Chip Off the Old Block – Module Overview of Activities

Student Challenge: Design a hypothetical baby by choosing genetic traits.

Module Intent:
- Introduction to bioengineering
- Learning to write a detailed lab report

Module Science Concepts:
- Heredity and genetics
- Mitosis & Meiosis

Module Maths Concepts:
- Independent vs. Dependent variables
- Make predictions based on probability
- Types of graphs

Module Engagement:
- Introduce module challenge
- Assess background knowledge

Activity 1: Take a Good Look at Yourself

Structured Inquiry – Students conduct inventories of their own inherited traits.
Concepts: Inherited traits. Simple random samples.

Activity 2: What is Your Pedigree?

Structured & Guided Inquiry – Students explore, explain and evaluate a pedigree chart.
Concepts: Inherited traits. Analyse tables and graphs

Activity 3: Are You My Phenotype?

Structured Inquiry – Students explore the phenotypes of genetic corn seedlings.
Concepts: Dominant and recessive genes. Probability.

Activity 4: Language of Chromosomes

Guided Inquiry – Students explore the structure of cells and chromosomes.
Concepts: Diploid and haploid.

Activity 5: Cell Cycle and Mitosis

Structured Inquiry – Students explore where new cells come from when old cells die.
Concepts: Mitosis. Cell Cycle

Activity 6: A Different Type of Cell Division: Meiosis

Structured & Guided Inquiry – Students explore the process by which sex cells are produced in plants and animals.
Concepts: Meiosis.

Activity 7: Dominant and Recessive Trains in Humans

Structured & Guided Inquiry – Students begin designing their hypothetical baby.
Concepts: Homozygous, Heterozygous and Punnett Squares. Dominant and recessive traits.

Activity 8: In All Probability

Structured & Guided Inquiry – Students practise combining alleles through the use of Punnett Squares.
Concepts: Make predictions based on probability.

Activity 9: Engineering a Hypothetical Baby

Guided and Open Inquiry – Students engineer two hypothetical babies.
Concepts: Well-structured inquiry. Learn to write a detailed lab report.

Activity 10: DNA Fingerprinting

Structured Inquiry – Students explore the structure of DNA.
Concepts: Chemical structure of DNA. Replication and structure of base pairs.

Activity 11: Recombinant DNA

Structured Inquiry – Students explore the technologies of recombinant DNA.
Concepts: Present and future uses of recombinant DNA technology.

Binder Table of Contents

Teacher's Guide

Student Curriculum Module

Student Data and Response Section

Introduction to STEM-CIP

STEM-CIP

Science, Technology, Engineering, Mathematics-Curriculum Integration Program (STEM-CIP) is an innovative approach to the design of curriculum and instructional materials in which the disciplines of science, technology, engineering and mathematics are taught as one, rather than being distinct and separate as in the past. The natural connections among the four disciplines, which have always been there in the past in research labs and professional work, have not traditionally been emphasised in the design and process of present day education. The (upper primary, middle and high school) modules of the STEM Curriculum Integration Program have been designed to engage students in stimulating, authentic and contemporary problem-based STEM scenarios involving the life, physical, environmental, and earth/space sciences, technology and engineering, and mathematics. Drawing from the best in STEM pedagogy, the STEM-CIP modules provide students with the opportunity to learn age-appropriate concepts, skills and processes, and to acquire STEM attitudes and "habits of mind".

Curriculum Design Template

All modules within STEM-CIP have been designed using principles of Understanding by Design (Wiggins and McTighe, 1998). Understanding by Design (UbD) is a well-known curriculum design process used to write units (modules of instruction) in a three-stage process – Desired Results, Assessment Evidence and the Learning Plan. Many departments of education, tertiary institutions and universities, and entire school systems advocate the use of Understanding by Design as a contemporary planning process for teaching and assessing applicable standards.

Many authors, among them Reeves (2003), Marzano, Pickering and McTighe (1993) and Lantz (2004) have been proponents of performance-based assessment in which students must demonstrate what they know and can do through the completion of meaningful performance tasks. All modules within STEM-CIP present opportunities for students to engage in performance-based tasks and assessments, along with more traditional forms of assessment, such as selected-response items.

5E Teaching, Learning and Assessing Cycle

A modified 5E teaching, learning and assessing cycle, incorporated into all STEM-CIP modules, is based upon research findings about how students learn science. These findings indicate that students learn best when they have an opportunity to engage in explorations in a hands-on/minds-on environment in which they make and pose explanations for their discoveries. Engagement, Exploration, Explanation, Elaboration and Evaluation are the recursive phases of the 5E teaching, learning and assessing cycle. A brief guide to the 5E model appears next.

The Original 5E Model – At-a-glance Guide (Trowbridge & Bybee, 1996)

Engage
This stage is designed to interest students in the learning, linking it with past learning and common background knowledge. It stimulates curiosity and promotes questioning, while linking the learning to real world experiences. This has a twofold purpose – it interests students in what is coming, while simultaneously showing them the purpose for the learning by situating it in their existing worldview. Teachers can guide this stage by asking specific questions to elicit prior knowledge from students.

Activity 3: Are You My Phenotype?

Activity Description

"Are You My Phenotype?" is a **structured inquiry** activity in which students grow and explore the phenotypes of genetic corn seedlings, explore and elaborate upon the concept of probability, learn about the work of Gregor Mendel, and apply the concepts of dominant and recessive traits to their inventory from Activity 1.

WHERETO Elements

E How will we equip students to explore and experience the expected performances?

R How will we help students to rethink, rehearse, revise and refine?

E-2 How will students self-evaluate and reflect on their learning?

O How will we organise and sequence learning?

Materials Needed

Per group: 8 corn seeds
1 beaker or clear container (about 1000 ml)
paper towels (dampened)

Explore and Evaluate

In this investigation, you will explore how often albino corn seedlings tend to occur. To do this, obtain eight corn seeds and place them in a clear container. Fill your beaker with a damp paper towel so that the seeds are pressed against the glass for easy viewing, as shown in the diagram.

3a. On page 144 of the SDR, design a table to record your observations. In addition to data, include a place on the data table to compile your data with the rest of the class.

Possible Data Table for Germination Observations		
Phenotype	My Group's No. of Seeds	Entire Class No. of Seeds
Green		
White		

Assessment Rubric

See "Data Organisation Table" assessment/evaluation tool on page 77.

3b. Write a lab report on page 144 of the SDR that answers the experimental question based on your data.

Assessment Rubric

See "Lab Report" assessment/evaluation tool on page 73.

Probability

If students need additional support understanding probability, use the website below. It has very good graphics that illustrate probability and other mathematics concepts.

www.mathsisfun.com/probability_line.html

Explain and Evaluate

3c. Refer to the data you collected on page 144 of the SDR and determine your probability and the class probability of green plants to albino plants. Record your results on page 147 of the SDR. How do you explain these results?

Activity 4: The Language of Chromosomes

Activity Description

"The Language of Chromosomes" is a guided inquiry activity, in which students explore the structure of the cell and chromosomes, the 23 pairs of human chromosomes, the concepts of diploid and haploid, and the Human Genome Project (HGP). In addition, students explore and explain the development of the map for the mouse genome, the structure of DNA and what a genome is, through a reading selection.

WHERETO Elements

E How will we equip students to explore and experience the expected performances?

R How will we help students to rethink, rehearse, revise and refine?

E-2 How will students self-evaluate and reflect on their learning?

O How will we organise and sequence learning?

Explain and Evaluate

4a. On page 151 of the SDR, record what you think is important to remember about the HGP.

Use *Cornell Notes* format (*coe.jmu.edu/learningtoolbox/cornellnotes1.html*) and include the following:

1. What is the Human Genome Project (HGP)?
2. What were the goals for HGP?
3. What are some of the benefits of HGP?
4. What are some of the ethical issues surrounding HGP?
5. How is information from HGP being used in medicine and genetics?
6. How does the genome of human beings compare to that of other organisms?

Assessment Rubric

3 = Student thoroughly completes, in *Cornell Notes* format, information on the Human Genome Project that includes minimally the six questions outlined above.

2 = Student substantially completes, in *Cornell Notes* format, information on the Human Genome Project that includes minimally the six questions outlined above.

1 = Student partially completes, in *Cornell Notes* format, information on the Human Genome Project.

0 = Not attempted

4b. Research the mapping of the mouse genome and find an example of a genome map. Then respond to the following questions on page 155 of the SDR.

1. Why should we be excited about mapping the mouse genome?

   We should be excited about mapping the mouse genome because the mouse is the single most important test organism in medical research, and from it we can learn about biological principles common to all mammals, including humans.

Activity 4: The Language of Chromosomes

Activity Description

You are making great progress in learning about heredity and genetics so that you can engineer your hypothetical baby at the end of the module. In this activity, you will begin to learn about the 23 pairs of chromosomes that make up the human genome and research information about the Human Genome Project.

Difference Between Science and Engineering

In this module you have been using science and mathematics extensively. Over the next several activities you will be using technology and engineering more. Both science and engineering are in the acronym STEM (Science, Technology, Engineering and Mathematics). Some of the differences among science, engineering and technology are listed below.

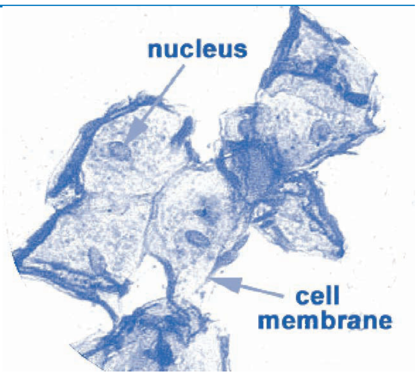
Science, Technology, Engineering and Mathematics (STEM): A Summary of the Differences

- **Science:** Expanding our understanding of our natural world. Science is grounded in researchable questions.
- **Engineering:** Applying scientific knowledge and mathematics to utilise nature for the benefit of mankind by developing new methods, tools and processes to solve problems, control our environments and improve our lives. Engineering is grounded in problems.
- **Technology:** Skilfully applying existing methods, tools and processes to particular needs and wants.
- **Mathematics:** Problem solving, communicating, reasoning and connecting using estimation, number sense, geometry and spatial sense, measurement, statistics and probability, fractions and decimals, and patterns and relationships.

Engineers must know something of science and technology. Engineers create the designed world. Technologists need to know something of engineering, but little of science. Scientists need to know little about engineering or technology, except when they require technology to conduct their experiments.

Science is characterised by a relative unconcern for application (although scientists generally hope their work has some ultimate application). Engineering is distinguished from technology by the design of new technologies. Technology is distinguished from engineering in that technology uses the products and processes designed by engineers. Mathematics is applied in all three areas (STE).

Have you ever seen one of your body cells, such as a cell from the inside lining of your cheeks? Have a look at the diagram of the cheek cells. Inside the nucleus of each cheek cell are 23 pairs of **chromosomes**.



The cell cycle begins when the cell is formed and ends when it divides and forms new cells. Before it divides, it must make a copy of the information (i.e. its DNA) that tells the cell how to make proteins. This information is organised into structures called chromosomes. Copying chromosomes ensures that each new cell will be able to survive.

Activity 4: The Language of Chromosomes

4b. Research the mapping of the mouse genome and find an example of a genome map. Then respond to the following questions.

1. Why should we be excited about mapping the mouse genome?

2. Describe a genome map. What does it look like?

3. Why has rapid progress been made on mapping the genomes of mice, humans and rice?

Engineering a Hypothetical Baby Rubric

Traits	Understanding of Content	Product or Performance
Scale	Weights 70 %	30 %
4 Expert	Shows an in-depth and advanced understanding of the concepts of heredity and genetics contained within the module *Chip off the Old Block*. These concepts are applied accurately to the scientific drawings of the heads of the two hypothetical babies. Question 9e is answered in depth and the language used reveals an in-depth understanding of heredity and genetics. There are no misunderstandings of science and mathematics key concepts.	All traits for the hypothetical baby have been determined through coin tosses. The genotypes are complete, accurate and effectively communicated. The scientific drawings of the head of the hypothetical babies are completed using the Scientific Drawing performance list rubric. The drawings are presented in an engaging and highly informative manner.
3 Proficient	Shows a solid understanding of the concepts of heredity and genetics contained within the module *Chip off the Old Block*. These concepts are mostly applied accurately to the scientific drawings of the heads of the two hypothetical babies. Question 9e is answered and the language used reveals an understanding of heredity and genetics. There are minor misunderstandings of science and mathematics key concepts.	All traits for the hypothetical baby have been determined through coin tosses. The genotypes are mostly complete, accurate and effectively communicated. The scientific drawings of the head of the hypothetical babies are mostly completed using the Scientific Drawing performance list rubric. The drawings are mostly presented in an engaging and highly informative manner.
2 Emergent	Shows a limited understanding of the concepts of heredity and genetics contained within the module *Chip off the Old Block*. These concepts are loosely applied to the scientific drawings of the heads of the two hypothetical babies. Question 9e is answered but the language used reveals a limited understanding of heredity and genetics. There are major misunderstandings of science and mathematics key concepts.	Most traits for the hypothetical baby have been determined through coin tosses. The genotypes are incomplete, inaccurate and not effectively communicated. The scientific drawings of the head of the hypothetical babies are completed using some of the criteria of the Scientific Drawing performance list rubric. The drawings are not presented in an engaging and highly informative manner.
1 Novice	Shows little understanding of the concepts of heredity and genetics contained within the module *Chip off the Old Block*. These concepts are not applied to the scientific drawings of the heads of the two hypothetical babies. Question 9e is answered but the language used reveals little to no understanding of heredity and genetics. There are major misunderstandings of science and mathematics key concepts.	Some traits for the hypothetical baby have been determined through coin tosses. The genotypes are mostly incomplete, inaccurate and not effectively communicated. The scientific drawings of the head of the hypothetical babies are incomplete and show little to no use of the criteria of the Scientific Drawing performance list rubric.