Genetic Technologies, DNA & Disease
Depth study and Classroom Activities for HSC Biology

KINGHORN CENTRE FOR CLINICAL GENOMICS

GARVAN INSTITUTE OF MEDICAL RESEARCH

Syllabus Map
modules 5, 6 and 8 and Working Scientifically

Outcomes marked (x) are covered indirectly or depend on student choice of diseases

Subtopic & Inquiry Question	Knowledge and Understanding content	REPORT (assessment)	TINY GENOME	SIX Ws	TECHNOLOGIES EXPLAINER	RESEARCH MATRIX	ISSUE SCAN
Module 5: Heredity							
	BIO12-12 A student: explains the structures of DNA and analyses the mechanisms of inheritance and how processes of reproduction ensure continuity of species						
Reproduction *How does reproduction ensure the continuity of a species?*	● explain the mechanisms of reproduction that ensure the continuity of a species, by analysing sexual and asexual methods of reproduction in a variety of organisms, including but not limited to: – animals: advantages of external and internal fertilisation – plants: asexual and sexual reproduction – fungi: budding, spores – bacteria: binary fission – protists: binary fission, budding ● analyse the features of fertilisation, implantation and hormonal control of pregnancy and birth in mammals ● evaluate the impact of scientific knowledge on the manipulation of plant and animal reproduction in agriculture						
Cell Replication *How important is it for genetic material to be replicated exactly?*	● Model the processes involved in cell replication, including but not limited to: – mitosis and meiosis – DNA replication using the Watson and Crick DNA model, including nucleotide composition, pairing and bonding ● assess the effect of the cell replication processes on the continuity of species						
DNA and Polypeptide Synthesis *Why is polypeptide synthesis important?*	● construct appropriate representations to model and compare the forms in which DNA exists in eukaryotes and prokaryotes						
	● model the process of polypeptide synthesis, including:	x	x			x	
	– transcription and translation		x				
	– assessing the importance of mRNA and tRNA in transcription and translation						
	– analysing the function and importance of polypeptide synthesis	x	x			x	
	– assessing how genes and environment affect phenotypic expression	x	x	x	(x)	x	
	● investigate the structure and function of proteins in living things	x				x	
Genetic Variation *How can the genetic similarities and differences within and between species be compared?*	● conduct practical investigations to predict variations in the genotype of offspring by modelling meiosis, including the crossing over of homologous chromosomes, fertilisation and mutations ● model the formation of new combinations of genotypes produced during meiosis, including but not limited to: – interpreting examples of autosomal, sex-linkage, co-dominance, incomplete dominance and multiple alleles – constructing and interpreting information and data from pedigrees and Punnett squares		(x)				
	● collect, record and present data to represent frequencies of characteristics in a population, in order to identify trends, patterns, relationships and limitations in data, for example:	x	x			x	
	– examining frequency data	x				x	
	– analysing single nucleotide polymorphism (SNP)		x				
Inheritance Patterns in a Population *Can population genetic patterns be predicted with any accuracy?*	● investigate the use of technologies to determine inheritance patterns in a population using, for example:	x	x	x			x
	– DNA sequencing and profiling	x	x	x			x
	● investigate the use of data analysis from a large-scale collaborative project to identify trends, patterns and relationships, for example:		x			(x)	
	– the use of population genetics data in conservation management						
	– population genetics studies used to determine the inheritance of a disease or disorder	x	x			(x)	
	– population genetics relating to human evolution						

Module 6: Genetic Change							

BIO-12-13 A student: explains natural genetic change and the use of genetic technologies to induce genetic change

Topic	Content						

Mutation
 	
How does mutation introduce new alleles into a population?
	● explain how a range of mutagens operate, including but not limited to:
	  – electromagnetic radiation sources
	  – chemicals
	  – naturally occurring mutagens						

	● compare the causes, processes and effects of different types of mutation, including but not limited to:	x	x			x	
	– point mutation	(x)	x				
	– chromosomal mutation	(x)	x				
	● distinguish between somatic mutations and germ-line mutations and their effect on an organism				x		
	● assess the significance of 'coding' and 'non-coding' DNA segments in the process of mutation		x				
	● investigate the causes of genetic variation relating to the processes of fertilisation, meiosis and mutation						
	● evaluate the effect of mutation, gene flow and genetic drift on the gene pool of populations						

Biotechnology
 	
How do genetic techniques affect Earth's biodiversity?
	● investigate the uses and applications of biotechnology (past, present and future), including:
	  – analysing the social implications and ethical uses of biotechnology, including plant and animal examples
	  – researching future directions of the use of biotechnology
	  – evaluating the potential benefits for society of research using genetic technologies
	  – evaluating the changes to the Earth's biodiversity due to genetic techniques						

Genetic Technologies *Does artificial manipulation of DNA have the potential to change populations forever?*	● investigate the uses and advantages of current genetic technologies that induce genetic change	(x)			x		

	● compare the processes and outcomes of reproductive technologies, including but not limited to:
	  – artificial insemination
	  – artificial pollination
				(x)	x		

	● investigate and assess the effectiveness of cloning, including but not limited to: – whole organism cloning				x		
	– gene cloning				x		
	● describe techniques and applications used in recombinant DNA technology, for example:	(x)			x		
	– the development of transgenic organisms in agricultural and medical applications				x		
	● evaluate the benefits of using genetic technologies in agricultural, medical and industrial applications	x	x	x	x		x
	● evaluate the effect on biodiversity of using biotechnology in agriculture						
	● interpret a range of secondary sources to assess the influence of social, economic and cultural contexts on a range of biotechnologies	x		x	x		x

Module 8: Non-infectious Disease and Disorders							
BIO12-15 A student: explains non-infectious disease and disorders and a range of technologies and methods used to assist, control, prevent and treat non-infectious disease							
Homeostasis *How is an organism's internal environment maintained in response to a changing external environment?*	● construct and interpret negative feedback loops that show homeostasis by using a range of sources, including but not limited to: – temperature – glucose ● investigate the various mechanisms used by organisms to maintain their internal environment within tolerance limits, including: – trends and patterns in behavioural, structural and physiological adaptations in endotherms that assist in maintaining homeostasis – internal coordination systems that allow homeostasis to be maintained, – mechanisms in plants that allow water balance to be maintained						
Causes and Responses *Do non-infectious diseases cause more deaths than infectious diseases?*	● investigate the causes and effects of non-infectious diseases in humans, including but not limited to: – genetic diseases – diseases caused by environmental exposure – nutritional diseases – cancer ● collect data that shows the incidence, prevalence and mortality rates of non-infectious disease, for example: – nutritional diseases – diseases caused by environmental exposure	x x (x) (x) (x) x		x x x		x x (x) x	
Epidemiology *Why are epidemiological studies used?*	● analyse patterns of non-infectious diseases in populations, including their incidence and prevalence, including but not limited to: – nutritional diseases – diseases caused by environmental exposure ● investigate the treatment/management, and possible future directions for further research, of a non-infectious disease using an example from one of the non-infectious diseases categories listed above ● evaluate the method used in an example of an epidemiological study ● evaluate, using examples, the benefits of engaging in an epidemiological study	x (x) (x) x		 x	 x	x x	
Prevention *How can non-infectious diseases be prevented?*	● use secondary sources to evaluate the effectiveness of current disease-prevention methods and develop strategies for the prevention of a non-infectious disease, including but not limited to: – educational programs and campaigns – genetic engineering	(x) (x)		x	x x	x	
Technologies and Disorders *How can technologies be used to assist people who experience disorders?*	● explain a range of causes of disorders by investigating the structures and functions of the relevant organs, for example: – hearing loss – visual disorders – loss of kidney function ● investigate technologies that are used to assist with the effects of a disorder, including but not limited to: – hearing loss: cochlear implants, bone conduction implants, hearing aids – visual disorders: spectacles, laser surgery – loss of kidney function: dialysis ● evaluate the effectiveness of a technology that is used to manage and assist with the effects of a disorder	 (x) (x) (x)					

Working Scientifically Outcomes	Skill Descriptors	REPORT (assessment)	TINY GENOME	SIX Ws	TECHNOLOGIES EXPLAINER	RESEARCH MATRIX	ISSUE SCAN
Year 12 WS skills							
Questioning and Predicting *BIO11/12-1 A student: develops and evaluates questions and hypotheses for scientific investigation*	● develop and evaluate inquiry questions and hypotheses to identify a concept that can be investigated scientifically, involving primary and secondary data	x					
	● modify questions and hypotheses to reflect new evidence	x	x				
Planning Investigations *BIO11/12-2 A student: designs and evaluates investigations in order to obtain primary and secondary data and information*	● assess risks, consider ethical issues, and select appropriate materials and technologies when designing and planning an investigation	(x)					
	● justify and evaluate the use of variables and experimental controls to ensure that a valid procedure is developed that allows for the reliable collection of data						
	● evaluate and modify an investigation in response to new evidence	(x)					
Conducting Investigations *BIO11/12-3 A student: conducts investigations to collect valid and reliable primary and secondary data and information*	● employ and evaluate safe work practices and manage risks						
	● use appropriate technologies to ensure and evaluate accuracy						
	● select and extract information from a wide range of reliable secondary sources and acknowledge them using an accepted referencing style	x			x	x	
Processing Data and Information *BIO11/12-4 A student: selects and processes appropriate qualitative and quantitative data and information using a range of appropriate media*	● select qualitative and quantitative data and information and represent them using a range of formats, digital technologies and appropriate media	(x)			x	x	
	● apply quantitative processes where appropriate						
	● evaluate and improve the quality of data						
Analysing Data and Information *BIO11/12-5 A student: analyses and evaluates primary and secondary data and information*	● derive trends, patterns and relationships in data and information	(x)	x			x	x
	● assess error, uncertainty and limitations in data	(x)	x				
	● assess the relevance, accuracy, validity and reliability of primary and secondary data and suggest improvements to investigations	x			x		x
Problem Solving *BIO11/12-6 A student: solves scientific problems using primary and secondary data, critical thinking skills and scientific processes*	● use modelling (including mathematical examples) to explain phenomena, make predictions and solve problems using evidence from primary and secondary sources		x		x		
	● use scientific evidence and critical thinking skills to solve problems	x	x	x	x		
Communicating *BIO11/12-7 A student: communicates scientific understanding using suitable language and terminology for a specific audience or purpose*	● select and use suitable forms of digital, visual, written and/or oral communication	x		x		x	
	● select and apply appropriate scientific notations, nomenclature and scientific language to communicate in a variety of contexts	x		x		x	
	● construct evidence-based arguments and engage in peer feedback to evaluate an argument or conclusion	x		x			x