sequence overview

Gene expression

Links to the Western Australian ATAR syllabus: Human Biology

Science understanding concepts include:

Unit 2: Reproduction and inheritance

DNA

- DNA stores the information for the production of proteins that determines the structure and function of cells
- protein synthesis involves transcription of a gene into messenger ribonucleic acid (mRNA) in the nucleus, and translation into an amino acid sequenced at the ribosome with the aid of transfer RNA
- 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.

Cell reproduction

- mitosis forms part of the cell cycle producing new cells with the same genetic content
- uncontrolled division of cells can result in the development of tumours and cancers

Unit 4: Human variation and evolution

Mutations

- mutations in genes and chromosomes can result from errors in DNA replication, cell division or from damage caused by mutagens

Evidence for evolution

- biotechnological techniques provide evidence for evolution by using PCR (to amplify minute samples of DNA to testable amounts), bacterial enzymes and gel electrophoresis to facilitate DNA sequencing of genomes
- protein synthesis involves transcription of a gene into messenger ribonucleic acid (mRNA) in the nucleus, and translation into an amino acid sequenced at the ribosome with the aid of transfer RNA

Science as a human endeavour concepts include:

- discoveries made through the use of biotechnological techniques have increased understanding of DNA and gene expression

Science inquiry skills concepts include:

Unit 2: Reproduction and inheritance

- interpret a range of scientific and media texts, and evaluate processes, claims and conclusions considering the quality of available evidence; and use reasoning to construct scientific arguments

Unit 4: Human variation and evolution

- conduct investigations, including the use of virtual or real biotechnological techniques of polymerase chain reaction (PCR), gel electrophoresis for deoxyribonucleic acid (DNA) sequencing and techniques for relative and absolute dating, safely, competently and methodically for valid and reliable data collection

Links to the Western Australian ATAR syllabus: Biology

Science understanding concepts include:

Unit 3: Continuity of species

Heredity

- the genetic code is a base triplet code; genes include 'coding' and non-coding' DNA, and many genes contain information for protein production
- protein synthesis involves transcription of a gene into messenger RNA in the nucleus, and translation into an amino acid sequenced at the ribosome
- the phenotypic expression of genes depends on the interaction of genes and the environment
- mutations in genes and chromosomes can result from errors in DNA replication or cell division, or from damage by chemical factors in the environment

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Links to the Australian Curriculum: Senior Secondary Biology

Science understanding concepts include:

Unit 3: Heredity and continuity of life

Heredity

- genes include 'coding' and 'non coding' DNA and many genes contain information for protein production (ACSBL078)
- protein synthesis involves transcription of a gene into messenger RNA in the nucleus, and translation into an amino acid sequence at the ribosome (ACSBL079)
- phenotypic expression of genes depends on factors controlling transcription and translation during protein synthesis, the products of other genes, and the environment (ACSBL081)
- mutations in genes and chromosomes can result from errors in DNA replication or cell division, or from damage by physical or chemical factors in the environment (ACSBL082)
- differential gene expression controls cell differentiation for tissue formation, as well as the structural changes that occur during growth (ACSBL083)
- biotechnology can involve the use of bacterial enzymes, plasmids as vectors and techniques including gel electrophoresis, bacterial transformations and PCR (ACSBL087)

Science as a human endeavour concepts include:

- People can use scientific knowledge to inform the monitoring, assessment and evaluation of risk (ACSBL071)

Science inquiry skills concepts include:

- Select, construct and use appropriate representations, including models of DNA replication, transcription and translation, Punnett squares and probability models of expression of a specific gene in a population, to communicate conceptual understanding, solve problems and make predictions (ACSBL066)

Background

These SPICE resources may be drawn together into a learning pathway to develop students' understanding of gene expression and regulation. The pathway is structured around a constructivist model based on the 5-Es where teachers may:

- **Engage** student interest in gene expression through investigation of a human disease condition, melanoma.
- Provide opportunities for students to **Explore** biotechnological techniques used in the study of gene expression patterns, polymerase chain reaction and microarray.
- **Explain** regulation of gene expression during transcription and translation.
- **Elaborate** on the relevance of gene expression investigation to contemporary medicine by investigating personalised medical treatment for melanoma.
- **Evaluate** students' progress through the pathway, and through summative reflection.

The resource is designed for Year 11 and Year 12 Biology and Human Biology students, but may also be used with students from other years at the discretion of the teacher.

Learning pathway

Gene expression 1: Melanoma risk factors

Melanoma risk factors includes a teacher guide, learning object and background sheet.

Students use an interactive learning object that describes six major risk factors for melanoma. The learning object is designed to engage student interest in risks associated with development of melanoma, and introduce them to the concept that melanoma, like all cancers, is a genetic disease. A background sheet for teachers contains information about melanoma genetics. See the teacher guide for detailed information on the purpose and use of this resource

Gene expression 2: Polymerase chain reaction

Polymerase chain reaction includes a teacher guide, presentation, procedure sheet and workbook.

Students simulate polymerase chain reaction (PCR) in the classroom using paper, scissors and sticky tape. A presentation provides background information on PCR, and adds a competitive element to the classroom game. See the teacher guide for detailed information on the purpose and use of this resource.

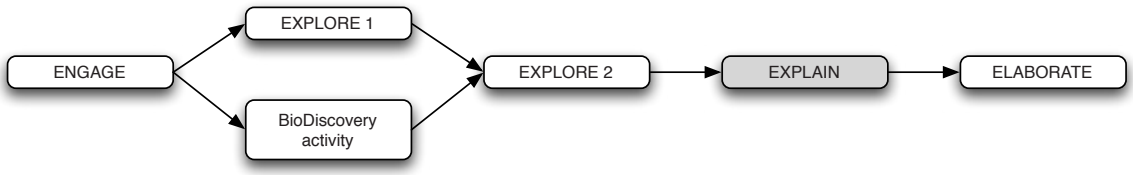
Students may also attend the LotteryWest Biodiscovery Centre at the Harry Perkins Institute of Medical Research to participate in the SPICE-developed PCR laboratory activity, *Searching for melanoma mutants with PCR*.

See https://www.perkins.org.au/biodiscovery-centre/schools/ for details of the **Next Gen program for schools**.

Gene expression 3: Measuring gene expression

Measuring gene expression includes a teacher guide, presentation and student workbook.

Students measure gene expression via a microarray simulation conducted in the school laboratory. Teachers may use a presentation to provide background information on microarray technique. The classroom laboratory is designed to be simple, effective and demonstrate concepts behind microarray technology. See the teacher guide for detailed information on the purpose and use of this resource.



Gene expression 4: Regulating gene expression

Regulating gene expression includes a teacher guide, animation, fact sheet, glossary, student worksheet and background sheet.

Students watch an animation about regulation of gene expression. A fact sheet provides more information about different types of RNA and their role in regulating gene expression. Students use a worksheet to review information presented in the animation. See the teacher guide for detailed information on the purpose and use of this resource.

Gene expression 5: Personalised medicine

Personalised medicine includes a teacher guide, interactive story and worksheet.

Students explore an interactive story to discover how increased understanding of molecular genetics and advances in biotechnology have led to development of personalised medical treatments for melanoma patients. A worksheet demonstrates how an individual's genetic information is used to diagnose disease and select the most effective treatment. See the teacher guide for detailed information on the purpose and use of this resource.

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