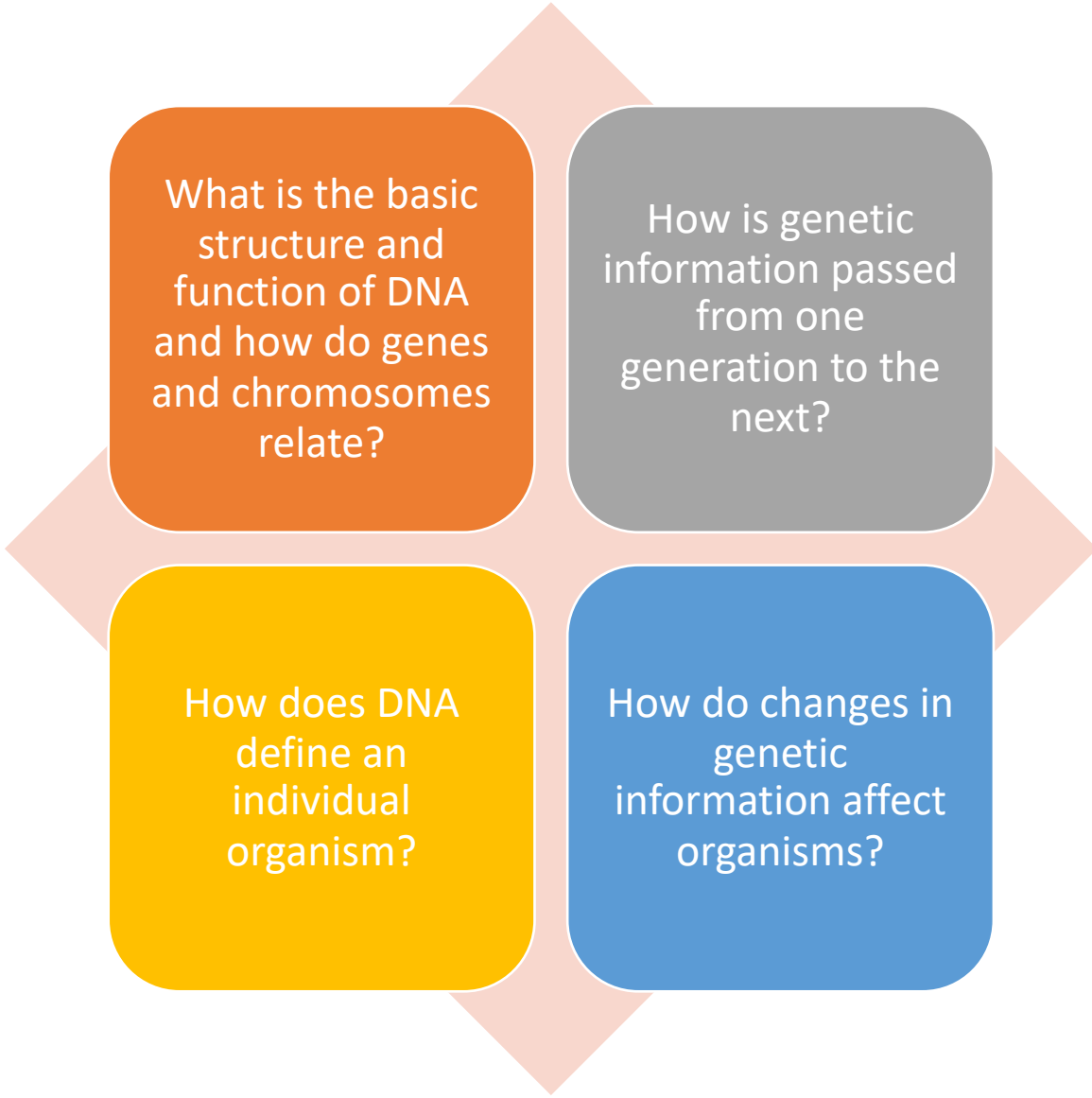
GED Science
Day 5

Essential Questions



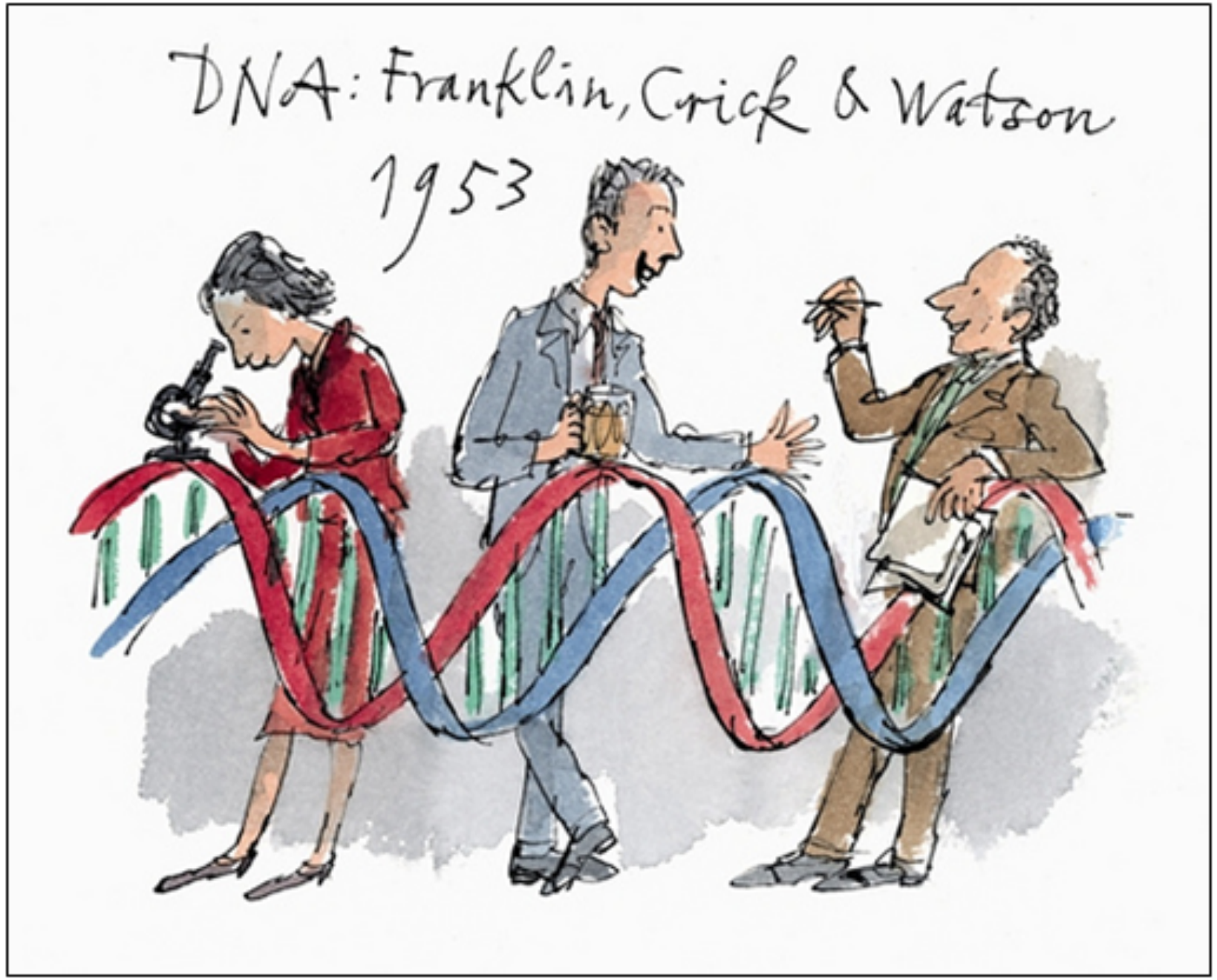
Big Ideas:

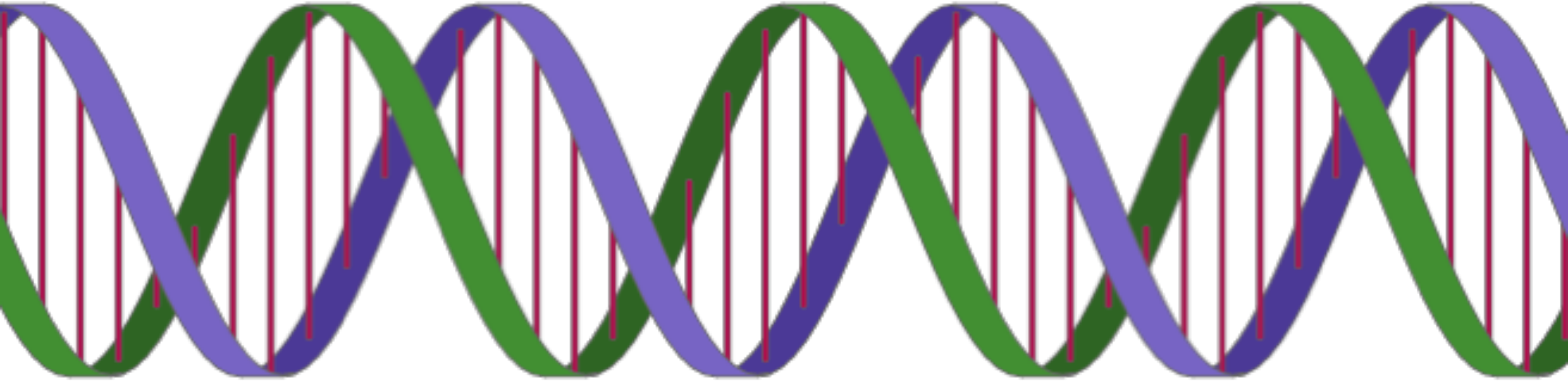
Living systems, from the organism to the cellular level, demonstrate the complementary nature of structure and function.

DNA contains the instructions for building the necessary materials that cells require for survival.

Genes are segments of DNA molecules located in the chromosome of each cell. DNA molecules contain information that determines a sequence of amino acids, which result in specific proteins.

Inserting, deleting, or substituting DNA segments can alter the genetic code. An altered gene may be passed on to every cell that develops from it. The resulting features may help, harm, or have little or no effect on the offspring's success in its environment.


DNA: Franklin, Crick & Watson
1953

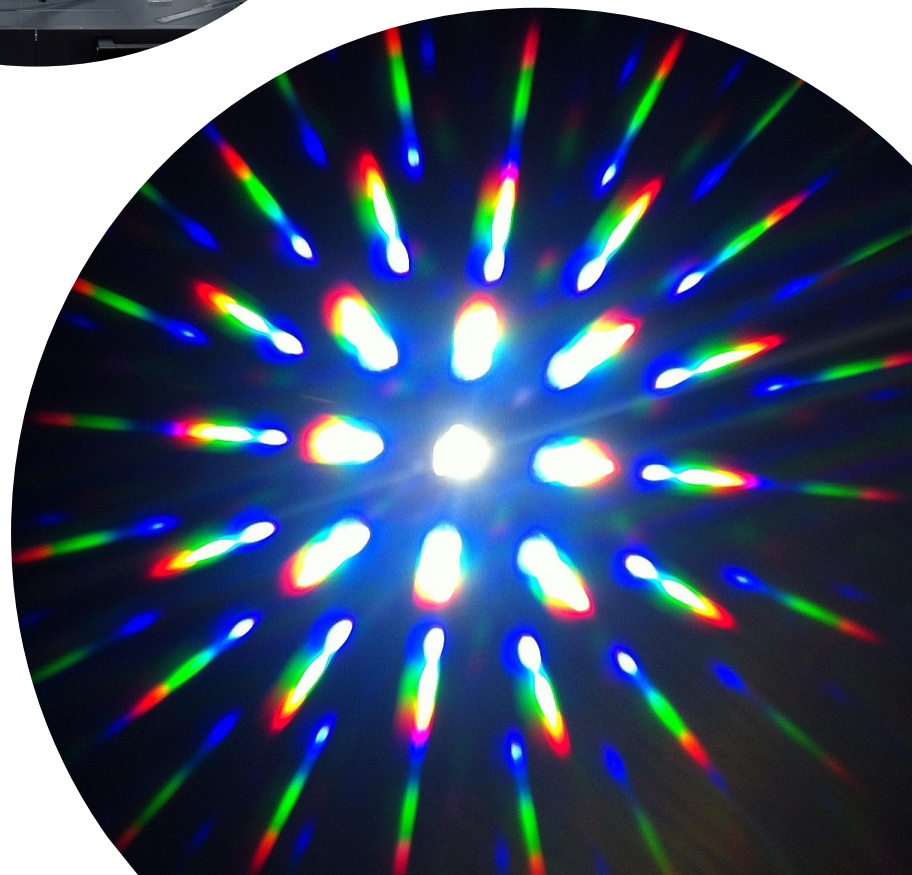


Watson, Crick, and Rosalind Franklin

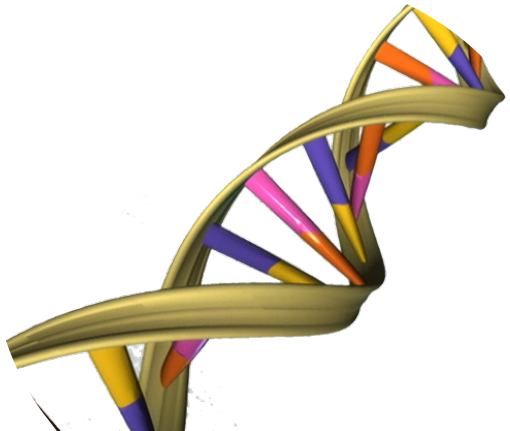
In the early 1950s, American biologist James Watson and British physicist Francis Crick came up with their famous model of the DNA double helix. They were the first to cross the finish line in this scientific "race," with others [...] also trying to find the correct model.

Rather than carrying out new experiments in the lab, Watson and Crick mostly collected and analyzed existing pieces of data, putting them together in new and insightful ways. Some of their most crucial clues to DNA's structure came from Rosalind Franklin, a chemist working in the lab of physicist Maurice Wilkins.

Franklin was an expert in a powerful technique for determining the structure of molecules, known as **X-ray crystallography**. When the crystallized form of a molecule such as DNA is exposed to X-rays, some of the rays are deflected by the atoms in the crystal, forming a **diffraction pattern** that gives clues about the molecule's structure.



Franklin’s crystallography gave Watson and Crick important clues to the structure of DNA. Some of these came from the famous “image 51,” a remarkably clear and striking X-ray diffraction image of DNA produced by Franklin and her graduate student. (A modern example of the diffraction pattern produced by DNA is shown here). To Watson, the X-shaped diffraction pattern of Franklin's image immediately suggested a helical, two-stranded structure for DNA.



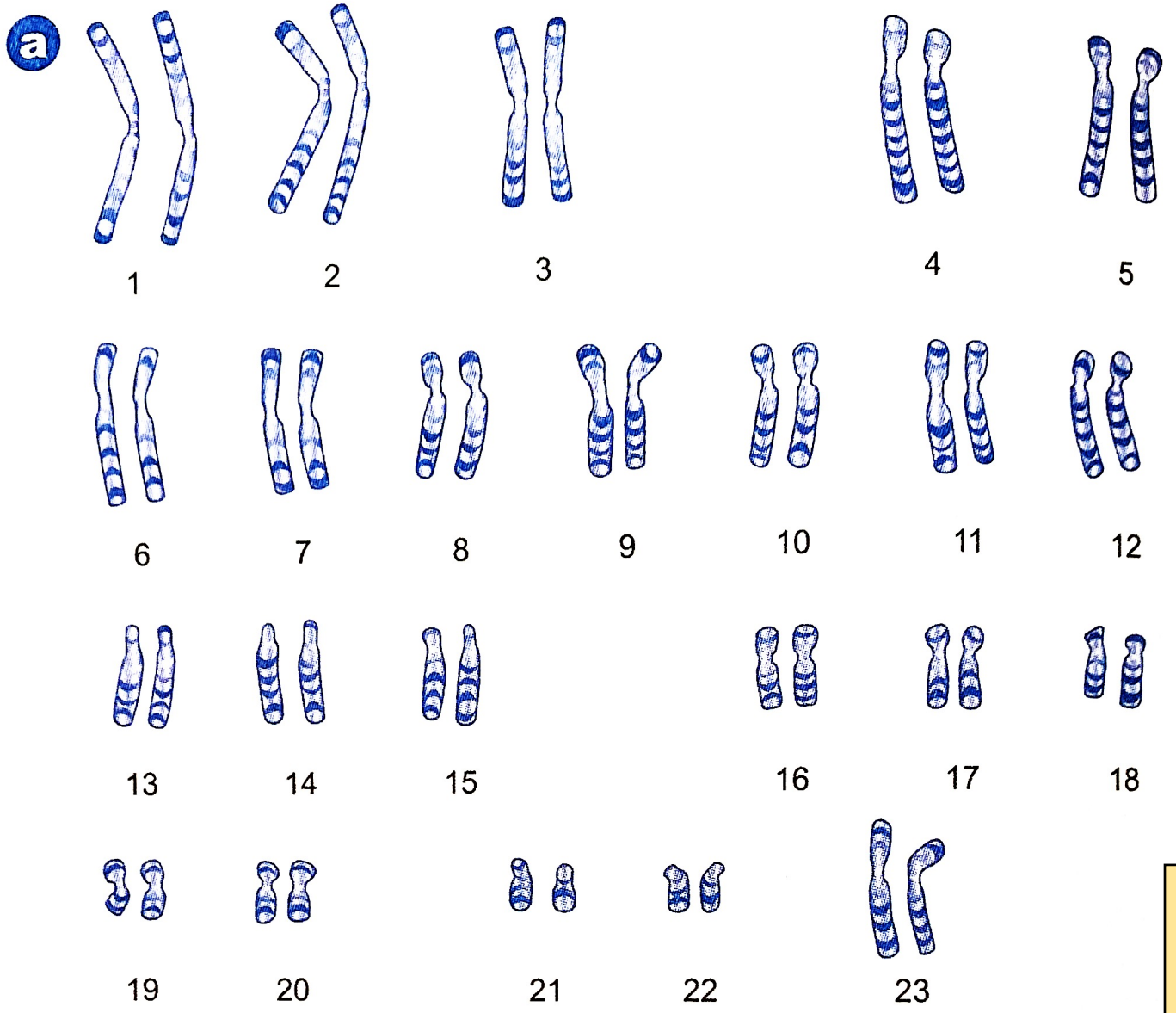
Watson and Crick brought together data from a number of researchers […] to assemble their celebrated model of the 3D structure of DNA. In 1962, James Watson, Francis Crick, and Maurice Wilkins were awarded the Nobel Prize in Medicine. Unfortunately, by then Franklin had died, and Nobel prizes are not awarded posthumously.

Discussion Question

- Who was Rosalind Franklin?
- What role did she play in Watson and Crick's discovery?
- What now-famous shape (structure) is DNA?

DNA and Genetics

HUMAN CHROMOSOMES



There are 23 pairs of chromosomes found in human cells.

Read the text that follows and answer the question:

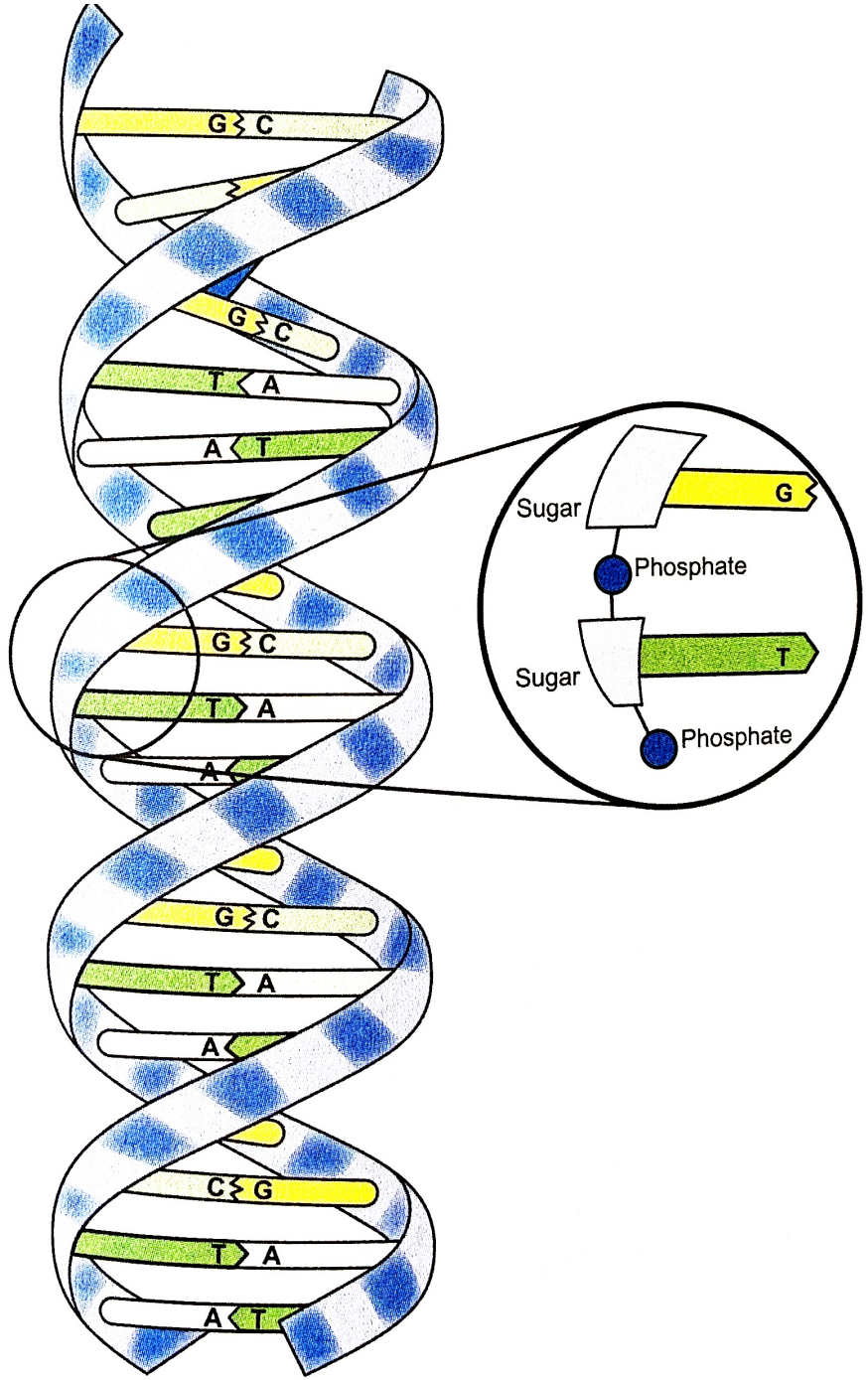
It is possible to identify a human as a human because organisms of the same kind are similar. Also, individuals are especially like their parents. All these similarities are due to heredity, or the passing of traits from one generation to the next. Hereditary material is carried on chromosomes, which are tiny structures in cells. Each species has a certain number of chromosomes in its cells. In humans and other organisms, chromosomes that are homologous—similar in size and structure—form pairs. When cells divide to form new cells, chromosomes copy themselves. This replication allows each new cell to have a complete copy of the organism's hereditary material. During sexual reproduction, cells from two parent organisms join so that hereditary material from both parents is passed on.

1. The illustration and passage suggest that

A. all human chromosomes are identical.
B. humans have 23 pairs of chromosomes in their cells.
C. human chromosomes double in size when a cell divides.
D. humans have fewer chromosome pairs than other species.

DNA

The basis of heredity is deoxyribonucleic acid, or DNA. The chromosomes in an organism's cells contain tightly coiled DNA molecules, with nearly every cell containing the same DNA. The thin, ladder-shaped DNA molecules are made of millions of tiny units called nucleotides. Each nucleotide contains one of four different bases—adenine (A), guanine (G), thymine (T), or cytosine (C); a sugar; and a phosphate. The bases form pairs, always A with T and C with G, and make up the rungs of the ladder. Sugars and phosphates form the ladder's sides.

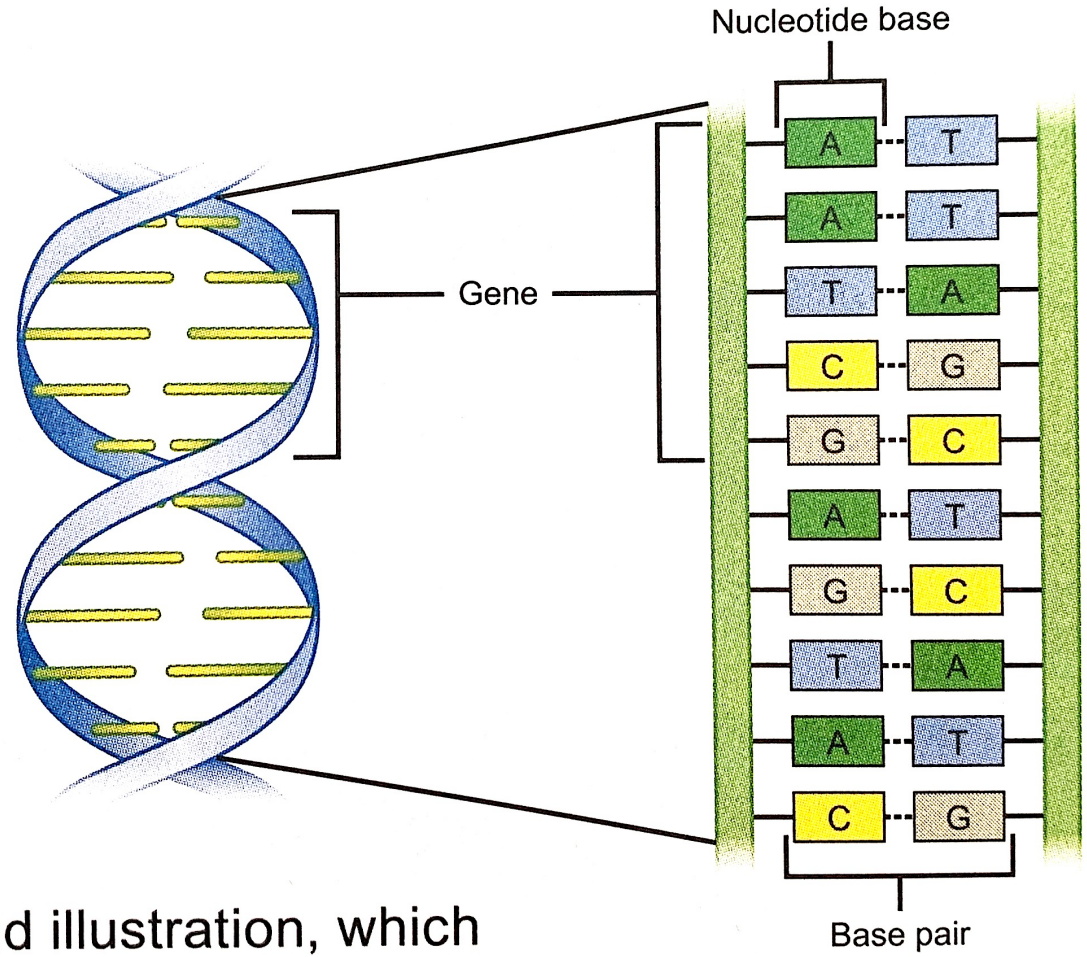


2. Based on the passage and illustration, which statement describes DNA structure?

A. Sugars are located along the sides and in the middle of a DNA molecule.
B. Sugars and phosphates form the rungs of the ladder shape of a DNA molecule.
C. One side of a DNA molecule is longer than the other side.
D. Nucleotide bases combine to form different patterns in different parts of a DNA molecule.

GENES

Proteins make the body develop and function as it does, from producing the substance that makes eyes a certain color to causing hair and nails to grow. The instructions for building these proteins come from genes. The DNA carried on an organism's chromosomes has many genes. Each gene consists of a unique sequence of nucleotide bases. According to the arrangement of these bases, genes give instructions for building proteins that determine the functions particular cells will perform.



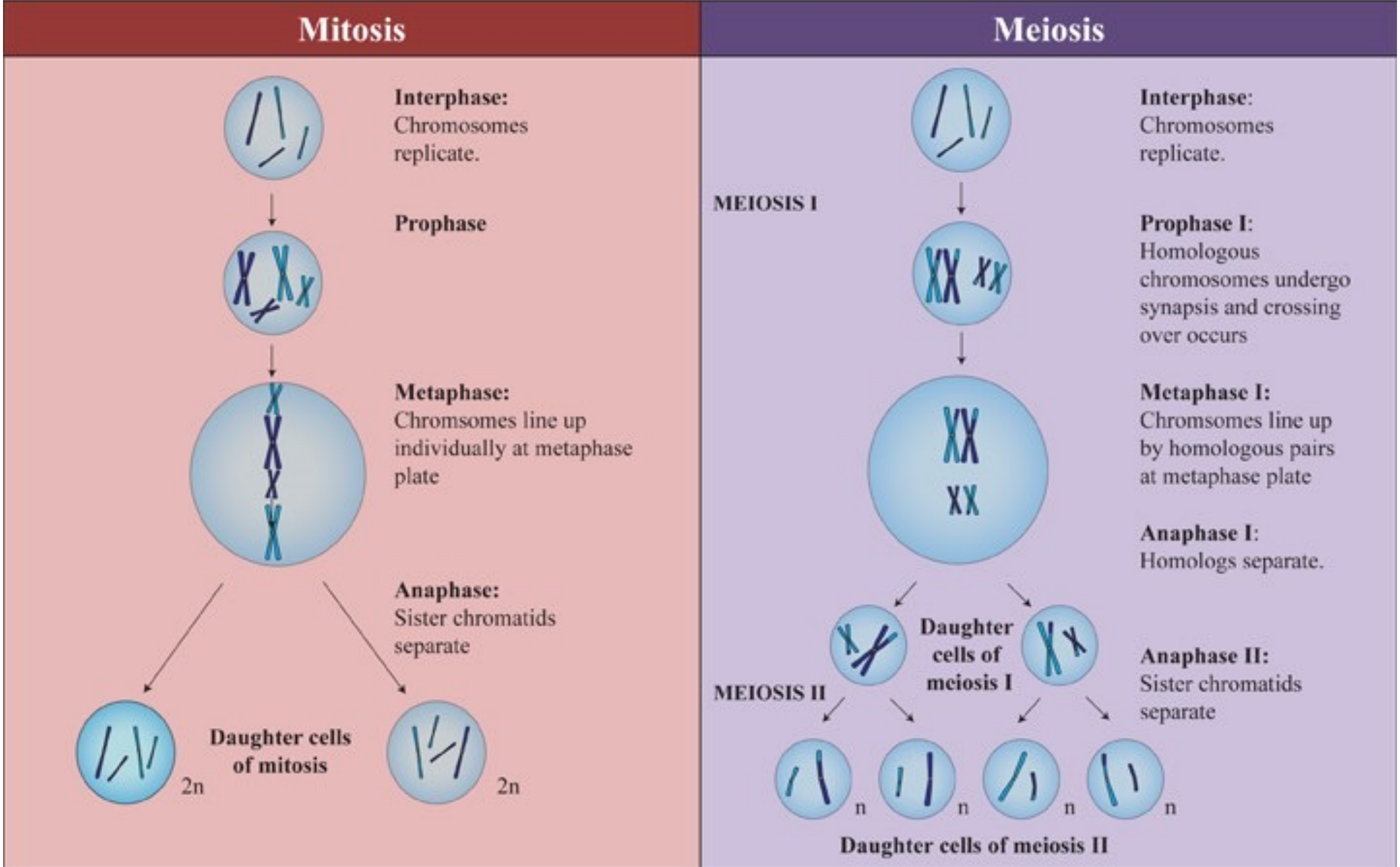
3. Based on the passage and illustration, which sentence is a correct statement about genes?

A. Genes are segments of DNA.
B. All genes have five pairs of bases.
C. One DNA strand may have millions of genes.
D. The nucleotide bases in genes are proteins.

GENETIC VARIATION

Organisms that reproduce sexually differ from one another. Factors causing organisms to develop uniquely include events that occur during meiosis, the cell division process that produces gametes (sex cells).

Because the chromosomes that carry genes occur in pairs, a gene has two forms, or alleles. During meiosis, the chromosomes making up a chromosome pair come together, and their parts may cross over each other. When this happens, DNA strands are broken and rejoined to form new combinations of genes. This process of genetic recombination mixes paternal and maternal genes, contributing to genetic variation.

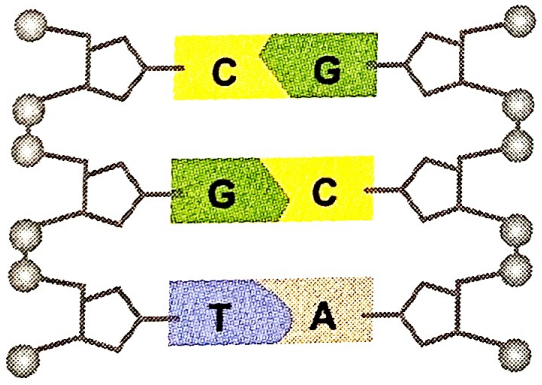

Mitosis
Interphase:
Chromosomes replicate.
Prophase
Metaphase:
Chromsomes line up individually at metaphase plate
Anaphase:
Sister chromatids separate
Daughter cells of mitosis
2n
2n
Meiosis
Interphase:
Chromosomes replicate.
MEIOSIS I
Prophase I:
Homologous chromosomes undergo synapsis and crossing over occurs
Metaphase I:
Chromsomes line up by homologous pairs at metaphase plate
Anaphase I:
Homologs separate.
Daughter cells of meiosis I
MEIOSIS II
Anaphase II:
Sister chromatids separate
n
n
n
n
Daughter cells of meiosis II

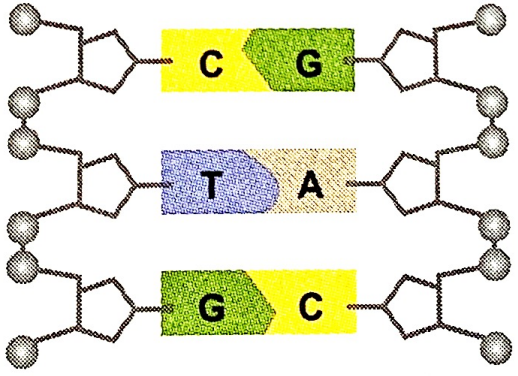
After paired chromosomes come together, they separate. Each gamete resulting from meiosis contains only one chromosome from each pair and, therefore, only one allele for each gene. This segregation of alleles helps further ensure that an organism produces gametes containing varied genes. Moreover, genes located on different chromosomes act independently from one another. That is, the distribution of one gene's alleles to one gamete or another does not affect the distribution of another gene's alleles. Because of this independent assortment of alleles, the inheritance of one trait typically is not related to the inheritance of another trait. However, two genes located close to each other on a chromosome may stay together during meiosis and be inherited together.

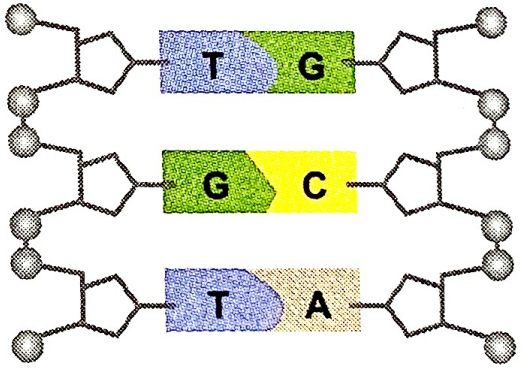
MUTATIONS

Over time, organisms show traits that were not present in previous generations. These new traits occur because of mutations, or changes that result when errors occur during DNA replication. In DNA replication, the two strands of a DNA molecule unwind from their double helix and then unzip from each other. Each single strand becomes a template for a new strand of DNA. Nucleotides move into place to form a new strand of DNA that is complementary to the template DNA. The positioning of nucleotides depends on their bases. For example, where the template DNA has bases CATG, the new DNA will have complementary bases GTAC because C pairs with G and A pairs with T. Sometimes a mistake happens, creating a mutation. Mutations can result from mitosis or meiosis. A mutation formed during meiosis is passed to offspring, creating a new allele for a gene that can be inherited by future offspring.

2. The illustrations represent results of DNA replication. Use context clues from the passage to determine the meaning of **mutation**. Then mark an *X* on any illustration that shows a mutation.







DIRECTIONS: Read the passage. Then read each question, and choose the **best** answer.

EPIGENOME

An organism's genome, or complete set of genetic material, can be influenced by its epigenome, or the set of chemical compounds that affect DNA. These chemical compounds do not change DNA; rather, they regulate the activity of genes. That is, epigenetic marks can turn genes on or off to make a cell function in a certain way. For example, an epigenetic mark in a bone cell may turn off a gene that promotes muscle growth. Unlike a genome, an organism's epigenome can change due to influences such as environmental factors. Specifically, what an organism eats or drinks and what pollutants it encounters can change its epigenome. These changes may be harmless or may have consequences and be passed to offspring.

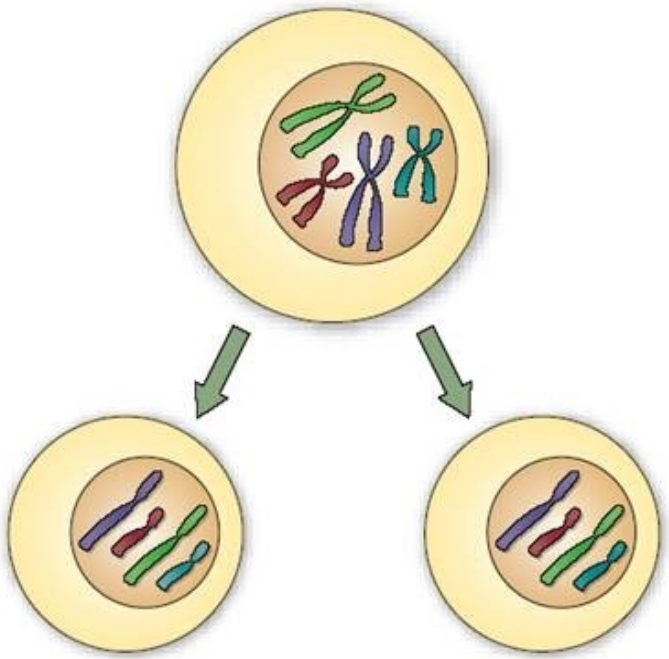
3. Based on context clues from the passage, what is an **epigenetic mark**?

   A. an environmental factor
   B. an organism's DNA
   C. a genetic mutation
   D. a chemical compound

4. One example of an **environmental factor** is

   A. a chemical compound on DNA.
   B. a gene for blue eyes.
   C. secondhand smoke.
   D. the trait of being double-jointed.

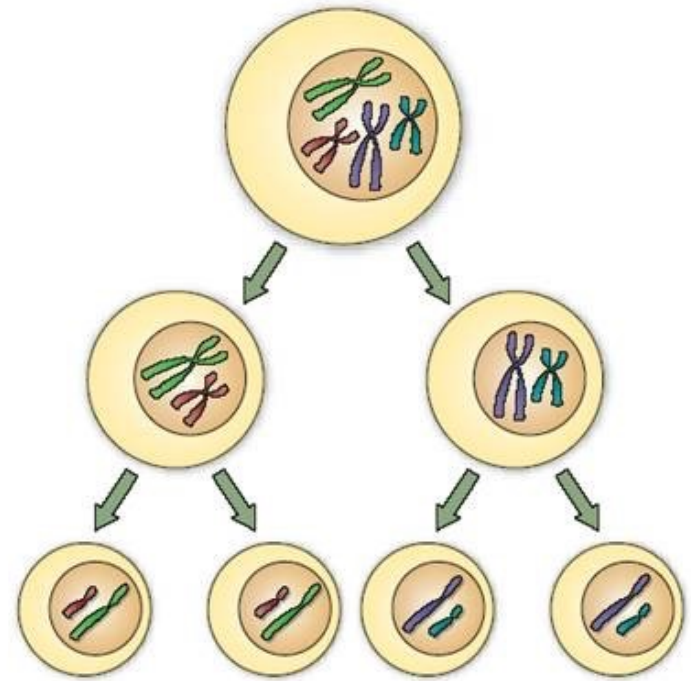
MITOSIS



- Produces genetically identical cells
- Results in diploid cells
- Takes place throughout an organism's lifetime
- Involved in asexual reproduction

MEIOSIS

- Produces genetically unique cells
- Results in haploid cells
- Takes place only at certain times in an organism's life cycle
- Involved in sexual reproduction



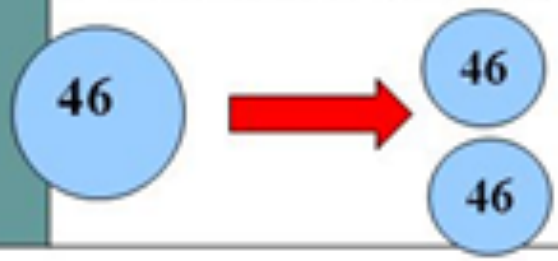
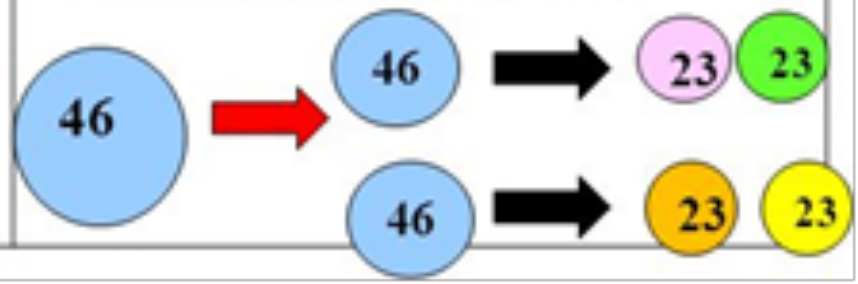
Key Points:

Mitosis and Meiosis are the two types of **cell division.**

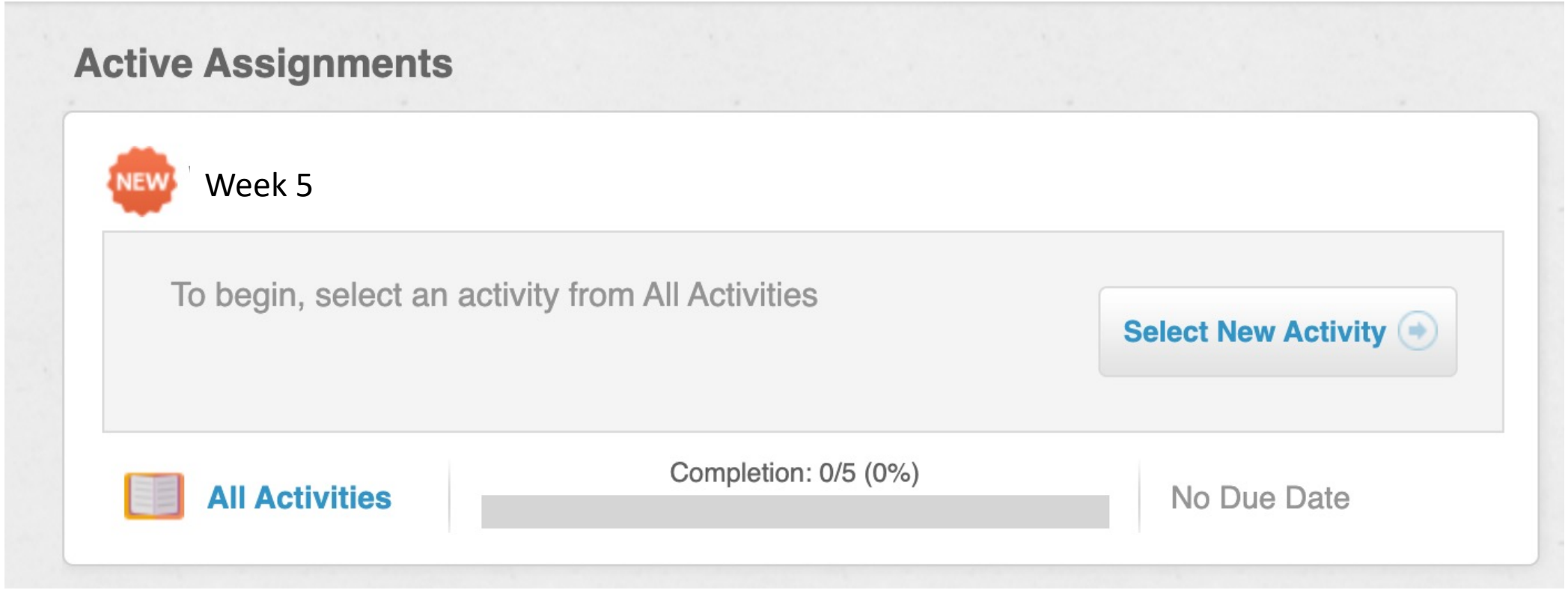
Mitosis serves to copy the chromosomes in cells exactly. It is used for growth/repair- when more of the same, identical cells are needed.

Meiosis is used only for sexual reproduction (to make gametes: eggs or sperm). Each gamete only has half the chromosomes of the parent, and must combine with another gamete to make a new organism. The offspring is genetically unique.

COMPARISON OF MITOSIS AND MEIOSIS

Characteristic	Mitosis	Meiosis (SEX)
Function	GROWTH, DEVELOPMENT, REPLACEMENT, REPAIR	Make GAMETES (egg and sperm)
Occurs in	BODY (Somatic) cells	Immature REPRODUCTIVE cells
Results in	2 daughter cells (clones of each other)	4 daughter cells (all different)
Chromosome #	Daughter cells are DIPLOID (2n) = 46 chromosomes	Daughter cells are HAPLOID (1n) = 23 chromosomes
Reproduction Type	ASEXUAL – 1 parent	SEXUAL – 2 parents
Stages	1 cell division (IPMAT)	2 cell divisions (PMAT x 2)
Drawing		

Homework!


Active Assignments
NEW
Week 5
To begin, select an activity from All Activities
Select New Activity
All Activities
Completion: 0/5 (0%)
No Due Date