Stone Ridge
School of the Sacred Heart

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Course Number (when applicable)
Course Title
H Molecular Biology and Biochemistry
Name of Assignment (title of book(s), Author, Edition, and ISBN (when applicable)
Adventures of a Female Medical Detective: in Pursuit of Smallpox and AIDS Mary Guinan, PhD, MD ISBN 978-1-4214-1999-2 *Can be found on Amazon for ~ $16 Molecular Biology Review Packet
Expectations/Instructions for Student When Completing Assignment

I'm excited that you have chosen to continue your studies in Biology next year, and I hope you are looking forward to this class. We will be building on the concepts you learned in Biology as we focus on the structural and functional properties of DNA and proteins through the lens of human disease.

Our studies will cover viruses, Prion diseases and Hemoglobinopathies. While I know you will be familiar with some of these diseases, others of them will be complete unknowns. While we study the molecular components and effects of these diseases it is easy to lose focus on their human impact, but it is vital that we do not. These diseases are very real, and the people affected by them face many challenges. Therefore, over the summer I'd like you to complete the following:

1. Please read Adventures of a Female Medical Detective, and write a 3-4 page double spaced reflection. Much of the content of this course will be very "zoomed in", and the purpose of my assigning this book is to put scientific research into perspective of public health, through the lens of a trailblazing woman scientist! We will examine several of the diseases mentioned in the book in detail throughout the course. Your reflection may include but is not limited to:What did you learn about the field of epidemiology and public health?
- What were some challenges that Dr. Guinan faced, and did she overcome them? How?
- How are diseases understood and addressed on a large scale?
- What specifics did you learn about diseases mentioned in this book? Did this change what you

previously thought?
- What do you hope to learn and study in this course?
- Anything else that you found particularly interesting about the book!

2. Find, read, and briefly summarize (~1 page double spaced) a science related article of your choosing. I would prefer a current article related to molecular biology or diseases. This does NOT need to be a research article. Feel free to send me your article if you're unsure if it is acceptable. Until I get my own school email, you can email me care of Mrs. Caudle at jcaudle@stoneridgeschool.org.
   Below are a few places to start:
   https://www.scientificamerican.com/
   https://www.sciencenews.org/
   http://www.sciencemag.org/news

3. Molecular Biology Review Packet- Please read through the packet at the end of this document, and be prepared for a quiz during the first week of class. All should be review from last year. This course requires a solid understanding of the Central Dogma of Biology (DNA → RNA → Proteins)

Have a wonderful summer, and see you in August! *Mr. Resnick*

One Essential Question for Assignment
What is the goal of public health, and what different roles do individuals and corporations play?
One Enduring Understanding for Assignment
Communication between scientific researchers, policy makers, healthcare workers, and the general public is key to controlling and preventing disease.
Parent Role and Expectations
None
Estimated Time Requirement
5-6 hours

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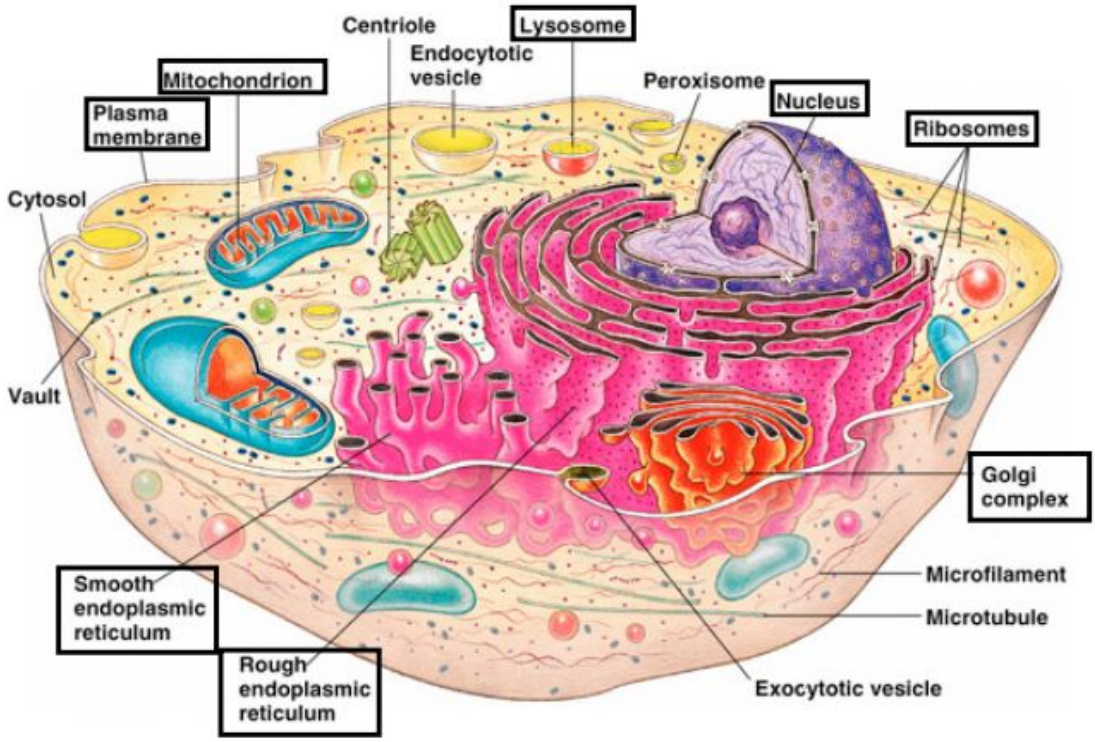
H-MOL BIO, REVIEW OF BIOLOGY

EUKARYOTIC ANIMAL CELLS

The cell is the basic functional unit of all living things.

- The cytoplasm consists of specialized bodies called organelles suspended in a fluid matrix, the **cytosol**, which consists of water and dissolved substances such as proteins and nutrients.
- The **plasma membrane** (cell membrane) separates internal metabolic events from the external environment and controls the movement of materials into and out of the cell.



The **nucleus**

- is bounded by the nuclear envelope, a phospholipid bilayer similar to the plasma membrane.
- contains DNA (deoxyribonucleic acid), the hereditary information of the cell.
    - Normally, the DNA is spread out within the nucleus as a threadlike matrix called **chromatin**.
    - When the cell begins to divide by either mitosis or meiosis, the chromatin condenses into rod-shaped bodies called **chromosomes**.

Ribosomes assist in the assembly of amino acids into proteins. Some ribosomes are free in the cytoplasm, others seem to be attached to the outside of the endoplasmic reticulum

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Lysosomes are vesicles that contain digestive enzymes. They break down food, cellular debris, and foreign invaders such as bacteria.

Endoplasmic reticulum, or **ER**

- **Appears** as a series of maze-like channels, often closely associated with the nucleus.
- Where ribosomes are present, the ER (called **rough ER)** proteins enter the ER, where they are modified.
- **Smooth ER** is involved in the breakdown of toxins and the synthesis of lipids.

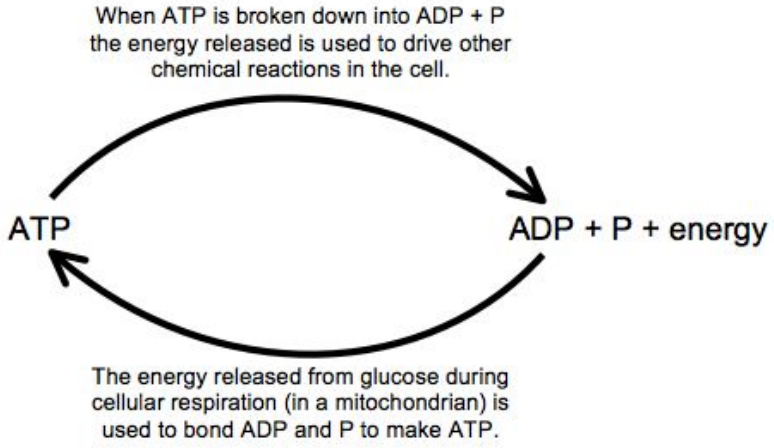
Golgi apparatus (**Golgi complex** or **Golgi body**)

- Modifies and packages proteins and lipids into vesicles
- These vesicles often migrate to and merge with the plasma membrane, releasing their contents to the outside of the cell.

Vacuoles and **vesicles** are fluid-filled, membrane-bound bodies.

Mitochondria carry out aerobic (using O_2) respiration, a process in which glucose is broken down and the energy released during this process is used to make ATP.

- **ATP** (adenosine triphosphate) is a common source of activation energy for metabolic reactions. In the process of giving up this energy, the last phosphate bond is broken and the ATP molecule is converted to **ADP** (adenosine diphosphate) and a **phosphate group** (indicated by P*i*). In contrast, new ATP molecules are assembled when ADP combines with a phosphate group using energy obtained from some energy-rich molecule (like glucose) during cellular respiration.



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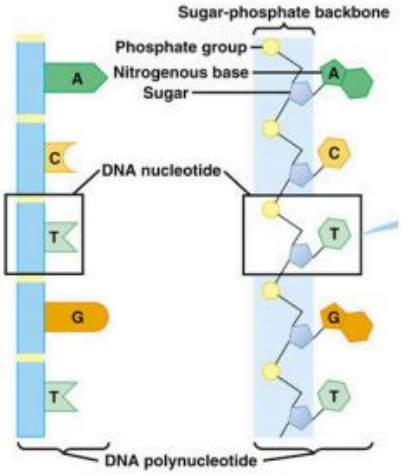
DNA

A single strand of **DNA** is a polymer of **nucleotides**. (Each strand is very long, often a million or more nucleotides in length.)

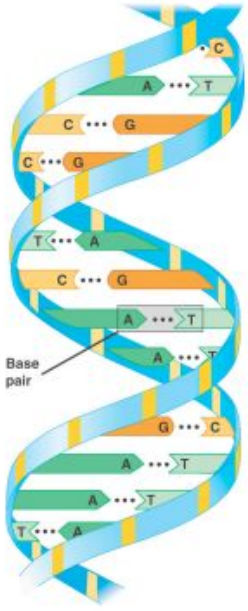
- A DNA nucleotide consists of three parts—a **nitrogen base,** a five-carbon sugar called **deoxyribose,** and a **phosphate group**.
- There are four DNA nucleotides, each with one of the four nitrogen bases, as follows
    - A - Adenine
    - T - Thymine
    - C - Cytosine
    - G – Guanine



The nucleotides are complimentary to each other (attract each other) so that the following pairs form:

- **A pairs with T**
- **G pairs with C**

A complete molecule of DNA is double stranded (composed of two complimentary strands) and twists into a double helix, as shown:



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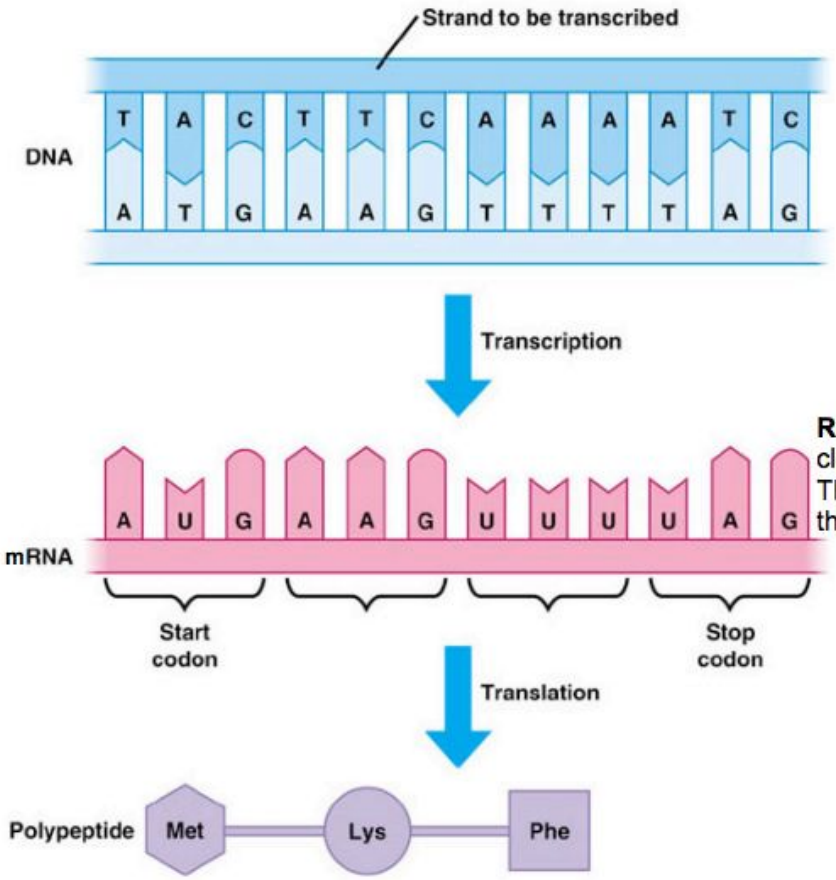
The genetic information is stored in molecules of DNA. The DNA, in turn, codes for mRNA, which codes for proteins such as enzymes, which, in turn, regulate chemical reactions that direct metabolism for cell development, growth, and maintenance. It is the sequence of the nitrogen bases in the DNA that determines the sequence of amino acids in the protein, with each three-base **codon** coding for one amino acid.



RNA is a nucleic acid, closely related to DNA. The differences between them are:

- RNA is usually single stranded.
- RNA nucleotides contain the sugar ribose rather than deoxyribose.
- The nitrogen base T is never found in RNA; it is replaced by U (uracil).

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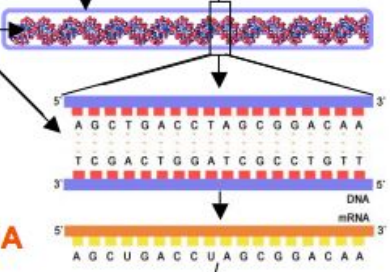
A chromosome is composed of one molecule of DNA along with many proteins. The nucleus of each human cell (except germ cells) contains 46 chromosomes. Each chromosome contains many genes (see "gene".)

Chromosome

Gene

DNA



The sequence of nitrogen bases in the DNA determines the sequence of nitrogen bases in the mRNA (messenger RNA) which, in turn, determines the order of the amino acids in the protein.

mRNA

Replication is the process of making identical copies of DNA molecules (chromosomes). It only occurs when a cell is going to divide by mitosis or meiosis.

Replication

DNA

Transcription

Transcription is synthesis of a complimentary RNA copy from DNA. When a cell needs to make a certain protein, the region of the DNA molecule coding for that protein "unzips" so that mRNA complimentary to the gene can be transcribed.

RNA

Nucleus

Cytoplasm

When mRNA enters the cytoplasm, a ribosome attaches to it and begins translation. During translation, molecules of tRNA (transfer RNA) deliver the amino acids needed to make the protein, which the mRNA (messenger RNA) codes for.

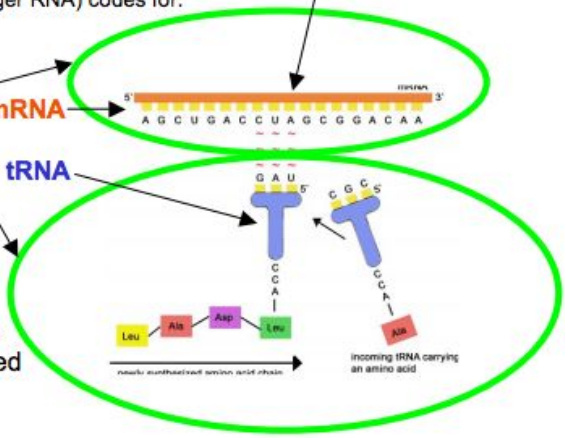
Translation

Translation is the process in which the genetic code carried by messenger RNA directs the synthesis of proteins from amino acids. It occurs in the cytoplasm.

Ribosome

mRNA

tRNA



Amino acids
Being assembled into protein

PROTEIN

Enzymes, antibodies, receptors, active transport carriers, hemoglobin and some hormones are all examples of proteins

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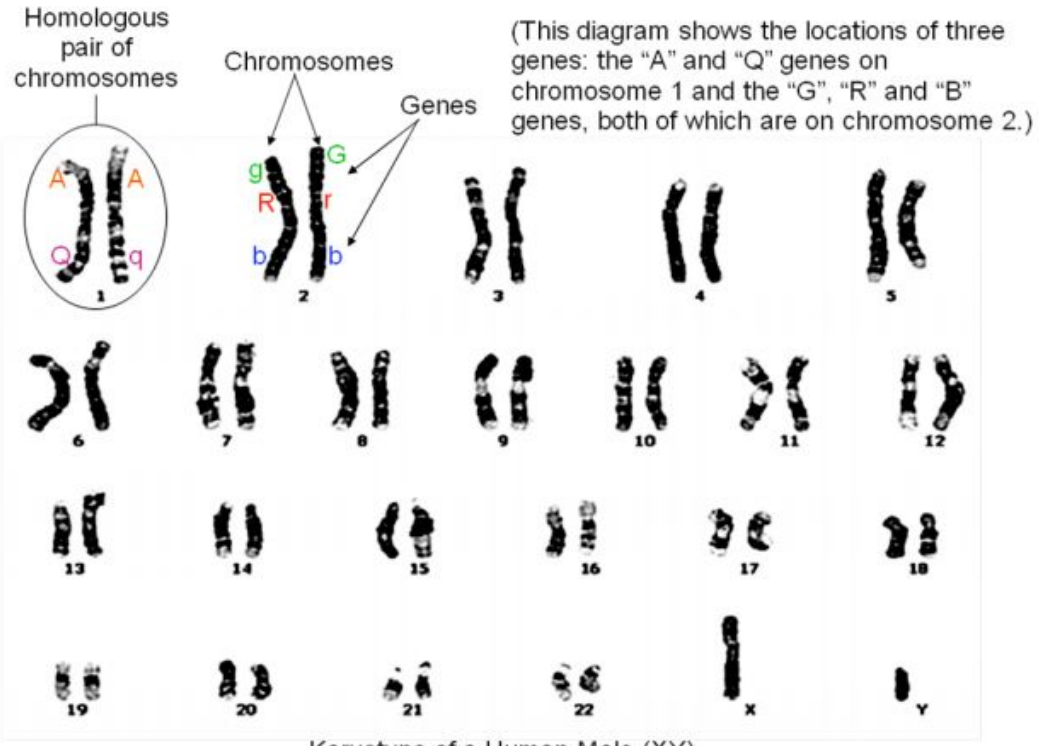
Every **diploid** cell contains two copies of each chromosome, one inherited from each parent. **Haploid** cells contain just one copy of each chromosome.

- Human **somatic** (body) cells are diploid and contain 46 chromosomes.
- Human **germ cells or gametes** (eggs and sperm) are haploid and contain 23 chromosomes.

The diagram below is a karyotype of a human somatic cell, showing 46 chromosomes (23 pairs of pair of chromosomes (the sex chromosomes) is an XY pair rather than an XX pair, which would be a female.



Karyotype of a Human Male (XY)

The two chromosomes identified as #1 chromosomes are an **homologous pair** of chromosomes.

- Each chromosome in the pair contains a gene for the same trait at exactly the same location.
- One chromosome of this homologous pair was inherited from the mother (in the egg) and the other was inherited from the father (in the sperm).
- Because diploid organisms have two copies of each chromosome, they have two copies of each gene (two **alleles** of each gene). The allele of the gene on the maternal chromosome does not have to be identical to the allele of that gene on the paternal chromosome.
    - For example, you can see above that with regard to the "Q" trait, which is on chromosome #1, this person received a Q (dominant) allele from one parent and a q (recessive) allele from the other parent.
    - On the other hand, this person received a b (recessive) allele from each parent with regard to the "B" trait which is on chromosome #2.

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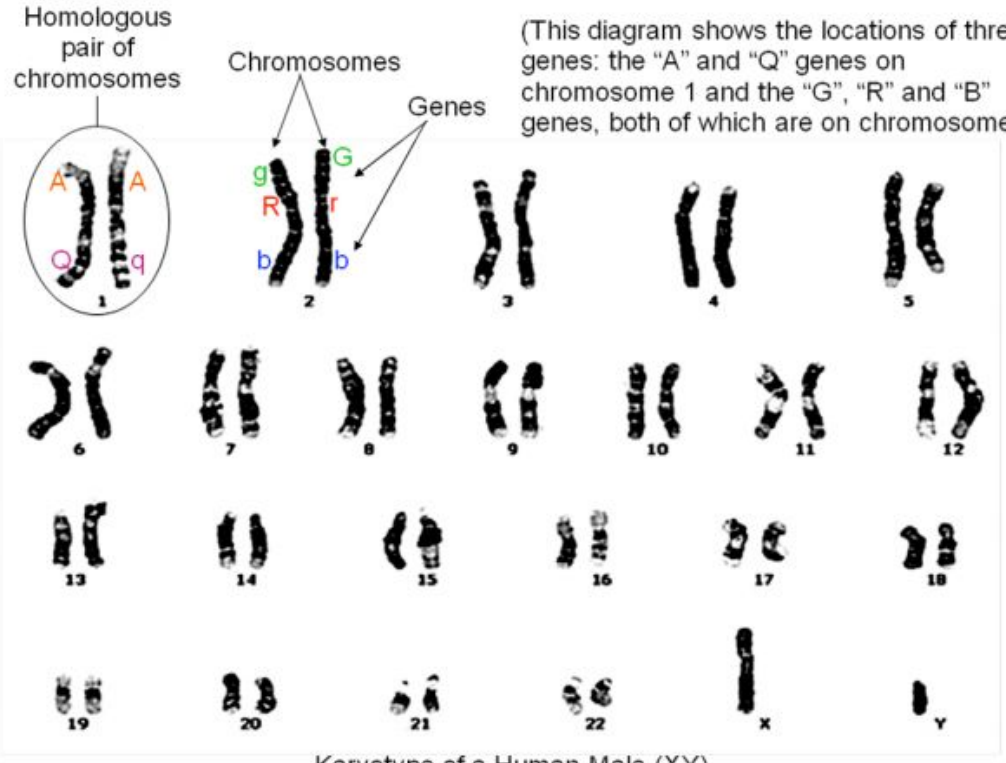

Karyotype of a Human Male (XY)

The person whose chromosomes are shown above has the genotype AA for the A gene on chromosome 1. This person received a dominant A allele from both her mother and her father. The AA genotype is described as being "homozygous dominant".

The person whose chromosomes are shown above has the genotype bb for the B gene on chromosome 2. This person received a recessive b allele from both her mother and her father. The bb genotype is described as being "homozygous recessive".

The person whose chromosomes are shown above has the genotype Gg for the G gene on chromosome 2. This person received a dominant G allele from one of her parents and a recessive g allele from the other parent. The Gg genotype is described as being "heterozygous".

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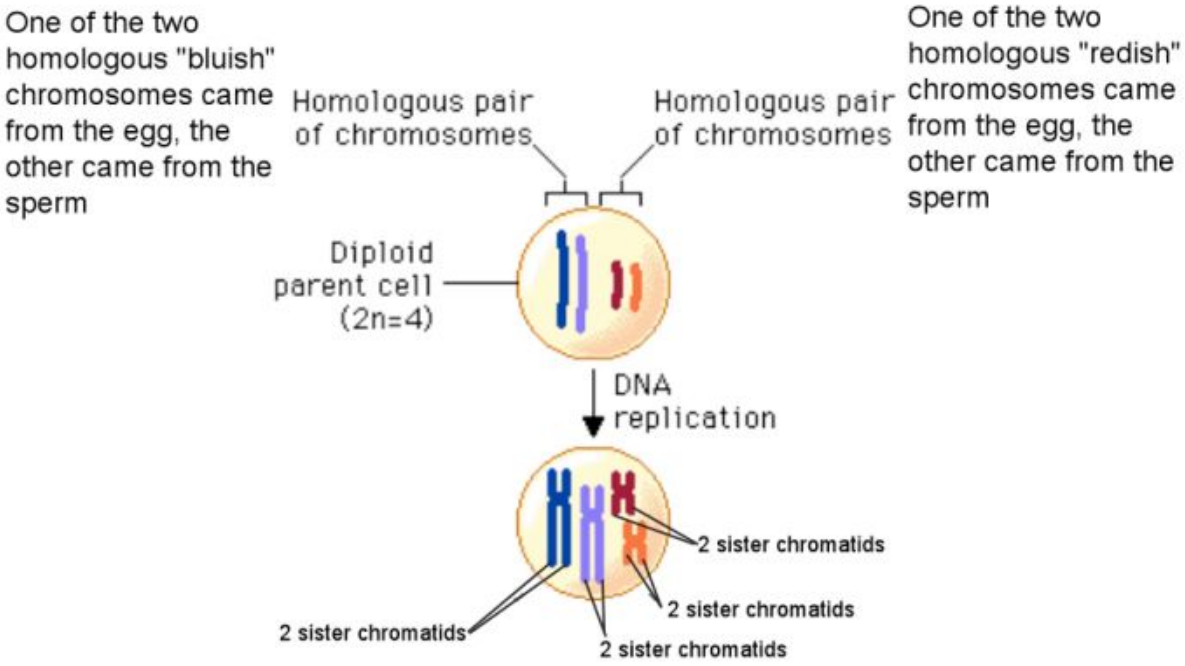

After DNA replication, each chromosome consists of two identical copies of the chromosome called "sister chromatids", which are connected to each other at the centromere. During cell division, the sister chromatids will become separated from each other and will end up in different daughter cells.