STAWA DEPTH and BREADTH of CONTENT: Teacher Support Documents

Senior Secondary Science WACE 2015 – 2016: Human Biology - Unit 2

The STAWA Depth & Breadth of Content documents have been developed through the collaboration of teachers working in Department of Education, Catholic Education and Independent Schools.

Purpose

The STAWA Depth & Breadth of Content documents are intended to promote a shared understanding of the course content that improves moderation across schools, regions and systems/sectors.

Caution

The Depth and Breadth points of elaboration are interpretations. The ATAR syllabus content statements are the only parts of these documents that are mandated. Examiners are required to address the mandated statements only.

The STAWA Depth & Breadth of Content documents are a great example of teachers helping teachers for the benefit of all students.

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Leadership in Science Education

HUMAN BIOLOGY
ATAR Year 11
Unit 2 – Reproduction and inheritance

Unit description

This unit provides opportunities to explore, in more depth, the mechanisms of transmission of genetic materials to the next generation, the role of males and females in reproduction, and how interactions between genetics and the environment influence early development. The cellular mechanisms for gamete production and zygote formation contribute to human diversity. Meiosis and fertilisation are important in producing new genetic combinations.

The transfer of genetic information from parents to offspring involves the replication of deoxyribonucleic acid (DNA), meiosis and fertilisation. The reproductive systems of males and females are differentially specialised to support their roles in reproduction, including gamete production and facilitation of fertilisation. The female reproductive system also supports pregnancy and birth. Reproductive technologies can influence and control the reproductive ability in males and females. Cell division and cell differentiation play a role in the changes that occur between the time of union of male and female gametes and birth. Disruptions to the early development stages can be caused by genetic and environmental factors: inheritance can be predicted using established genetic principles. The testing of embryos, resulting from assisted reproductive technologies, is conducted for embryo selection, and the detection of genetic disease. The application of technological advances and medical knowledge has consequences for individuals and raises issues associated with human reproduction.

Students investigate an aspect of a given problem and trial techniques to collect a variety of quantitative and qualitative data. They apply simple mathematical manipulations to quantitative data, present it appropriately, and discuss sources and implications of experimental error. They also consider the limitations of their procedures and explore the ramifications of results that support or disprove their hypothesis. They are encouraged to use ICT in the analysis and interpretation of their data and presentation of their findings.

Unit content

This unit includes the knowledge, understandings and skills described below.

Science Inquiry Skills

1. identify, research and construct questions for investigation; propose hypotheses; and predict possible outcomes
2. design investigations, including the procedure(s) to be followed, the materials required, and the type and amount of primary and/or secondary data to be collected; conduct risk assessments; and consider research ethics, including animal ethics
3. conduct investigations, safely, competently and methodically for the collection of valid and reliable data
4. represent data in meaningful and useful ways; organise and analyse data to identify trends, patterns and relationships; qualitatively describe sources of measurement error and uncertainty and limitations in data; and select, synthesise and use evidence to make and justify conclusions
5. interpret a range of scientific and media texts, and evaluate processes, claims and conclusions by considering the quality of available evidence; and use reasoning to construct scientific arguments
6. select, construct and use appropriate representations**, including models of DNA replication, transcription and translation, Punnett squares, pedigrees and karyotypes,** to communicate conceptual understanding, solve problems and make predictions
7. communicate to specific audiences, and for specific purposes, using appropriate language, nomenclature, genres and modes, including scientific reports

Green: specific content related to Unit 2. The rest of the statements are the same generic ones across the units.

Unit 2 Summary

DNA

SU 1, 2, 3: structure and function of DNA

SU 4: protein synthesis

SIS 6: models of DNA replication

SIS 6: models of protein synthesis

SU 5: epigenetics

SHE 2: discoveries made through the use of modern biotechnological techniques have increased understanding of DNA and gene expression

Cell reproduction

SU 6, 7, 8, 9: mitosis and stem cells

SHE 4: new technologies, including Pap smear, breast screening and blood tests for prostate cancer have made early detection of cancers possible

SU 10, 11: meiosis

SIS 6: models of karyotypes

SU 12: comparison between mitosis and meiosis

SU 13: variations is genotypes

SIS 6: models using Punnett squares, pedigrees and karyotypes

Human Reproduction

SU 14: male female reproductive systems

SU 15: reproductive hormones

SU 16: gametogenesis

SU 17, 18, 19: pregnancy and embryonic development, birth

SHE 5: impacts of lifestyle choices on foetal development

SU 20 contraception

SU 21: STIs

SU 22, 23: assisted reproductive technologies

Types of inheritance

SU 24: patterns of inheritance

SU 25: pedigree charts

SIS 6: models using Punnet squares, pedigree charts and karyotypes

SU 26: DNA profiling

SHE 1: the use of genetic profiling and genetic screening of adults and embryos have implicit ethical considerations

Unit Content	Elaboration	Activities	Assessment opportunities
DNA STAWA HB Yr 11 ATAR workbook activities - unless otherwise stated			
1. DNA occurs bound to proteins in chromosomes in the nucleus and as unbound DNA in the mitochondria	• location of DNA: nuclear and mitochondrial • maternal inheritance pattern due to mitochondrial DNA	Act 31: Human karyotypes	
2. DNA stores the information for the production of proteins that determines the structure and function of cells	• function of DNA: control of protein production/synthesis • information is in a code - the sequence of bases along the helix	Act 30 DNA: master molecule and protein synthesis	
3. the structural properties of the helical DNA molecule, including double-stranded, nucleotide composition and weak bonds, involved in base pairing between the complementary strands allow for its replication	• structure of DNA: nucleotide (phosphate, sugar and N base) • base pairing rules link A-T and G-C • double helix model allows for separation of the strands to enable transcription to occur • histones and nucleosomes are important in the packaging of DNA to produce chromosomes • hydrogen bonds between bases, covalent bonding between sugar and phosphates on backbone • process of DNA replication (leading strand, lagging strand (Okazaki fragments) and enzymes involved)	Act 30 DNA: master molecule and protein synthesis DNA from the beginning http://www.dnaftb.org/dnaftb/ DNA replication rap https://www.youtube.com/watch?v=1L8Xb6j7A4w DNA Structure and Replication: Crash Course Biology #10 https://www.youtube.com/watch?v=8kK2zwjRV0M (From: Crash course Biology https://www.youtube.com/watch?v=CBezq1fFUEA&list=PL3EED4C1D684D3ADF	

SIS 6 • select, construct and use appropriate representations, including models of DNA replication to communicate conceptual understanding, solve problems and make predictions			
4. protein synthesis involves the transcription of a gene on DNA into messenger RNA in the nucleus, and translation into an amino acid sequence at the ribosome with the aid of transfer RNA	• protein synthesis: the processes of transcription and translation of the genetic code to produce functioning proteins (location within cell) • RNA – 3 types and each has a different role • codons/anticodons and amino acids • enzymes are involved in all reactions associated with protein synthesis	Act 30 DNA: master molecule and protein synthesis search for Protein Synthesis - animation on YouTube for suitable video clips	
SIS 6 • select, construct and use appropriate representations, including models of, transcription and translation to communicate conceptual understanding, solve problems and make predictions			
5. epigenetics is the study of phenotypic expression of genes which depends on the factors controlling transcription and translation during protein synthesis, the products of other genes and the environment	• epigenetics is the study of heritable traits that do not involve changes to the DNA code • a variety of factors activate (switch on) or silence (switch off) genes and can be accumulated through-out a persons' life time and these can be linked to cancer, diabetes, mental illness • factors affecting the transcription of DNA include pathogens (bacterial and viral), heavy metals, drugs, pollution, stress • histone modification, DNA methylation affect the ability of the DNA to be transcribed for protein synthesis (turn genes on or off) • twin studies provide evidence for influence of epigenetics	Act 47: Epigenetics and gene expression Act 46: Nature vs nurture Why women are stripy https://www.youtube.com/watch?v=BD6h-wDj7bw&sns=em X inactivation and epigenetics - also has some suitable links in the side bar https://www.youtube.com/watch?v=mHak9EZjySs#action=share Epigenetics http://learn.genetics.utah.edu/content/epigenetics/	

SHE 2: discoveries made through the use of modern biotechnological techniques have increased understanding of DNA and gene expression			
Cell reproduction			
6. mitosis forms part of the cell cycle producing new cells with the same genetic content	• purpose of mitosis is to produce two identical daughter cells with diploid number of chromosomes for replacement of cells due to wear or damage • diploid and haploid cells differ in chromosome content and function	Act 29: Modelling mitosis	
7. the sequence of DNA replication, chromosome duplication and chromosome separation are important processes in the production of identical daughter cells by mitosis for growth, repair and replacement of tissues within the body	• DNA replication - use of enzymes; 3' and 5' ends are important in direction of replication process • stages of mitosis- prophase, metaphase, anaphase, telophase allow for the orderly distribution of diploid sets of chromosomes to daughter cells • cytokinesis- division of cytoplasm • micrographs and diagrams can be used to follow the events occurring in mitosis	Act 30 DNA: master molecule and protein synthesis	
8. stem cells have the ability to divide by mitosis and differentiate into many different tissues, depending on the level of cell potency	• function of stem cells • types of stem cells - embryonic , induced, somatic • totipotent, pluripotent, multipotent - related to differentiation into different tissues • origin of different types of stem cells	Stem cells http://www.science.org.au/nova/079/079key.htm	
9. uncontrolled division of cells can result in the development of tumours/cancers	• differentiate between malignant and benign cancers is important in terms of treatment and probability of ongoing cancers	Cell biology and cancer http://science.education.nih.gov/supplements/nih1/cancer/default.htm	

SHE 4: new technologies, including Pap smear, breast screening and blood tests for prostate cancer have made early detection of cancers possible • procedure for testing • impact of screening on survival rate			
10. meiosis produces gametes for reproduction and involves DNA replication, chromosome pairing and two successive nuclear divisions distributing haploid sets of chromosomes to each gamete	• stages of meiosis allow for the orderly distribution of haploid sets of chromosomes to daughter cells • micrographs and diagrams can be used to follow the events occurring in meiosis	Act 32: Meiosis: dividing to multiply	
SIS 6 • select, construct and use appropriate representations, including models of karyotypes to communicate conceptual understanding, solve problems and make predictions			
11. crossing over, non-disjunction and random assortment of chromosomes during meiosis will produce gametes with different genetic content	• crossing over can affect the linkage of genes • independent assortment of chromosomes - important in the chances of identical gametes being formed • non-disjunction - produces know syndromes - monosomy and trisomy • random fertilisation - important in determining probabilities of offspring geno/phenotypes	Act 32: Meiosis: dividing to multiply Meiosis: Crossing Over and Variability [3D Animation] http://www.youtube.com/watch?v=rqPMp0U0HOA	
12. differences between mitosis and meiosis reflect their roles in the body	• difference between mitosis/meiosis: ○ compare daughter cell functions ○ daughter cell location ○ number of daughter cells	Mitosis compared to meiosis http://www.diffen.com/difference/Meiosis_vs_Mitosis or http://highered.mcgraw-	

	○ chromosome number (diploid/haploid) ○ amount of variation	hill.com/sites/0072495855/student_view0/chapter2/animation__comparison_of_meiosis_and_mitosis__quiz_1_.html or http://www.pbs.org/wgbh/nova/miracle/divide.html	
13. variations in the genotypes of offspring, including gender, arise as a result of the processes of meiosis and fertilisation	• sex determination (XX/XY) • Punnet squares can be used to determine types and probabilities of offspring		
SIS 6 • select, construct and use appropriate representations, including Punnett squares, pedigrees and karyotypes, to communicate conceptual understanding, solve problems and make predictions			
Human reproduction			
14. the production of offspring is facilitated by the structure and function of the male and female reproductive systems in producing and delivering gametes for fertilisation and providing for the developing embryo and foetus	• structure and function of male and female reproductive systems • pathway of sperm in both male and female (following intercourse) to allow for fertilisation	Act 33: Reproductive systems Reproductive facts http://www.reproductivefacts.org/	
15. both male and female reproductive systems are regulated by hormones including the regulation of the menstrual and ovarian cycles	• hormonal regulation of female Menstrual and Ovarian cycle - FSH, LH, Oestrogen, Progesterone. • role of hormones in male reproductive system - FSH, LH, Testosterone	Act 34: Menstrual cycles Menstrual cycle FAQ sheet https://www.womenshealth.gov/publications/our-publications/fact-sheet/menstruation.html	

		Menstrual cycle - what's normal, what's not http://www.mayoclinic.org/healthy-living/womens-health/in-depth/menstrual-cycle/art-20047186 Menstrual cycle http://www.nhs.uk/livewell/menstrualcycle/Pages/menstrualcyclehome.aspx Animated video clip https://www.youtube.com/watch?v=WGJsrGmWeKE Ovulation https://www.youtube.com/watch?v=NkLUA05ExHA	
16. human gametes are produced through spermatogenesis and oogenesis, which are specific forms of meiosis but varying significantly in process and products	• spermatogenesis and oogenesis differ in terms of number of functional gametes produced, size and structure of gametes produced, location, when (foetal development, puberty, fertilisation), frequency		
17. for the establishment of a pregnancy, conception requires the union of viable sperm and ovum at the optimal time in the ovarian cycle	• sexual intercourse - events leading to fertilisation in fallopian tube • acrosomal reaction (why so many sperm needed) • zona pellucida reaction and completion of meiosis in oocyte following fertilisation • HCG levels used to determine if pregnancy is established		
18. the development of the embryo after implantation involves the differentiation of cells into three different germ	• embryonic germ layers: ectoderm, mesoderm, endoderm produce specific organs/systems • cleavage -→ morula → blastula (inner cell mass with trophoblast surrounding) → implantation ->	Act 37: Maternal observations and foetal growth	

layers that will eventually produce specific systems in the body and the placenta	gastrulation		
SHE 5: lifestyle choices including diet, illicit drugs, alcohol and nicotine may affect foetal development			
19. the stages of labour include birth during which there are circulatory system changes in the child	• three stages of labour • changes to circulatory system in new born (ductus ateriosis, ductus venosus, foramen ovale)		
20. contraception methods that reduce the probability of the union of gametes or implantation all have limitations, risks and benefits and include methods that: i. use steroid hormones ii. use physical barriers between gametes iii. use chemical spermicides iv. use sterilisation (tubal ligation, vasectomy) v. function after coitus (emergency contraceptive pill and intrauterine devices [IUDs])	• methods of contraception: hormonal, surgical and barrier • advantages, disadvantages, success rate, ethical considerations of different methods	Act 35: Birth control 18 ways to make a baby http://www.pbs.org/wgbh/nova/baby/ Birth control http://www.plannedparenthood.org/health-info/birth-control/ Birth control methods fact sheets https://www.womenshealth.gov/publications/our-publications/fact-sheet/birth-control-methods.html	
SHE 3:			

greater understanding of the menstrual cycle, conception and implantation has produced improved methods of the establishment of a pregnancy along with advancements in contraceptive methods; both have ethical considerations			
21. Sexually Transmitted Infections (STIs), diseases transmitted through unprotected sex or genital contact, can be prevented through safe sex methods; early detection and treatment of infection are important and, if left untreated, STIs can lead to serious health consequences	• causes, effects/symptoms, treatment, prevention of: Chlamydia, HIV, Genital warts, Herpes, Syphilis, Gonorrhoea • bacterial and viral classification of diseases • link prevention of disease to contraception methods	Act 36: STIs including HIV/AIDS STI health Australian government site http://www.sti.health.gov.au/internet/sti/publishing.nsf STIs - UK http://www.nhs.uk/conditions/Sexually-transmitted-infections/Pages/Introduction.aspx STI fact sheets http://www.womenshealth.gov/publications/our-publications/fact-sheet/sexually-transmitted-infections.html	
22. there are a variety of assisted reproductive technologies to help overcome infertility problems but each has its limitations, risks and benefits	• infertility occurs in males and females due to a variety of causes • IVF, AI, GIFT, ICSI - describe the processes involved, risks and benefits, ethical issues. • Assisted Reproductive Technology (ART) is used to treat infertility	Act 35: Birth control Assisted Reproductive Technology (ART) http://www.cdc.gov/art/ or http://www.sart.org/SART_Assisted_Reproductive_Technologies/ A guide for patients http://www.reproductivefacts.org/uploadedFiles/ASRM_Content/Resources/Patient_Resources/Fact_Sheets_and_Info_Booklets/ART.pdf Animation of how IVF works https://www.youtube.com/watch?v=GeigYib39Rs	

23. there are a range of techniques available to genetically screen embryos before implantation or during early development including blood tests, amniocentesis and chorionic villi sampling	• genetic conditions can be detected by various screening techniques; e.g. Down's, Cystic fibrosis, Muscular dystrophy, Huntington's, Mitochondrial disease and the ethical issues involved • specific screening techniques include blood test, nuchal fold scan, amniocentesis, genetic testing and the timing of these tests involve risks, and ethical considerations depending on the results	Act 44: Parental testing Act 48: Prenatal testing Prenatal testing http://www.health.wa.gov.au/docreg/Education/Prevention/Genetics/HP3131_prenatal.pdf or http://www.nlm.nih.gov/medlineplus/prenataltesting.html or http://americanpregnancy.org/prenataltesting http://library.med.utah.edu/WebPath/TUTORIAL/PRENATAL/PRENATAL.html	
Types of inheritance			
24. probable frequencies of genotype and phenotype of offspring can be predicted using Punnett squares and by taking into consideration patterns of inheritance, including the effects of dominance, co-dominance, autosomal or sex-linked alleles, and multiple alleles: Huntington's disease, PKU, ABO blood groups, red-green colour blindness /haemophilia show different inheritance	• Punnett Squares can be used to predict genotype/phenotype ratios for a range of examples of monohybrid crosses • autosomal and sex-linked conditions impact on probabilities of genotypes and phenotypes of offspring • probability of genotypes/phenotypes of offspring from monohybrid crosses can be determined from known parents or by test crosses • offspring of multiple allele inheritance eg blood groups, depends on the alleles present in the parents	Act 38: Monohybrid crosses Act 39: What will my kids look like? Act 40: Why do I have red hair AND freckles? Learn genetics http://learn.genetics.utah.edu/ Teach genetics http://teach.genetics.utah.edu/	

patterns			
25. pedigree charts can be constructed for families with a particular genetic disorder and can be used to reveal patterns of inheritance and assist in determining the probability of inheriting the condition in future generations	• pedigree charts can be interpreted to identify genotypes/phenotypes of individuals • the mode of inheritance can be deduced from pedigree charts/family trees • pedigree charts use internationally recognised symbols	Act 41: Family trees Act 42: Multi-allelic inheritance	
26. DNA profiling identifies the unique genetic make-up of individuals and can be used in determining parentage	• the use of DNA profiling to determine parentage has implications • DNA profiles are produced gel electrophoresis - Southern Blot or STR profiles are produced	Act 43: DNA profiling Act 44: Parental testing Act 45: Who did it? Paternity testing http://www.nature.com/scitable/topicpage/paternity-testing-blood-types-and-dna-374 or http://www.sumanasinc.com/webcontent/animations/content/paternitytesting.html (animation of testing process)	
SHE 1: the use of genetic profiling and genetic screening of adults and embryos have implicit ethical considerations			