Engage: Designer Genes

Origin of the Saying

Although the origin of the saying *"Chip off the Old Block"* is hundreds of years old, it is still used today and means a person or thing that derives from the source of parentage. Think of a block of wood that is being chipped apart. Each chip can be identified as a piece of the original block. In the same manner, you can be biologically identified as the son or daughter of one, and only one, set of parents. Therefore, your parents are considered the block and you are the chip. This module will help you understand why you look so much like your biological parents.

Mathematics Readiness Assessment

Mathematics and science go hand-in-hand. Often mathematics is necessary to understand and work with science concepts. In order to fully understand the science in this module, and be successful with investigations and activities, it is important for your teacher to know if you already know some mathematics computations and skills. On page 4 of the Student Data and Response Book (SDRB) is a mathematics readiness assessment designed for this module. Complete it to the best of your ability. It will not be marked, but it will be used to help your teacher create strategies so that you can successfully complete the activities.

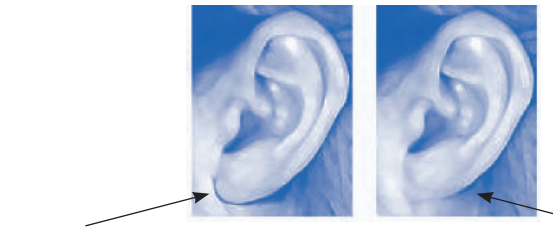
How Much Do You Already Know?

In order for you to understand what is presented in this module, it is important for you and your teacher to assess how much information you already know about cells and cell structure. On page 10 of the Student Data and Response Booklet (SDRB), you will find a "What Do You Already Know?" survey. This survey will not be marked; however, it is important that you respond to the questions as best you can. If you forgot concepts that are a foundation of the material presented in this module, your teacher can provide additional instruction.

Inherited Traits

The colour of a person's eyes is not accidently determined. Every characteristic about you is inherited from your parents. These inherited characteristics are called traits.

Even the kind of earlobe you have is an inherited trait. Consider the types of earlobes below. Which kind of earlobe do you have? If you have problems determining if your earlobe is free or attached, ask a classmate to help.



Another good example of an inherited trait is the human tongue. Look at the next picture and determine if you can "roll" your tongue. To roll your tongue, try and make the sides roll upward. If you're not sure whether you can do it, look in a mirror or ask a classmate.

For most people, no amount of practice will help them learn to roll their tongue. Why? Because the ability to roll one's tongue is probably not learned. Many scientists believe it is inherited — another one of your traits.

Activity 2: What is Your Pedigree?

Activity Description

"What is Your Pedigree?" is an activity about tracking inherited traits over several generations. You will learn to interpret, design and describe pedigrees in this activity. What you learn from Activity 2 will be used to assist you in "engineering your hypothetical baby" at the end of the module. Pedigrees are often used by farmers, and others, who breed plants and animals for certain traits.

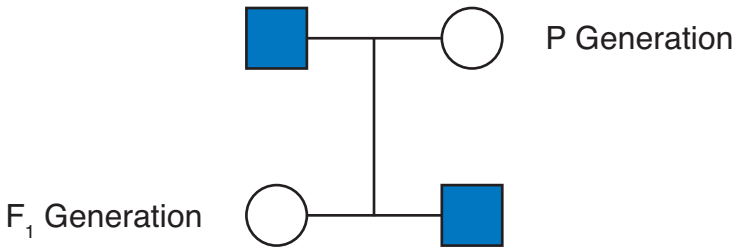
Symbols in a Pedigree

Inherited traits that are passed on from one generation to the next are shown in diagrams called pedigrees, such as the example given next. The key to reading this example of a pedigree can be found in the following chart.

Symbol	Description
□	Male without trait
■	Male with trait
○	Female without trait
●	Female with trait
———	Horizontal line links parents or siblings
|	Vertical line links parents to offspring

Pedigree for Brown Eyes

The following example is a pedigree showing a female parent with brown eyes and the male parent without brown eyes in the top row, the P (parent) Generation. These parents have two offspring — one male and one female. The offspring are found in the second row called the F_1 Generation (F stands for filial — a son or daughter — in the relationship between a parent and a child) and linked to their parents with a vertical line. Note: It is not important which parent is listed first. However, the offspring (children) in pedigrees are listed in order of oldest to youngest — oldest on the left to youngest on the right.



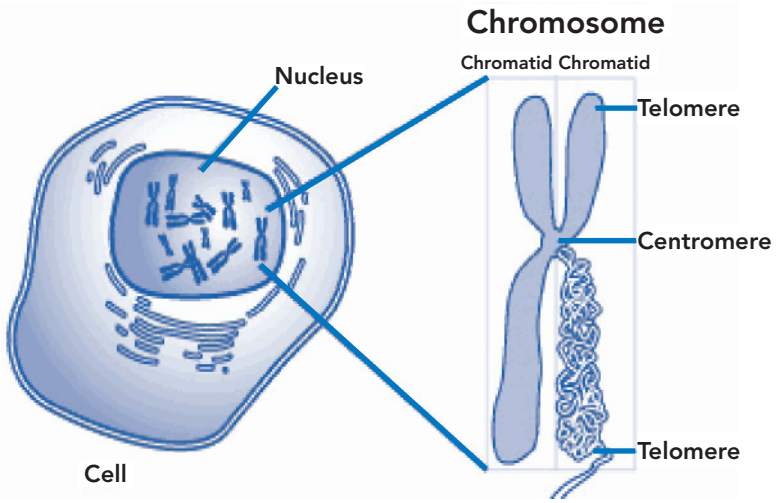
Explain

2a. On page 23 of the SDRB, describe the offspring in the pedigree above. In your description, be certain to include gender, age, relationship and eye colour. Also, what is the probability of having brown eyes based on that pedigree?

2b. To see if you really get pedigrees, on page 23 of the SDRB, draw a pedigree for the following description.

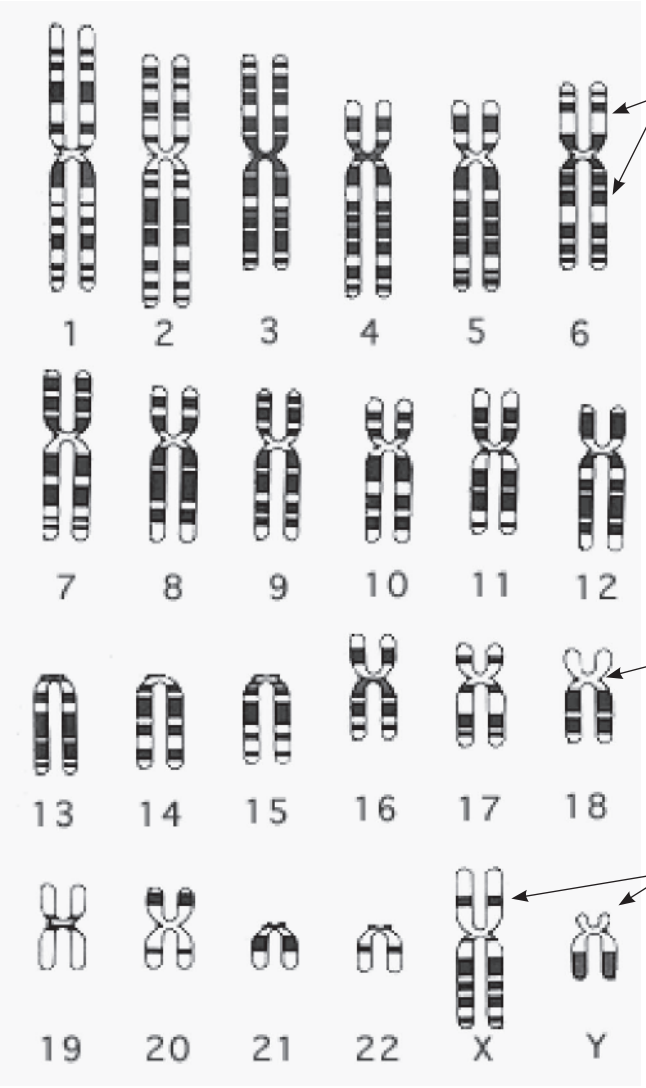
Description: Male parent with black hair, female parent without black hair, three offspring — the oldest child a male with black hair, the second child a female with black hair and the third child a male without black hair.

The next diagram shows a very rough drawing of a cell and the chromosomes in its nucleus. Notice the enlargement of an individual chromosome and its parts.



Human Genome

A genome is all the genetic material contained in an organism, including its chromosomes and genes. The human genome is made up of 23 pairs of chromosomes, as shown in the next diagram.



Many genes (segments of DNA) are located along the length of the 23 pairs (46 total) of human chromosomes. One chromosome of each pair came from your mother and the other one from your father.

The centromere is the region where two chromatids join.

23rd pair — X and Y chromosomes

Activity 6: A Different Type of Cell Division: Meiosis

Activity Description

In this activity, you will explore the process by which sex cells (i.e. sperm and eggs) are produced in both plants and animals.

Sperm are male reproductive cells and eggs are female reproductive cells. If sperm and eggs each contained 46 chromosomes, what would happen to the number of chromosomes with each generation?

You will participate in an electronic version of meiosis in a Meiosis Simulation. In one exploration, you will simulate the process of meiosis using pipe cleaners. Lastly, you will compare the processes of mitosis and meiosis.

Materials Needed

- 12 pipe cleaners each cut about 10 cm in length (6 red and 6 blue)
- 6 pipe cleaners each cut about 3 cm in length (3 red and 3 blue)
- 2 sheets of paper (blank) – one sheet can be the same one used in Activity 5
- Red and blue coloured pencils
- Materials to create a poster

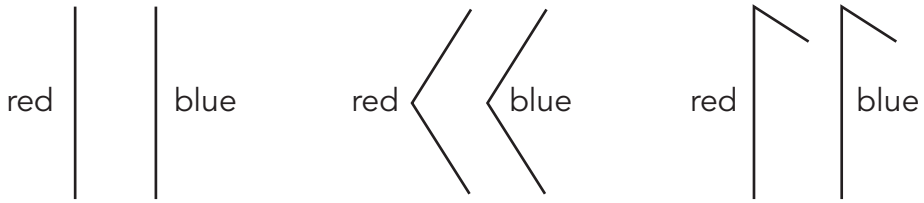
Meiosis

6a. Review the following website that describes meiosis. Use Cornell Notes format to describe meiosis on page 49 of the SDRB.

http://www.johnkyrk.com/meiosis.html

Explore

To show meiosis, a different kind of cell division, you will need 12 pipe cleaners — six red and six blue. Begin by bending the pipe cleaner into the following shapes. You will have two of each shape and colour.



Each individual pipe cleaner represents a different chromosome pair, homologous chromosomes. Remember chromosomes occur in pairs.

Explore Meiosis I

6b. Start with a blank sheet of paper with a circle (representing a reproductive cell) big enough to contain the chromosomes (pipe cleaners). Arrange homologous pairs of chromosomes (you should have 6 pipe cleaners total in the nucleus) in a random pattern in the **nucleus** of the cell. This is **Interphase I** of Meiosis. On page 50 of the SDRB, draw and label a model of your cell nucleus and chromosomes and name the phase.

6c. In preparation for the first cell division in Meiosis, the chromosomes will have duplicated themselves during Interphase I. But now the chromosomes have shortened and thickened and are now visible as distinct chromosomes. To simulate this, add the second chromatid to each chromosome and connect them with the small pieces of pipe cleaners (simulating the centromeres). This is **Prophase I** of Meiosis. On page 50 of the SDRB, draw and label a model of your arrangement and name the phase.

6d. The cell is preparing to divide for the first division in Meiosis. The chromosomes (now chromatid pairs) move towards the centre of the nucleus and