explanations.	nortonbooks.com/college/biology/animations/ch16a01.htm **Rich questions:** • How is genetic drift fundamentally	C1,C3,Sp 2

		Explain why genetic drift is important only in small populations	Repeat calculation of allele frequencies. Discuss findings, as chance should mean that some groups have significantly reduced the frequency of one allele • teacher explanation of genetic drift using animation • ask students to explain how this differs to natural selection • provide an example eg achromatopsia on the island of Pinegelap. Ask students to write a suggested explanation. **Skills developed by learning activities:** • AO1 – development of understanding of genetic drift • AO2/AO3 – application of knowledge to explain unfamiliar examples • MS 1.5 – apply knowledge of sampling to the concept of genetic drift AT l – use computer programs to model the effects of genetic drift.		different to natural selection? Why does genetic drift only have noticeable effects in small populations?	

3.7.4 Populations in ecosystems TO START IN YEAR 12 IFPOSSIBLE	3.7.4 Populations in ecosystems TO START IN YEAR 12 IFPOSSIBLE	3.7.4 Populations in ecosystems TO START IN YEAR 12 IFPOSSIBLE	3.7.4 Populations in ecosystems TO START IN YEAR 12 IFPOSSIBLE	3.7.4 Populations in ecosystems TO START IN YEAR 12 IFPOSSIBLE	3.7.4 Populations in ecosystems TO START IN YEAR 12 IFPOSSIBLE	3.7.4 Populations in ecosystems TO START IN YEAR 12 IFPOSSIBLE

~~17 3.7.4 Populations in ecosystems~~	~~Populations of different species form a community.~~ ~~Within a habitat, a species occupies a niche governed by adaptation to both abiotic and biotic conditions.~~ ~~An ecosystem supports a certain size of population of a species, called the carrying capacity.~~ ~~This population size can vary as a result of:~~ • ~~the effect of abiotic factors~~ ~~interactions between organisms:~~	• ~~Define the terms community, biotic, abiotic, ecosystem and niche.~~ • ~~Explain what is meant by the carrying capacity of a population, and the biotic and abiotic factors which determine population size.~~ • ~~Explain how some common abiotic factors could be measured.~~ • ~~Explain why no two species have exactly the same niche.~~	~~**Learning activities:**~~ • ~~teacher-led explanation of ecosystems, populations and communities~~ • ~~ask pupils to brainstorm factors which could influence population sizes. Accept feedback and categorise into biotic and abiotic factors~~ • ~~do a card sort matching abiotic factors to the instruments/techniques used to measure them (and the units if appropriate)~~ • ~~teacher-led explanation of niches~~ • ~~use a past exam question to work through data to determine an organism's niche~~ • ~~students attempt further exam questions.~~ ~~**Skills developed by learning activities:**~~ • ~~AO1 – development of understanding relating to forms of natural selection and their effect on allele frequencies~~ • ~~AO2/AO3 – application of knowledge to experimentally derived data (in exam questions)~~ ~~MS 0.1 – recognise and use appropriate units for abiotic measurements.~~	~~**Past exam paper material**: BIOL4 Jan 2012 – Q1a and Q1c~~ ~~BIOL4 Jan 2012 – Q4~~ ~~BIOL4 – June 2012 – Q3~~	~~**Rich questions:**~~ • ~~Why do no two species have exactly the same niche?~~ • ~~What happens when niches overlap?~~ • ~~Why is it incorrect to say that no two organisms have the same niche?~~ ~~**Flipped learning opportunity**~~ ~~PiXL Independence: Biology – Student Booklet~~ ~~KS5 – Biodiversity and ecosystem~~	~~So5,Sp2 M2~~

	interspecific and intraspecific competition and predation.					
18	The size of a population can be estimated using randomly placed quadrats, or quadrats along a belt transect, for slow-moving or non-motile organisms	• Describe and explain the techniques of sampling at random using quadrats, and systematic sampling using transects. • Explain when it would be appropriate to use each technique. • Describe the different measures of abundance that can be measured. • Explain how sampling at random can be done to avoid bias. Explain how to ensure that estimates and conclusions are reliable.	**Learning activities:** • questioning about what students recall from GCSE • teacher explanation of the basis of sampling, how to conduct random and systematic sampling and how to ensure validity, reliability and eliminate bias • students conduct practical sampling. They should do sampling at random using quadrats and systematic sampling using transects. This could be done on a school field or as part of a field trip. **Skills developed by learning activities:** • AO1/PS 4.1 – development of understanding relating to sampling using quadrats and transects • AO2/AO3 – application of knowledge to experimentally derived data (in exam questions) • AT k – investigate the distribution of organisms in a named habitat using randomly placed frame quadrats, or a belt transect • AT k/MS 0.3 – use both percentage cover and frequency as measures of abundance of a sessile species • MS 0.4 – make estimates of percentage cover	**Past exam paper material**: BIOL4 Jan 2012 – Q3a BIOL4 June 2013 – Q7 BIOL4 June 2010 – Q7 BIOL4 Jan 2010 – Q4 BIOL4 Jan 2010 – Q7 BIOL4 June 2014 – Q8c	nuffieldfoundation.org/practical-biology/observing-patterns-distribution-simple-plant nuffieldfoundation.org/practical-biology/biodiversity-your-backyard	So5,Sp2 M2

			• MS 1.6 – calculate mean, median and mode for measured values from sampling • MS 1.5 – understand the principles of sampling • MS 1.7 – use a scatter diagram to identify a correlation between two measured values from a belt transect eg light intensity and percentage cover of Dog's mercury • MS 1.9 – select and use an appropriate statistical test PS 1.2/2.1 – understand how to design experiments to avoid bias and ensure a large enough sample size.			
19	The size of a population can be estimated using the mark-release-recapture method for motile organisms. The assumptions made when using the mark-release-recapture method.	• Explain the technique of mark-release-recapture and when it would be appropriate to use this technique. • Use given data to calculate the size of a population estimated using the mark-release-recapture method. • Explain why careful consideration must be given to the method used to mark animals. Explain the assumptions which must be made during mark-release-recapture.	**Learning activities:** • teacher led explanation of mark-release recapture technique, the ethical issues surrounding marking, and the assumptions/limitations of the technique • students conduct practical sampling using humane animal traps. Care should be taken not to harm the animals. This could be done on a school field or as part of a field trip • alternatively, the technique could be modelled using matchsticks, or sweets. Sample 10 matchsticks and mark them, then reintroduce back into the box and shake well. Resample 20 matchsticks and perform calculation as population estimate. Repeat using a different colour mark. Then count matchsticks to gauge accuracy of estimate • exam questions. **Skills developed by learning activities:**	**Specimen assessment material**: A-level Paper 3 (set 1) – Q1 **Past exam paper material**: BIOL4 June 2012 – Q1b BIOL4 June 2013 – Q4a and 4c BIOL4 June 2010 – Q2 Questions from BIO6T Q14	**Rich questions:** • Why might it be inappropriate to put a brightly coloured mark on an animal? • Predict the effect on the accuracy of your estimate if: a) some marks were to rub off prior to recapture b) the second sample is conducted within an hour of release. • Assuming that the technique is done correctly, why might all individuals still not be equally catchable?	So5,Sp2 M2

			- AO1 – development of understanding relating to mark-release-recapture, the ethical issues surrounding it, and its assumptions/limitations - AO2 – application of knowledge, using given data to calculate population estimates - AT k/AT h – use the mark-release-recapture method to investigate the abundance of a motile species MS 2.3/2.4 – substitute numerical values into the mark-release-recapture equation to solve the equation.		Could mark-release-recapture be used to sample humans? Explain your answer. cleapss.org.uk	
20 **Required practical 12:** Investigation into the effect of a named environmental factor on the distribution of a given species.	- Propose a null hypothesis to test. - Design an experiment to investigate the effect of a named factor on the distribution of a given species, taking into account the need for data	**Learning activities:** students design an experiment to investigate the effect of a named variable on the distribution of a given plant/animal species eg light intensity of the percentage cover of Dog's mercury as you move away from a tree. This could include: - researching a method - designing an experiment and risk assessing - carrying out (subject to teacher approval) – this could be done in school or as part of a field trip - processing and presentation of data - calculation and interpretation of statistical tests	**Learning activities:** students design an experiment to investigate the effect of a named variable on the distribution of a given plant/animal species eg light intensity of the percentage cover of Dog's mercury as you move away from a tree. This could include: - researching a method - designing an experiment and risk assessing - carrying out (subject to teacher approval) – this could be done in school or as part of a field trip - processing and presentation of data - calculation and interpretation of statistical tests - conclusion and evaluation. **Skills developed by learning activities:** - AT a and k – use appropriate apparatus and sampling techniques in fieldwork	Marking of experimental write-up	cleapss.org.uk	Sp7,Sp2

	~~to be reliable.~~ • ~~Suggest what you will do for variables which cannot be controlled.~~ • ~~Represent raw and processed data clearly using tables and graphs.~~ • ~~Select and use an appropriate statistical test and interpret the P value that results in terms of probabili~~	• ~~conclusion and evaluation.~~ ~~**Skills developed by learning activities:**~~ • ~~AT a and k – use appropriate apparatus and sampling techniques in fieldwork~~ • ~~PS 1.1/1.2/2.4 – apply scientific knowledge to design a sampling investigation, identifying key variables~~ • ~~PS 2.2/PS 3.1/ MS 1.7 – plot the experimental data on a scatter graph~~ • ~~MS 1.6 – calculate mean, median or mode for measured values from sampling~~ • ~~MS 1.9 – use an appropriate statistical test~~ • ~~MS 1.4 – understand simple probability~~ • ~~AO1/AO2 – application of knowledge to explain trends~~ ~~8.4.2.1/8.4.2.2/8.4.2.3/8.4.2.4/8.4.2.5.~~	• ~~PS 1.1/1.2/2.4 – apply scientific knowledge to design a sampling investigation, identifying key variables~~ • ~~PS 2.2/PS 3.1/ MS 1.7 – plot the experimental data on a scatter graph~~ • ~~MS 1.6 – calculate mean, median or mode for measured values from sampling~~ • ~~MS 1.9 – use an appropriate statistical test~~ • ~~MS 1.4 – understand simple probability~~ • ~~AO1/AO2 – application of knowledge to explain trends~~ ~~8.4.2.1/8.4.2.2/8.4.2.3/8.4.2.4/8.4.2.5.~~			

	ty and chance. • Apply knowledge to draw and explain conclusions.					
21	Primary succession from pioneer species to climax community. At each stage, certain species may be recognised which change the environment so that it becomes more suitable for other species. The new species may change the environment in such a way that it	• Explain what succession is. • Explain how succession causes changes to ecosystems over time. • Explain the impact of environmental changes on biodiversity. • Apply knowledge to unfamiliar contexts.	**Learning activities:** • look at a family tree of royal family and the succession to the throne. Ask students to define the word • provide students with some plant species cards (eg mosses, lichens and algae, shallow rooted grasses, deep rooted shrubs, rowan trees and oak trees), and some facts cards with information about each species. Ask them to try and put the cards in order of succession from pioneer species to climax community, with reasons • teacher led explanation with examples • group discussion about data showing biomass, species diversity and primary production during succession • exam questions. **Skills developed by learning activities:** • AO1 – development of understanding relating to succession • AO2/AO3 – application of knowledge to unfamiliar contexts and experimentally derived data	**Past exam paper material**: BIOL4 Jan 2012 – Q3b BIOL4 Jan 2013 – Q4a and 4b BIOL4 June 2012 – Q1 BIOL4 June 2013 – Q2 BIOL4 Jan 2011 – Q8a BIOL4 Jan 2010 – Q6 BIOL4 June 2014 – Q3a-3b	geowords.org/ensci/imagesbook/04_03_succession.swf **Rich question:** Why does succession begin with a pioneer species?	So5,Sp2 M2

	becomes less suitable for the previous species. Changes that organisms produce in their abiotic environment can result in a less hostile environment and change biodiversity.		• AT i – students could use turbidity measurements to investigate the growth rate of a broth culture of microorganisms • MS 2.5 – students could use logarithmic scale in representing the growth of a population of microorganisms extended exam answers.			
22	Conservation of habitats frequently involves management of succession	• Use their knowledge and understanding to present scientific arguments and ideas relating to the conservation of species and habitats. • Evaluate evidence and data concerning issues relating to the conservation of species and habitats and consider conflicting evidence. Know that management of succession can involve preventing succession occurring to maintain a desired community.	**Learning activities:** • provide students with materials/web pages regarding conservation of habitat projects. Ask them what they have in common (all managing succession) • teacher led explanation of why conservation frequently involves managing succession • students should be given evidence (some of which should be conflicting) about conservation of habitats, and discuss the relative arguments • provide students with the role of presenting to the environment agency for funding to manage succession. They should present a reasoned, evidence-based case • exam question. **Skills developed by learning activities:**	**paper material:** BIOL4 June 2010 – Q5 **Exampro:** BYA5 Jan 2003 – Q9d BYA5 Jan 2004 – Q2 BYB4 June 2005 – Q4 BYB6 June 2005 – Q2a BYB6 Jan 2005 – Q2 BYB6 Jan – 2004 Q7c.	beep.ac.uk/content/415.0.html rspb.org.uk/ourwork/conservation/advice/wetscrub/managing.aspx **Rich questions:** • What is conservation? • Why does conservation often involve managing succession?	So5,Sp2 M2

			~~• AO1 – development of understanding relating to conservation and succession management~~ ~~AO2/AO3 – application of knowledge to, and interpretation of, scientific data and evidence to form reasoned arguments.~~			