



About Science Prof Online PowerPoint Resources

- Science Prof Online (SPO) is a free science education website that provides fully-developed Virtual Science Classrooms, science-related PowerPoints, articles and images. The site is designed to be a helpful resource for students, educators, and anyone interested in learning about science.
- The SPO Virtual Classrooms offer many educational resources, including practice test questions, review questions, lecture PowerPoints, video tutorials, sample assignments and course syllabi. New materials are continually being developed, so check back frequently, or follow us on Facebook (Science Prof Online) or Twitter (ScienceProfSPO) for updates.
- Many SPO PowerPoints are available in a variety of formats, such as fully editable PowerPoint files, as well as uneditable versions in smaller file sizes, such as PowerPoint Shows and Portable Document Format (.pdf), for ease of printing.
- Images used on this resource, and on the SPO website are, wherever possible, credited and linked to their source. Any words underlined and appearing in blue are links that can be clicked on for more information. PowerPoints must be viewed in *slide show mode* to use the hyperlinks directly.
- Several helpful links to fun and interactive learning tools are included throughout the PPT and on the Smart Links slide, near the end of each presentation. You must be in *slide show mode* to utilize hyperlinks and animations.
- This digital resource is licensed under Creative Commons Attribution-ShareAlike 3.0:
<http://creativecommons.org/licenses/by-sa/3.0/>

Alicia Cepaitis, MS
Chief Creative Nerd
Science Prof Online
Online Education Resources, LLC
alicia@scienceprofonline.com

Tami Port, MS
Creator of Science Prof Online
Chief Executive Nerd
Science Prof Online
Online Education Resources, LLC
info@scienceprofonline.com

Molecular Genetics

DNA Replication & Gene Expression

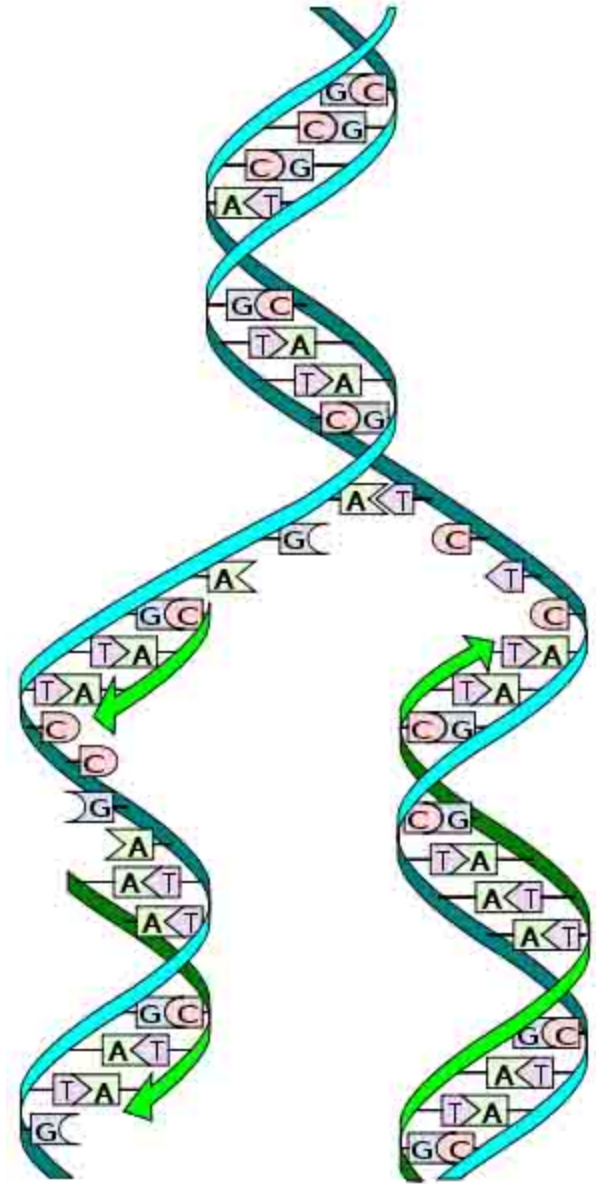
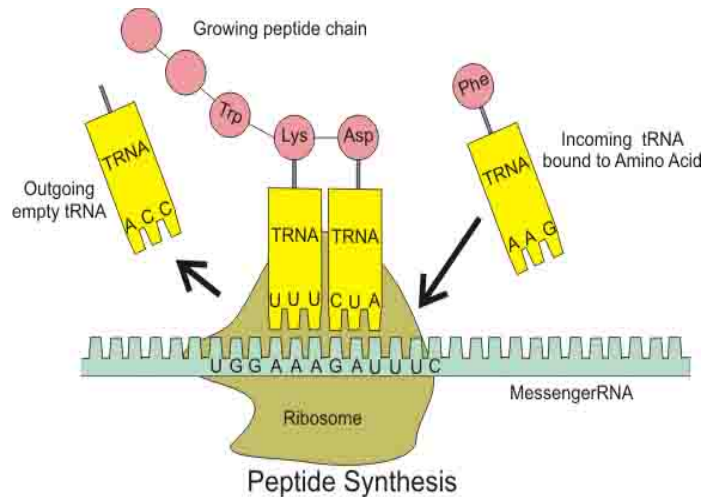
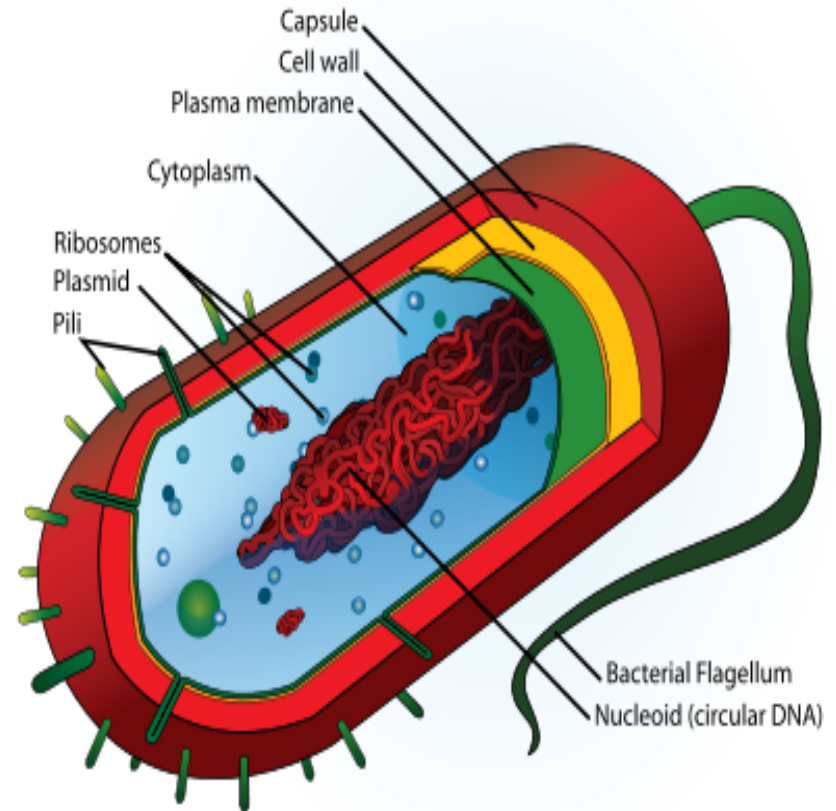


Image: [Peptide Synthesis Diagram](#): Bumphreyfr, Wiki;
[Replication Diagram](#): Madprime, Wiki

Prokaryotic Genomes

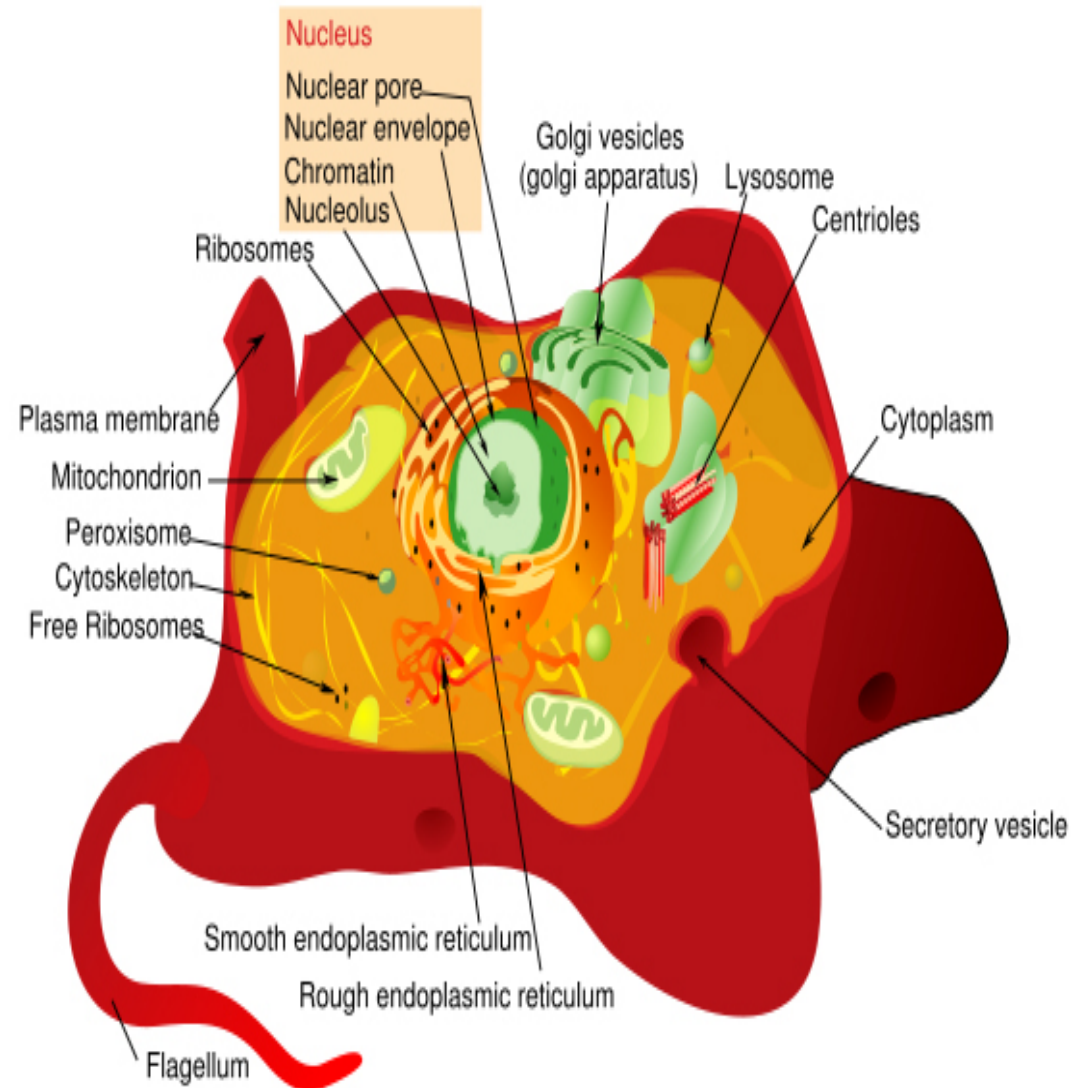
- Made of DNA
- Chromosomes can be circular or linear
- Genome floats freely within cytoplasm
- **Q:** Where is DNA found in prokaryotes?

- _____
- _____



Eukaryotic Genomes

- Genomes of eukaryotic organisms made of DNA.
- Eukaryotic genomes frequently include many linear chromosomes within a membrane-bound nucleus
(Q: How many do we have?).
- Where is DNA found in eukaryotes?
 - Nuclear DNA
 - Extranuclear DNA(Q: What is extranuclear DNA?)

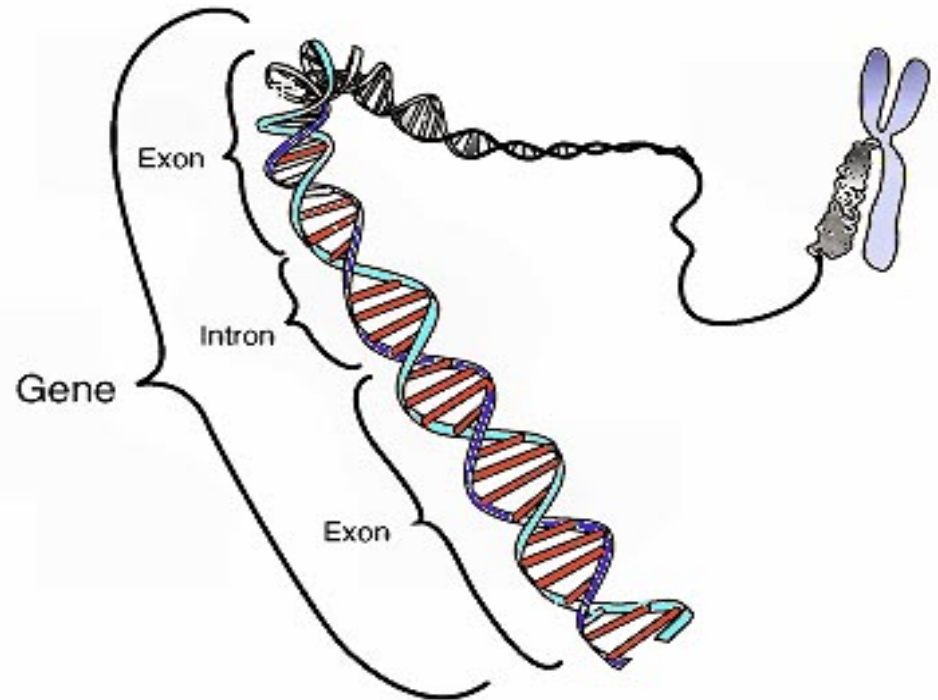


Chromosomes & Genes

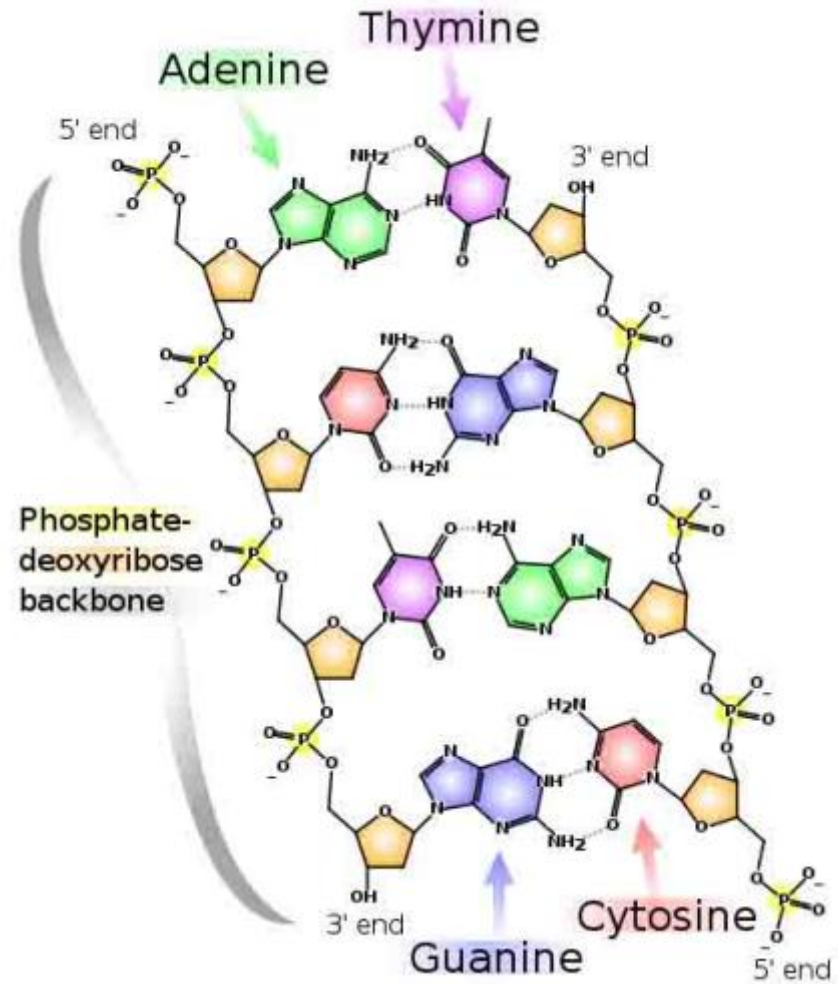
- **Genome** - Complete complement of an organism's DNA.
- Cellular **DNA** is organized in **chromosomes**.
- **Genes** have specific places on chromosomes.



Mary G. Gitter (2004)

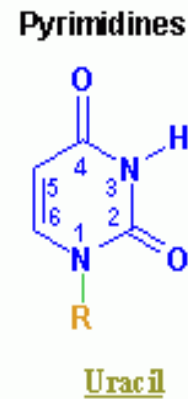
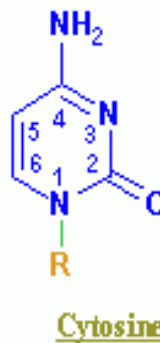
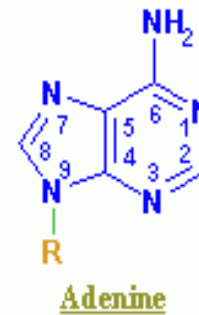
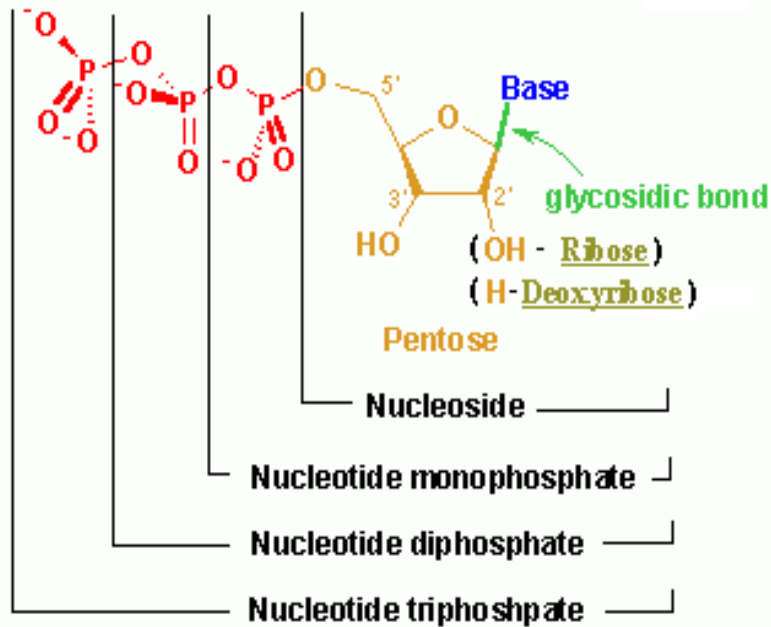


Nucleotides and Nucleic Acids



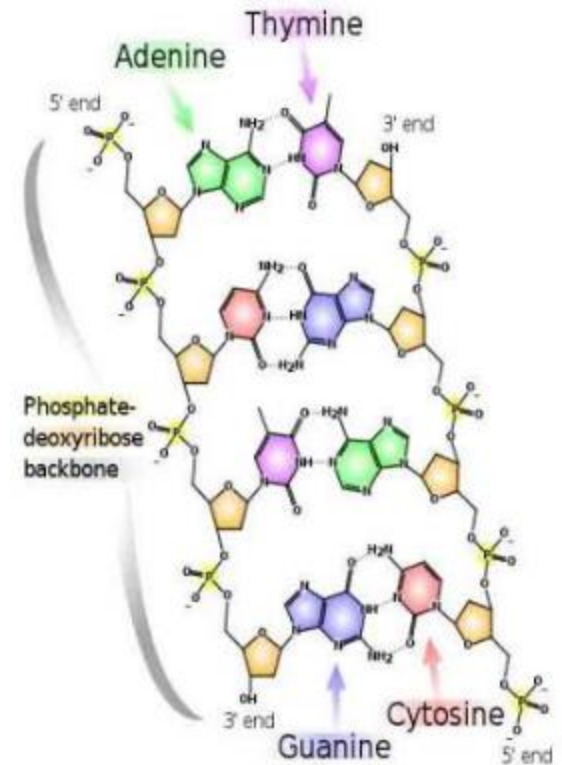
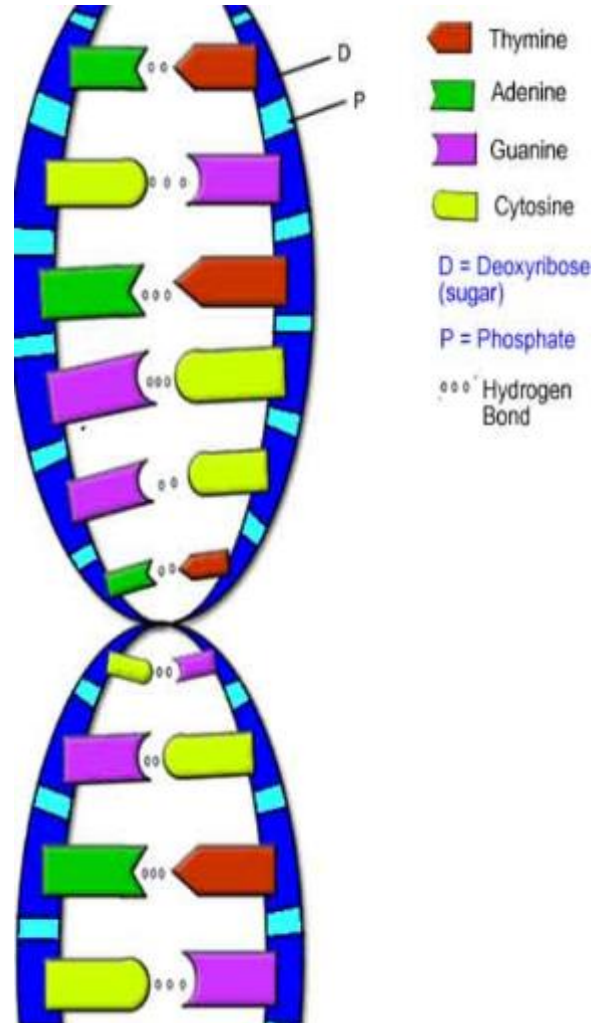
Nucleic Acids

Q: What type of monomer are nucleic acids made of?



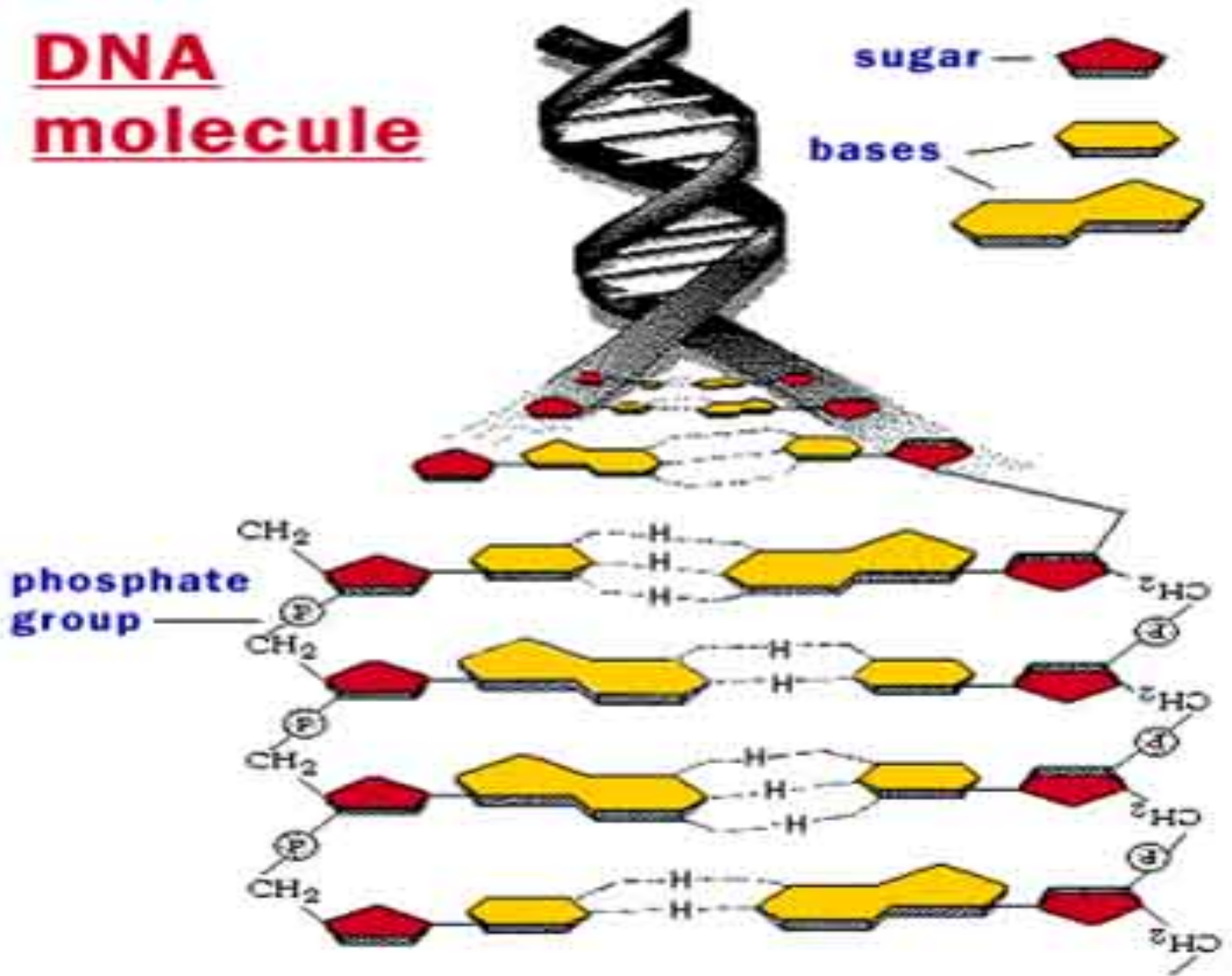
DNA Structure

- Double stranded molecule, analogous to a spiral staircase:
 - two deoxyribose-phosphate chains as the "side rails"
 - base pairs, linked by hydrogen bonds, are the "steps"
- **Purine Bases**
(double ring)
Adenine & Guanine
- **Pyrimidine Bases**
(single ring)
Cytosine & Thymine



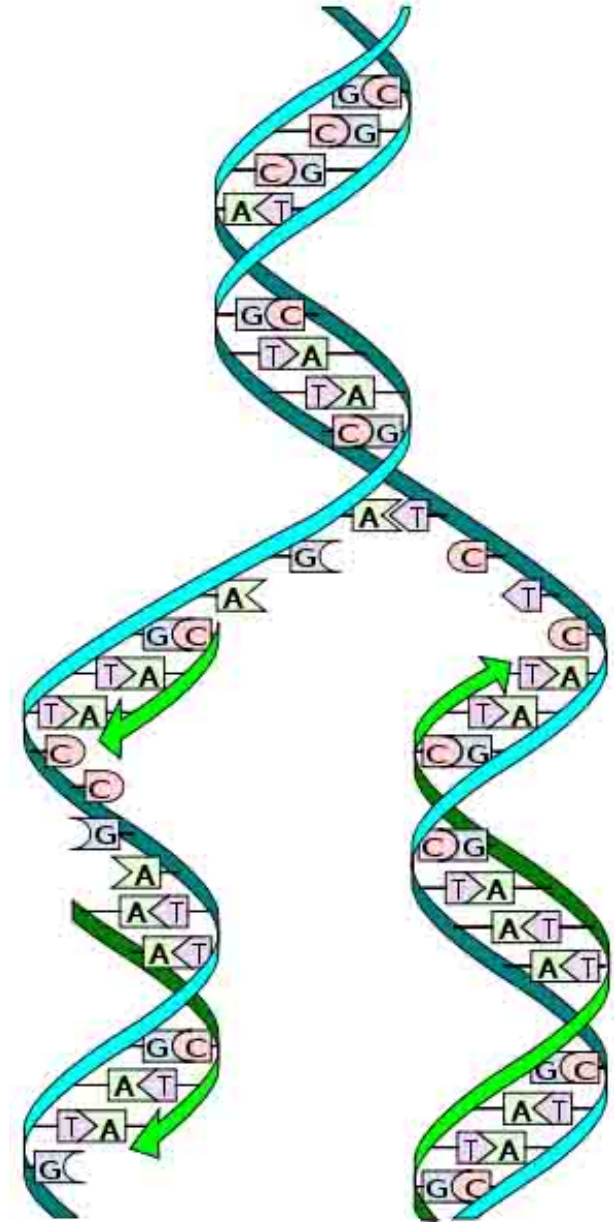
Images: [Model of DNA Molecule](#), Field Museum, Chicago, T. Port;
[DNA Detail Diagram](#): Madprime; [DNA Molecule](#), Biology Corner

DNA molecule



DNA Replication

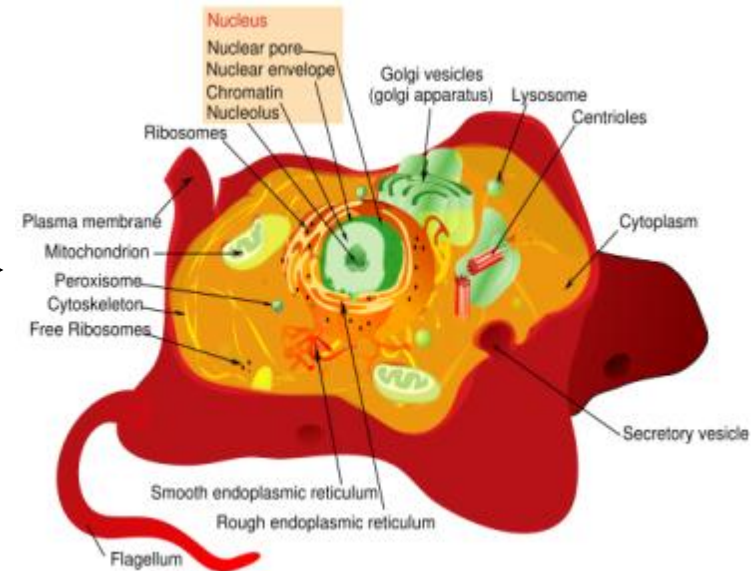
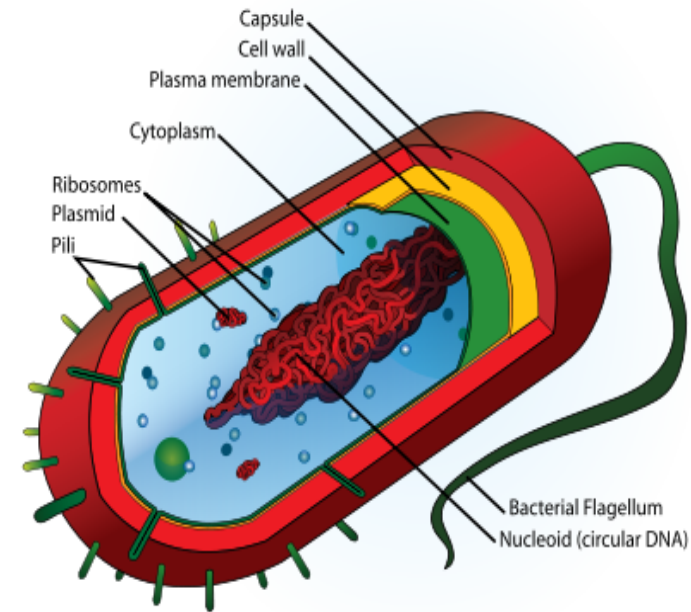
- **Copying** of a double-stranded DNA molecule.
- Each **DNA** strand holds the same genetic information, so each strand can serve as a template for the new, opposite strand.
- The **parent** (a.k.a. _____) strand is preserved and the **daughter** (a.k.a. _____) strand is assembled from nucleotides.
- This is called **semi-conservative** replication.
- Resulting double-stranded DNA molecules are identical.
- **Q: Why would a cell need to copy its DNA?**



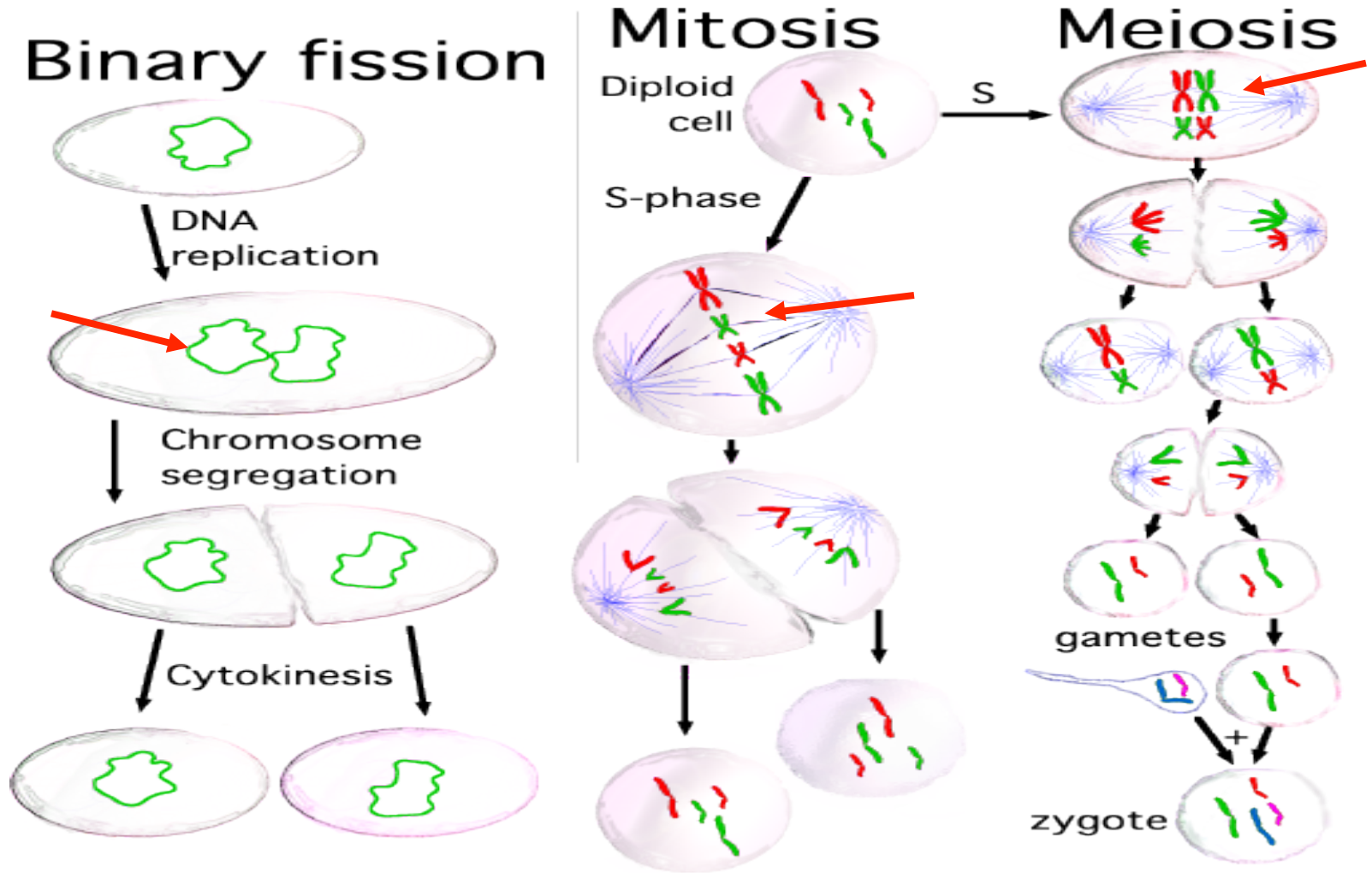
DNA Replication

In a cell, DNA replication must happen before cell division.

- **Prokaryotes** replicate their DNA throughout the interval between cell divisions.
- In **eukaryotes**, timing of replication is highly regulated.

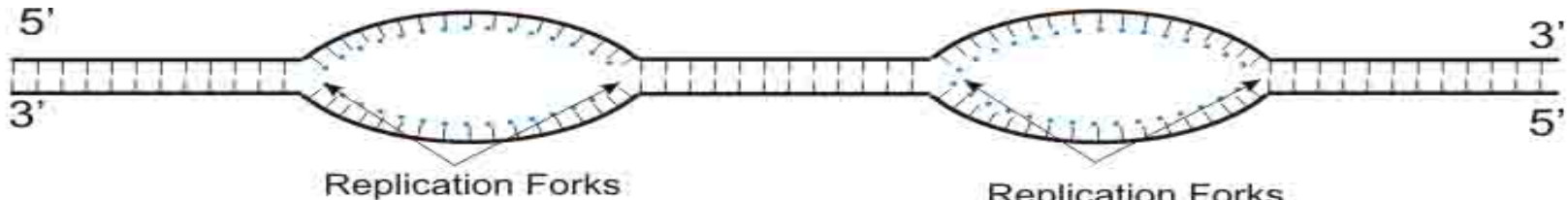
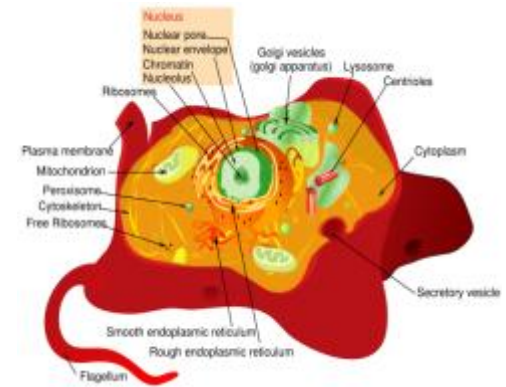


DNA Replication

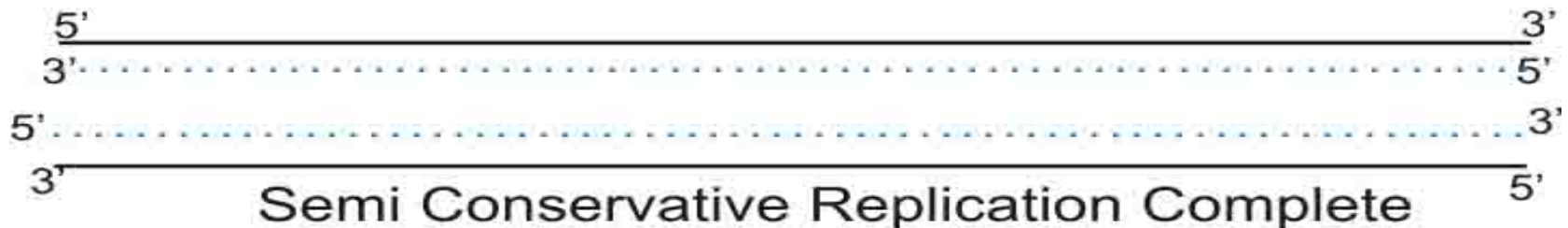


EUKARYOTIC DNA Replication: Replication "Bubbles"

- Multiple origins of replication > These "bubbles" are the start points of replication.
- Replication fork: 'Y'-shaped region where new strands of DNA are elongating.



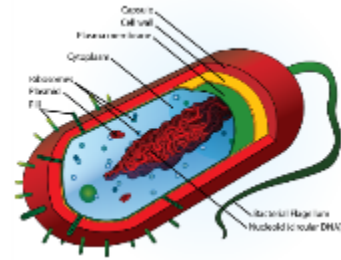
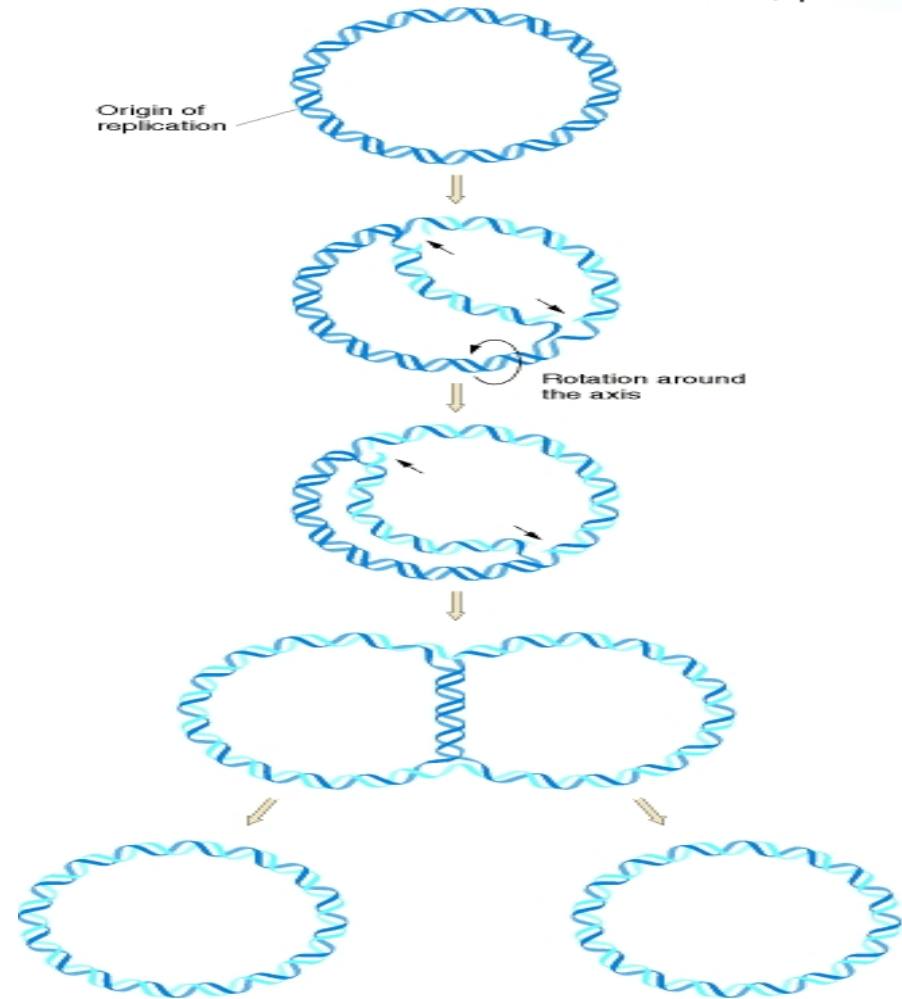
Replication bubbles form in DNA



PROKARYOTIC DNA Replication

One Origin

- Prokaryotic DNA is arranged in a circular shape, and there is only one replication origin.
- Despite these differences, the underlying process of replication is the same for both prokaryotic and eukaryotic DNA.



How Do Nucleotides Put Themselves Together Into Nucleic Acids?

- An **anabolic polymerization** process.

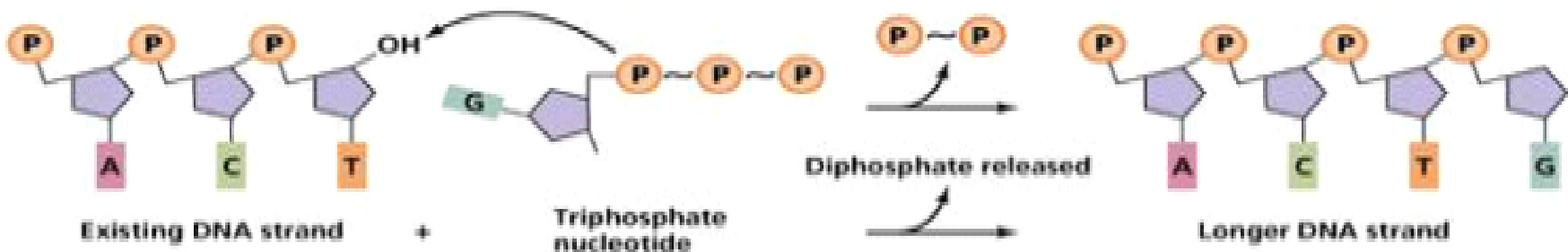
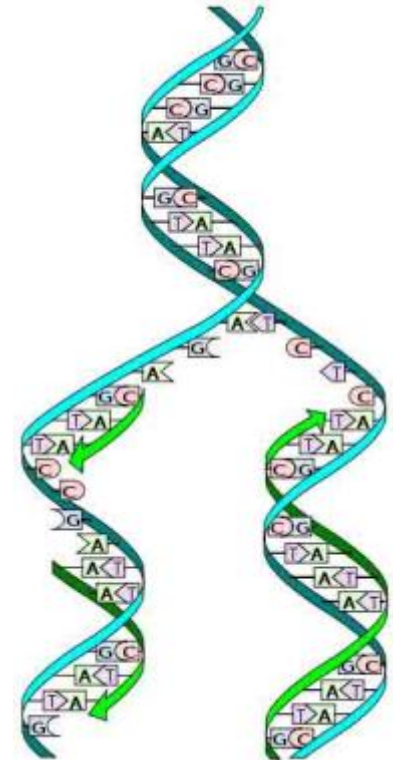
Q: Anabolic or Anabolism is....? _____

Q: Polymerization is ...? _____

- Polymerization requires **monomers** (building blocks) and **energy**.

- Triphosphate deoxyribonucleotides provide both.

- These building blocks of DNA bring their own energy for polymerization.



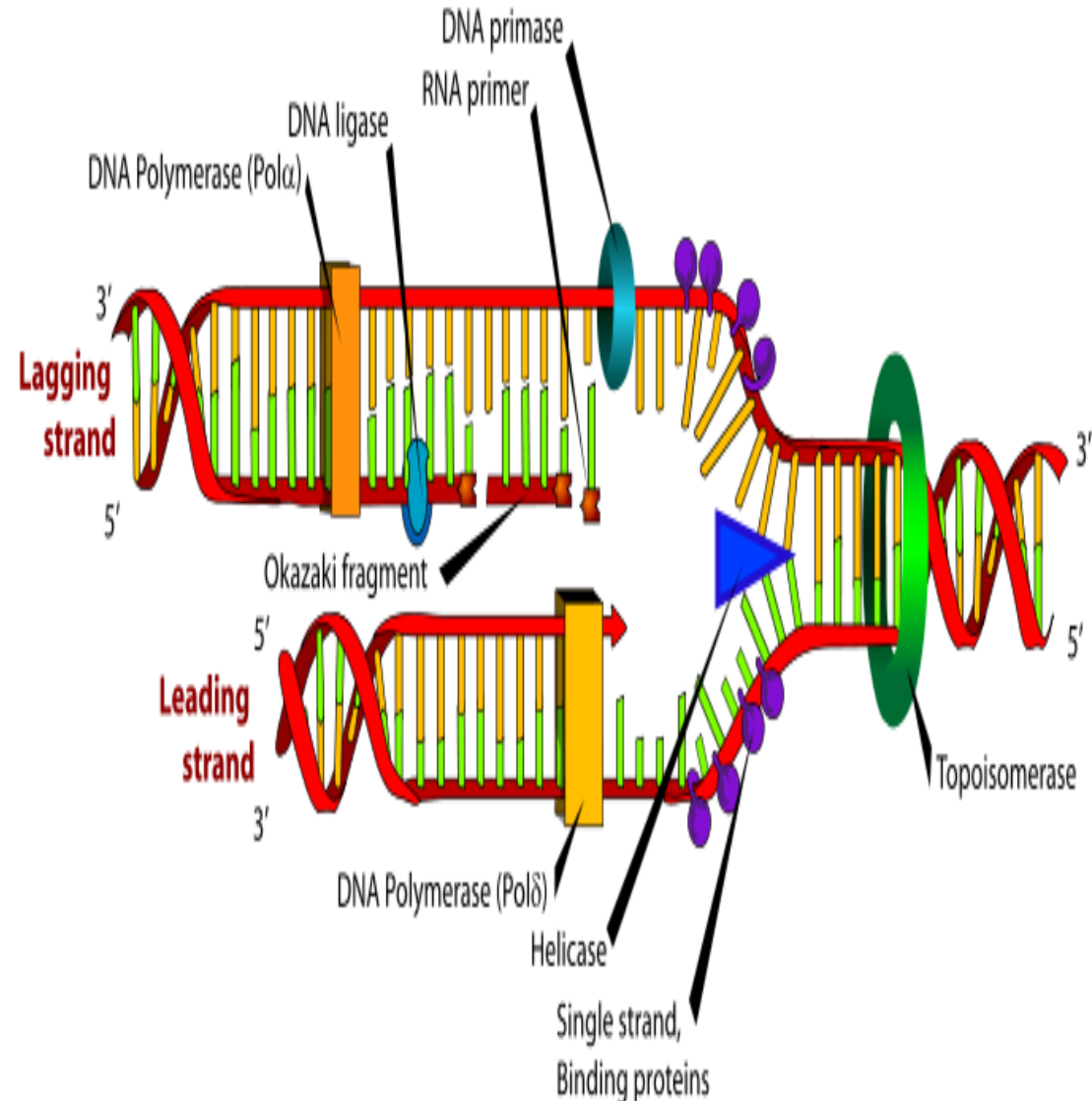
DNA Replication: Leading & Lagging Strand

Leading Strand

Synthesis proceeds smoothly as the replication fork unzips.

Lagging Strand

Synthesis away from the replication fork (Okazaki fragments); joined by DNA ligase.



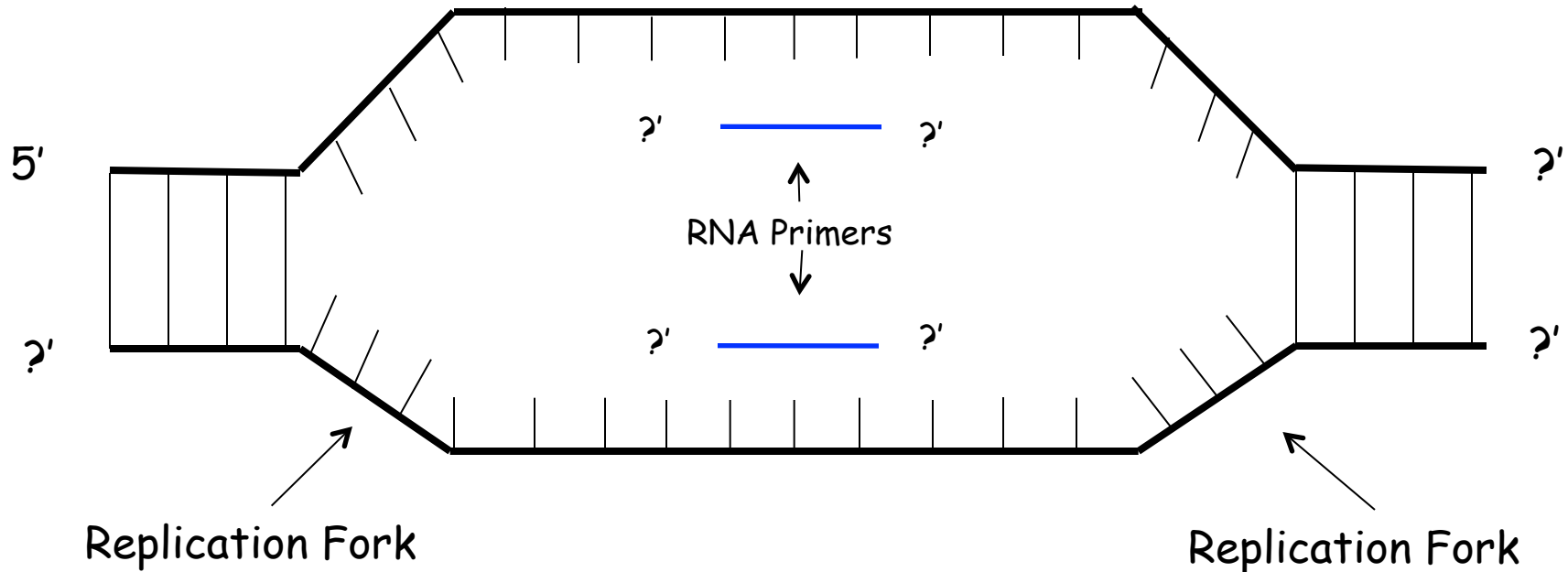
REVIEW

[DNA Replication Animations](#)

from McGraw-Hill

This link will take you to a page with 4 links on it. Please view the first, "How Nucleotides are Added in DNA Replication" and the fourth "DNA Replication Fork".

Let's Practice How Leading & Lagging Daughter Strands Are Built Within the Replication Bubble

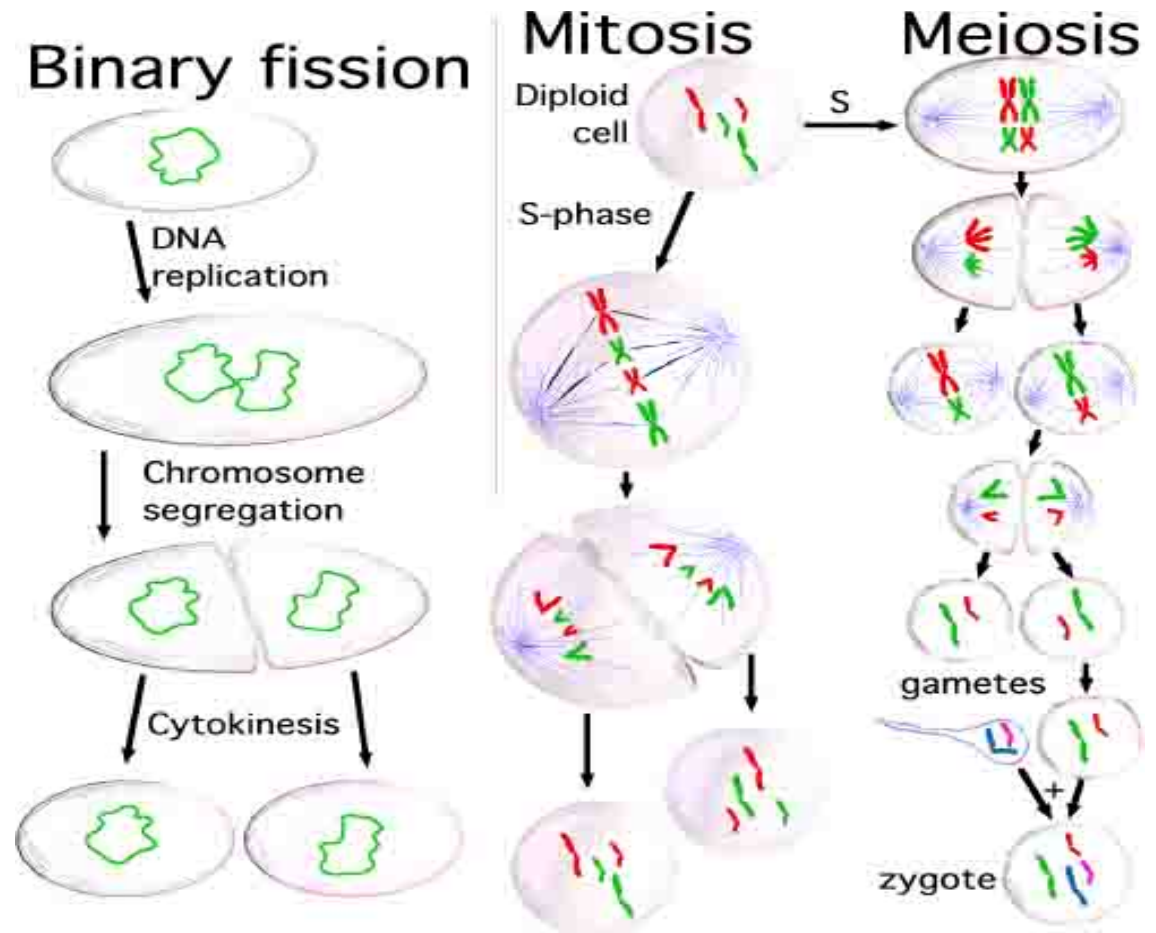


Now let's look at how replication of the leading and lagging strands occurs at each of the two replication forks within the replication bubble:

1. Label each end of the parent strands as either 5' or 3'.
2. Start a RNA primer for each daughter strand and label its 5' and 3' ends.
3. Show how new strands are built (continuously or discontinuously).

Reminder... Why is the DNA copied?

Replication occurs prior to cell division, because the new, daughter cell will also need a complete copy of cellular DNA.

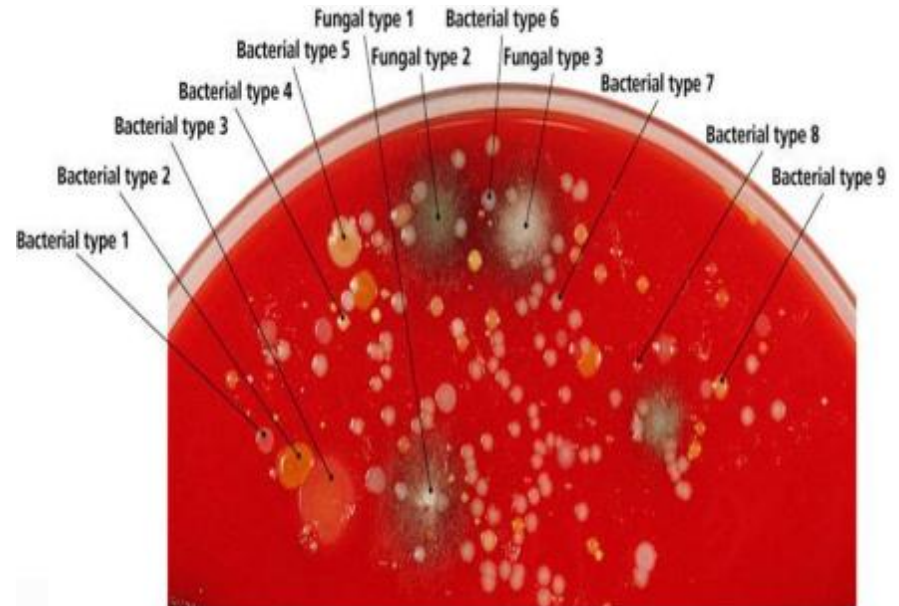
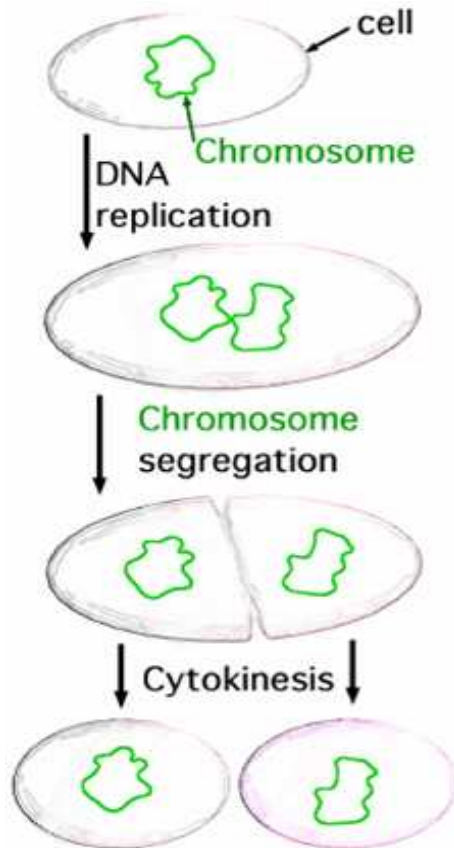


Genetic Diversity in Prokaryotes

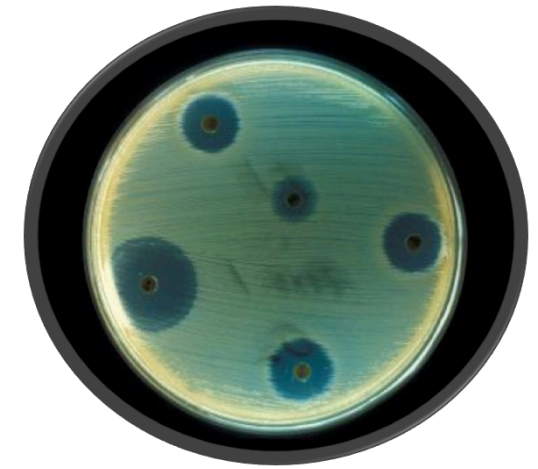
If binary fission creates clones...

...then:

- Why isn't there just one type of bacteria?
- How do bacteria change (for example develop resistance to antibiotics)?

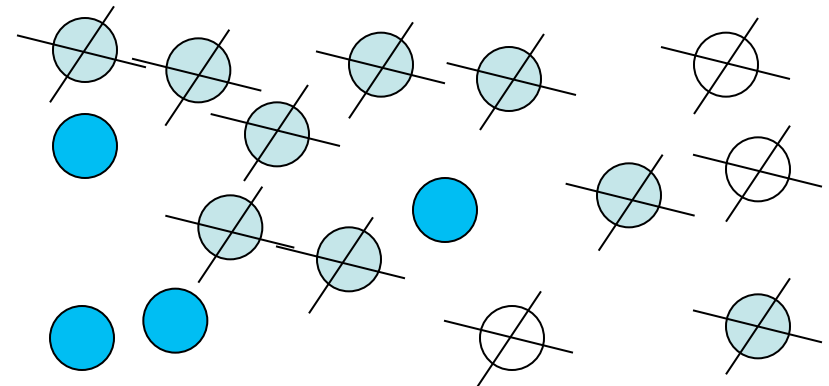


Mutation and Bacterial Change



- Antibiotic resistance = When a microorganism is able to survive exposure to an antibiotic.
- Genetic mutation in bacteria can produce resistance to antimicrobial drugs (example: beta-lactamase).
- If those genes are on a plasmid, they can be transferred between bacteria by conjugation and other forms of horizontal gene transfer.
- If a bacterium carries several resistance genes, it is called multidrug resistant (MDR) or, informally, a superbug or super bacterium.
- Any use of antibiotics can increase selective pressure in a population of bacteria to allow the resistant bacteria to thrive and the susceptible bacteria to die off.

REVIEW!
Antibiotic Resistance
Animation
from Sumanas

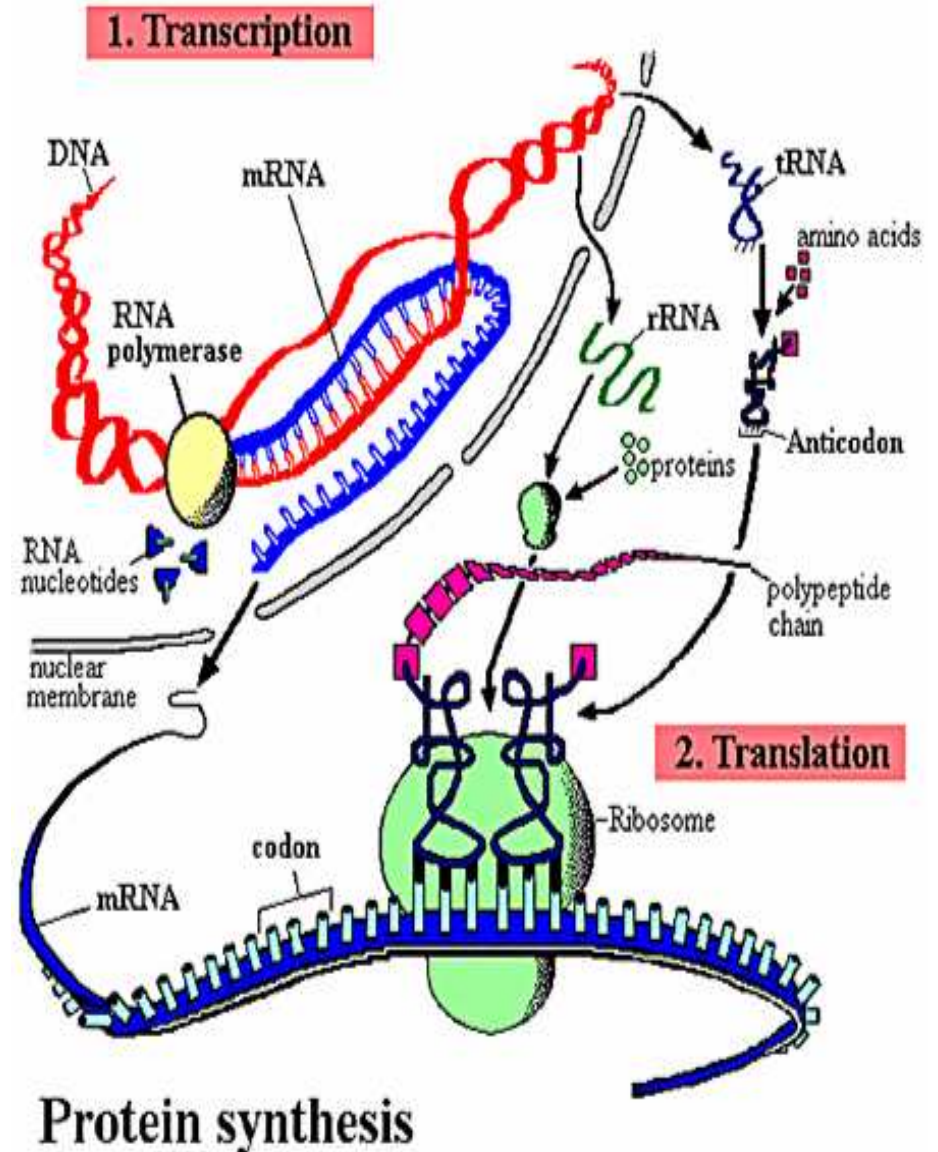


Gene Expression

Transcription

&

Translation
(Making Proteins)

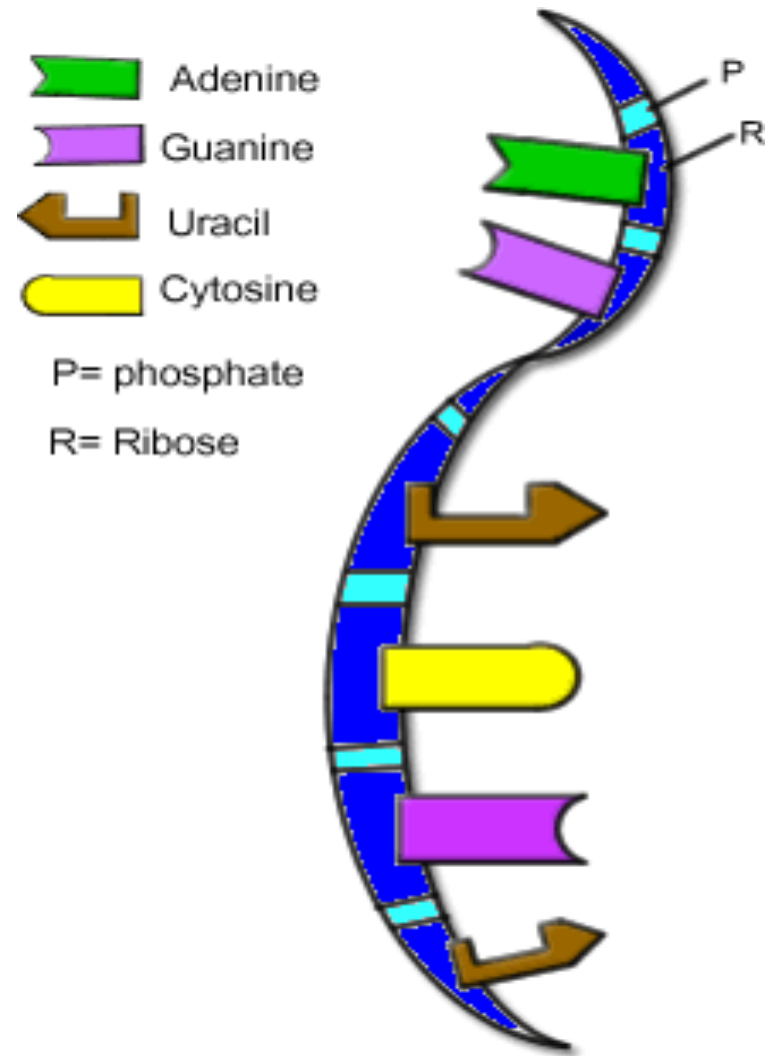


Nucleic Acids: RNA Structure

RNA is typically a single-stranded molecule.

Purine Bases (double ring)
Adenine & Guanine

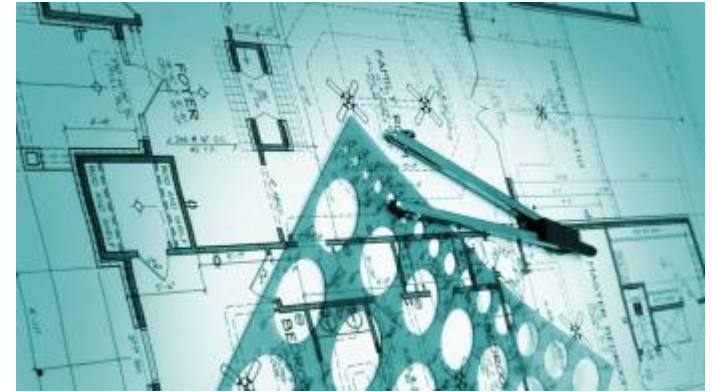
Pyrimidine Bases (single ring)
Cytosine & _____



Types of RNA

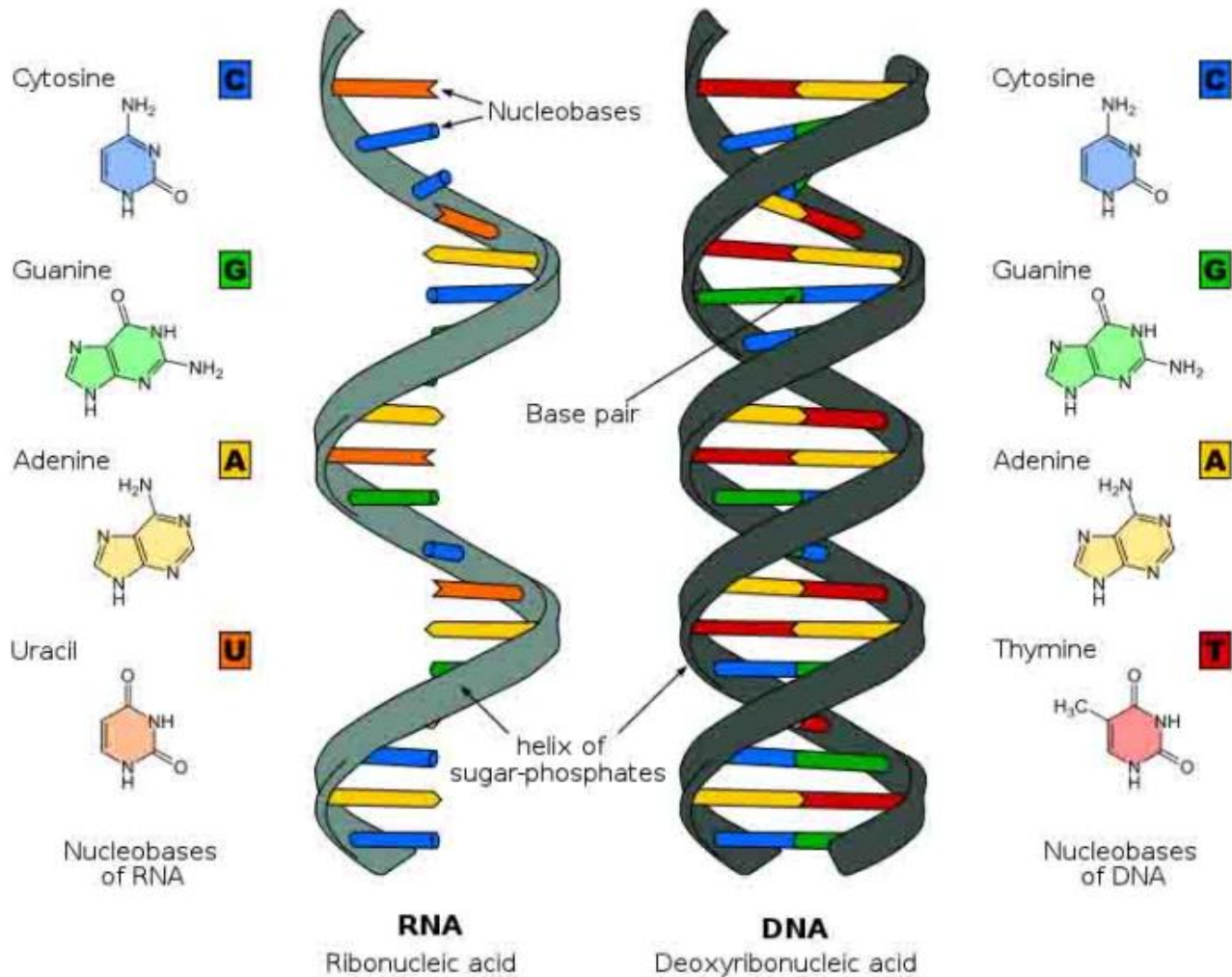
Genetic information copied from DNA is transferred to 3 types of RNA:

- **messenger** (mRNA) is like a Copy of information in DNA that is brought to the ribosome where the information is translated into a protein.
- **ribosomal** (rRNA) is like a The protein factories of the cells.
- **transfer** (tRNA) are like a Brings the amino acid to the ribosome.



Images: Blueprint, clipart; [Factory](#), Andreas Praefcke; [Truck](#), PRA; [Ribosome translating protein](#), Xvazquez.

Nucleic Acid Structure



See SPO Class Notes article on [Nucleotides & Nucleic Acids](#).

Transcription

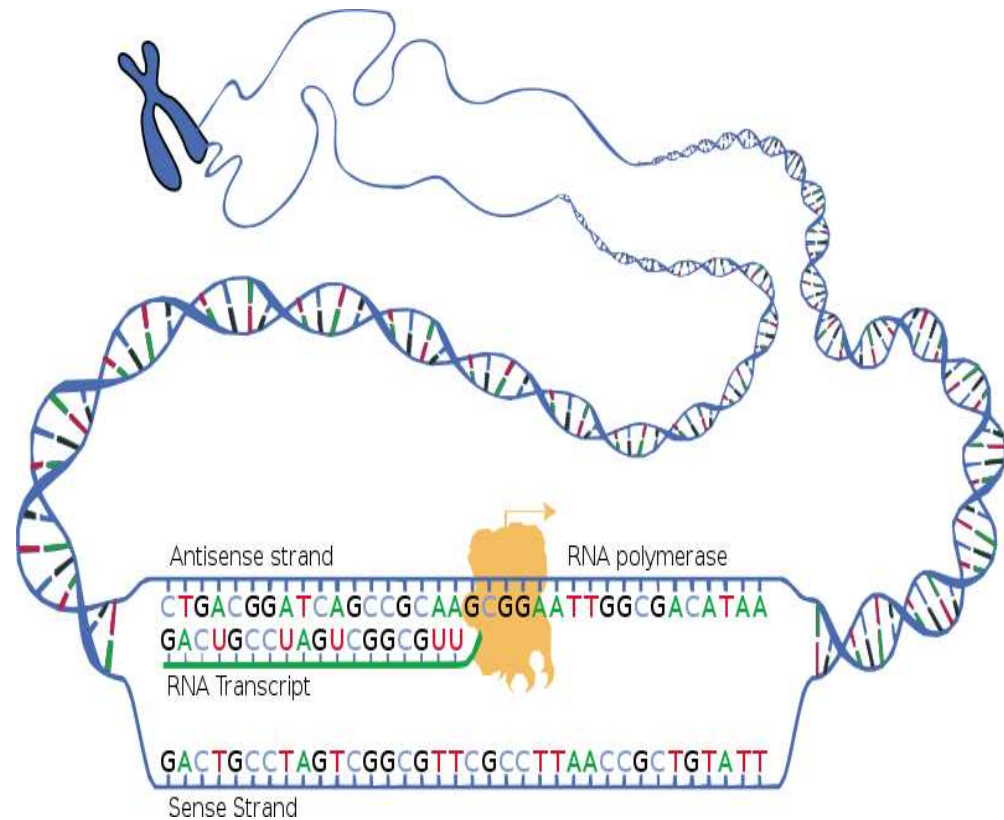
First Step of gene expression.

Process by which a DNA sequence is copied to produce a complementary mRNA strand.

In other words, it is the transfer of genetic information from DNA into RNA.

Like [replication](#), but making RNA.

Beginning of the process that ultimately leads to the translation of the genetic code (via mRNA) into a [protein](#).



REVIEW

Transcription Animations

1. [mRNA Synthesis](#) from McGraw-Hill
2. [Transcription](#) from WH Freeman

Translation

- Second Step of gene expression.
- Ribosomes (which contain rRNA) make proteins from the messages encoded in mRNA.
- The genetic instructions for a polypeptide chain are 'written' in the DNA as a series of 3-nucleotide 'words.'
- _____ on mRNA
- _____ on tRNA
- 'U' (uracil) replaces 'T' in RNA
- This is the **genetic code**.

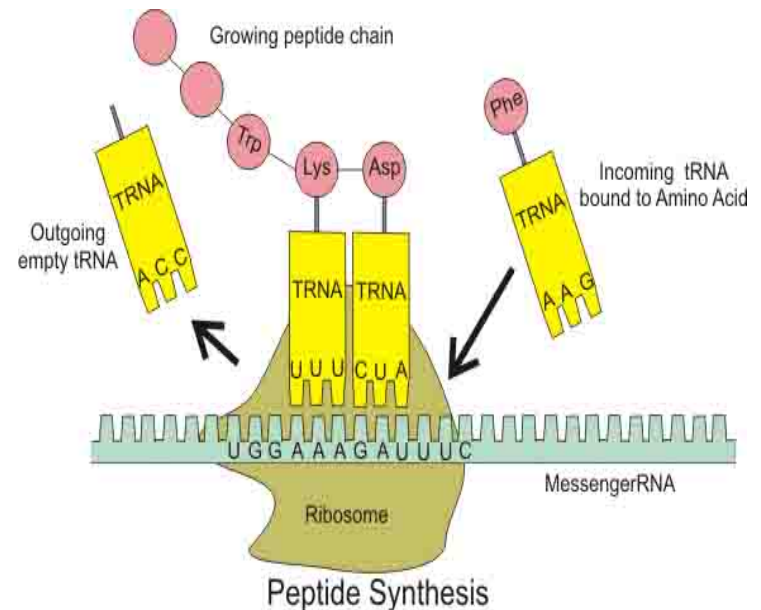
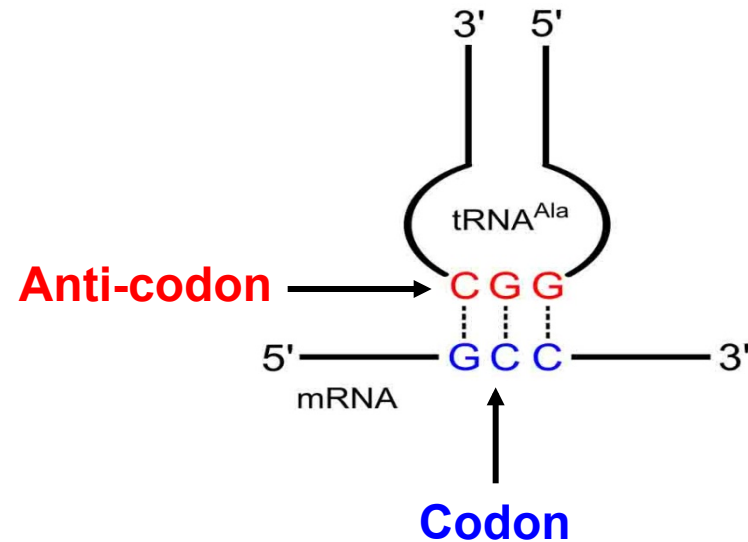
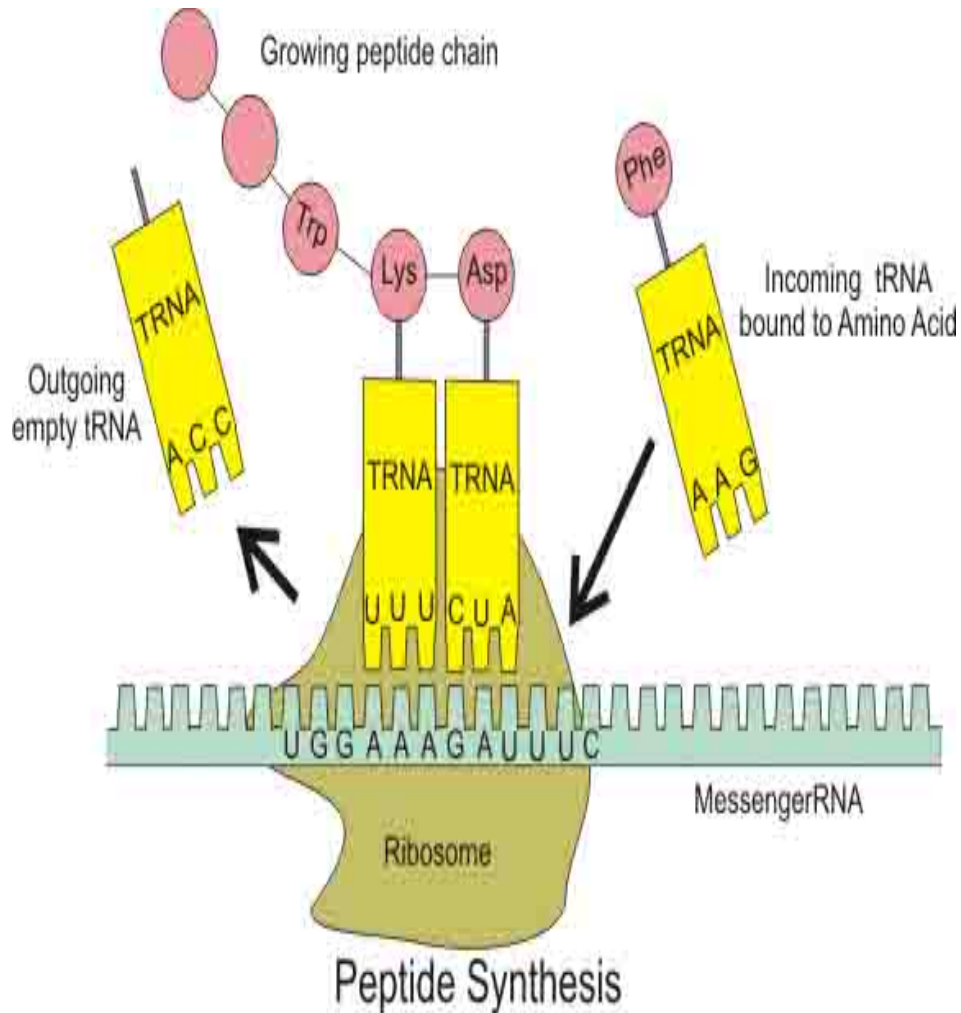


Image: [Codon-Anticodon pairing](#), Yikrazuul, Wiki;
[Peptide Synthesis Diagram](#): Bumphreyfr, Wiki.

Translation

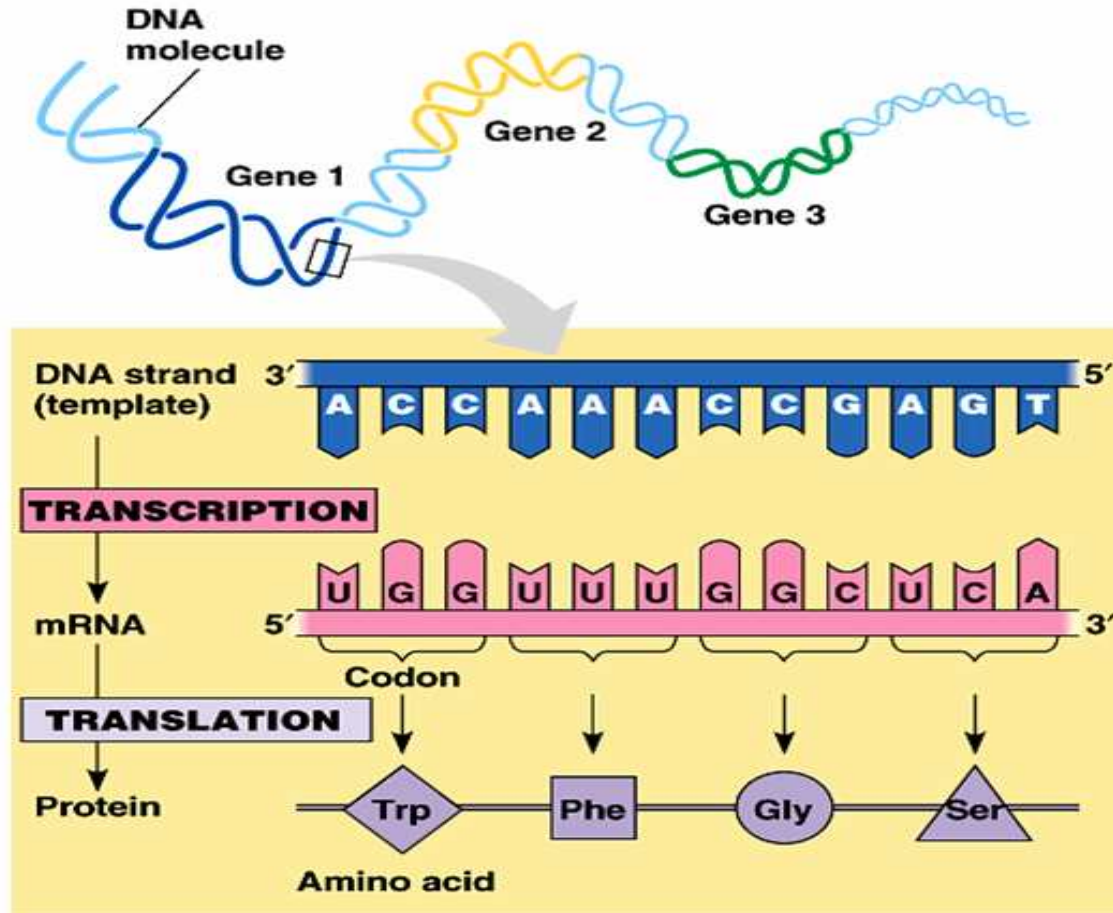


REVIEW

Translation Animations

1. [How Translation Works](#)
from McGraw-Hill
2. [Ribosome Building a Protein](#)
from Wikipedia

Transcription & Translation Overview



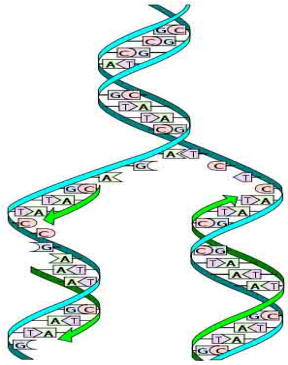
Copyright © Pearson Education, Inc., publishing as Benjamin Cummings.

REVIEW

Interactive animation that allows you to transcribe and translate a gene!

See SPO Class Notes article on [DNA Function: Transcription & Translation.](#)

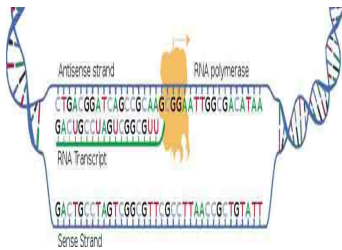
Replication, Transcription, Translation



MAKING DNA

Making a copy of the genetic material = **Replication**
When you think "replication" think "duplication"

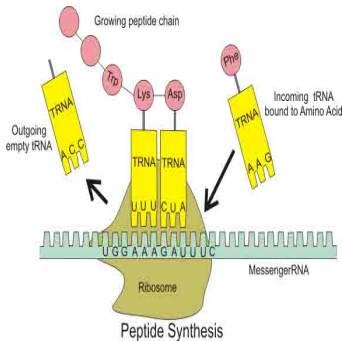
Q: Where does replication occur in prokaryotes? Eukaryotes?



MAKING RNA

Transferring genetic code (DNA) to RNA = **Transcription**
Think of a medical transcriptionist copying the physicians words into another format.

Q: Where does transcription occur in prokaryotes? Eukaryotes?



MAKING PROTEINS

Making proteins = **Translation**

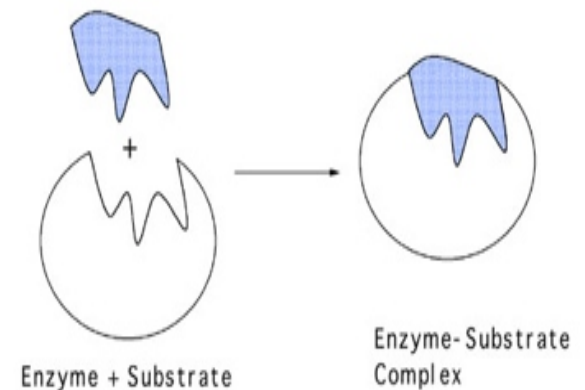
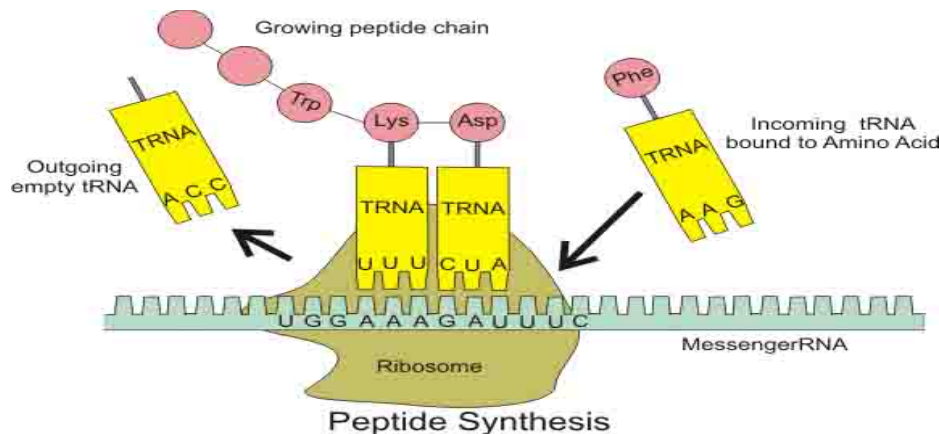
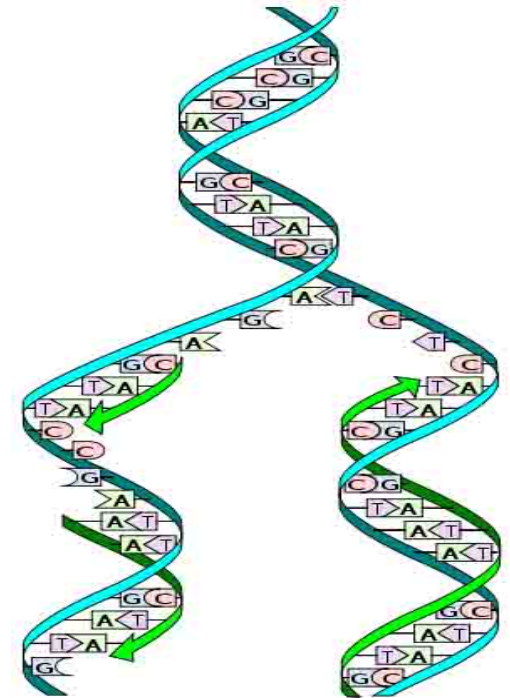
Think of how translation relates to languages.

The translation of DNA translates DNA information into proteins.

Q: Where does translation occur in prokaryotes? Eukaryotes?

Let's put it all together!

1. The order of nucleotide bases in the DNA, in three base groupings (codons), is the genetic code; the "blueprints" of an organism.
2. Mutations result when there is a mistake copying the DNA (replication).
3. DNA is instructions for building proteins (from amino acids).
4. Mutations in the DNA code can result in the wrong amino acid being added to a protein.
5. A different amino acid can change the shape of that protein, and if a protein's shape is changed, it can't do its job.



Genetic Disease: **Cystic Fibrosis** (CF)

Cystic fibrosis (CF) is the most common, fatal genetic disease in the US.

Causes the body to produce thick mucus that clogs the lungs, leads to infection, and blocks the pancreas from delivering digestive enzymes to the intestine.

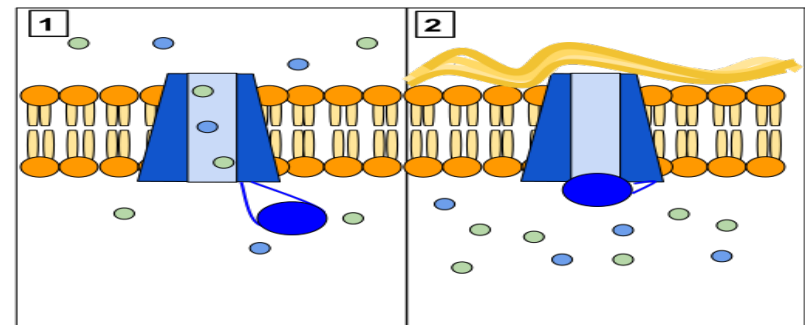
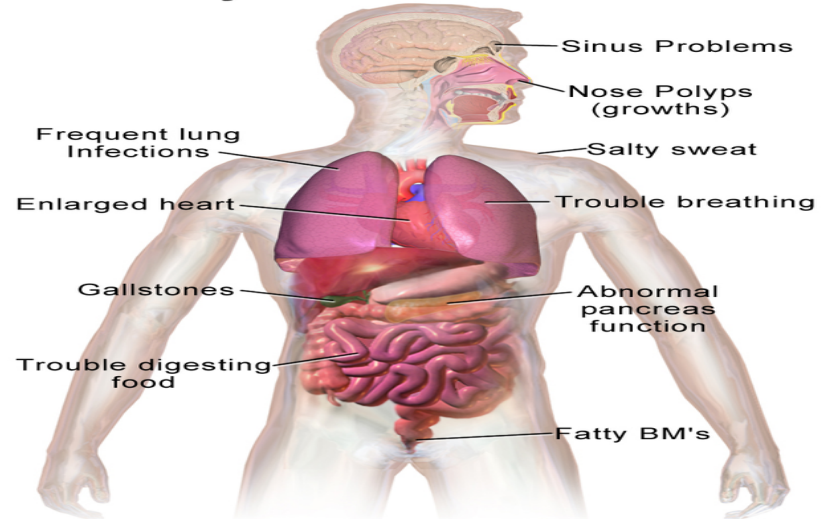
Results from mutations in a single gene: Cystic Fibrosis Transmembrane Regulator (CFTR) gene.

In normal cells, the CFTR channel protein allows cells to release chloride and other ions.

In people with CF, this protein is defective and the cells are not able to release the chloride, resulting in an improper salt balance in the cells and thick, sticky mucus.

Medical research is focusing on ways to cure CF by correcting the defective gene, or correcting the defective protein.

Health Problems with Cystic Fibrosis



CFTR channel protein controls flow of H₂O and Cl⁻ inside the lungs. When this protein is working correctly (Panel 1) ions can flow in and out of the cells. But, when the CFTR protein is blocked (Panel 2) these ions cannot flow out of the cell due.

Genetic Disease: Sickle Cell Disease

Most common inherited blood disorder in the United States.

In the US, sickle cell disease is most prevalent among African Americans.

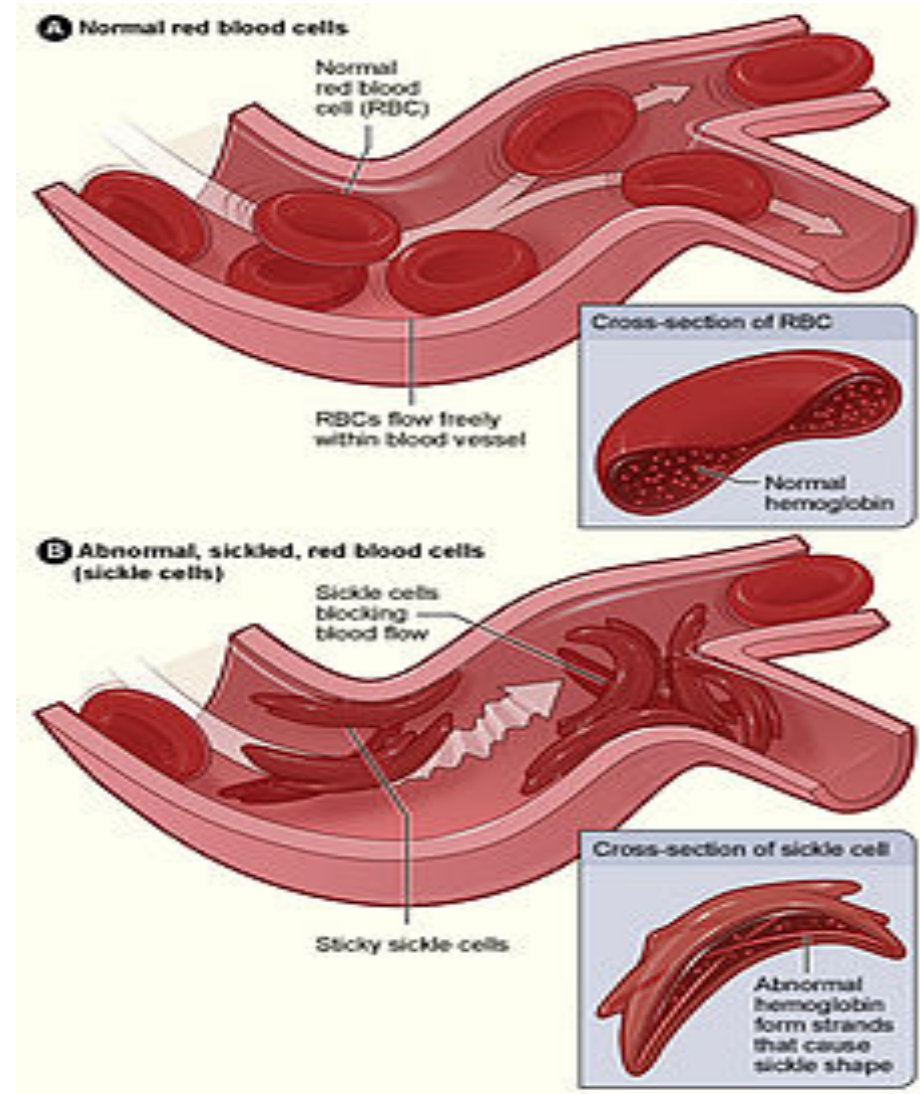
Caused by a mutation in the hemoglobin-Beta gene found on chromosome 11.

Hemoglobin transports oxygen from the lungs to other parts of the body.

Red blood cells with normal hemoglobin (hemoglobin-A) are smooth and round and easily flow through blood vessels.

People with this disease have abnormal hemoglobin molecules that stick to one another and cause red blood cells to become sickle shaped and pile up, rather than flow, causing blockages and damaging vital organs and tissue.

People who only carry the sickle cell trait typically don't get the disease, but can pass the defective gene on to their children.



What is Epigenetics?

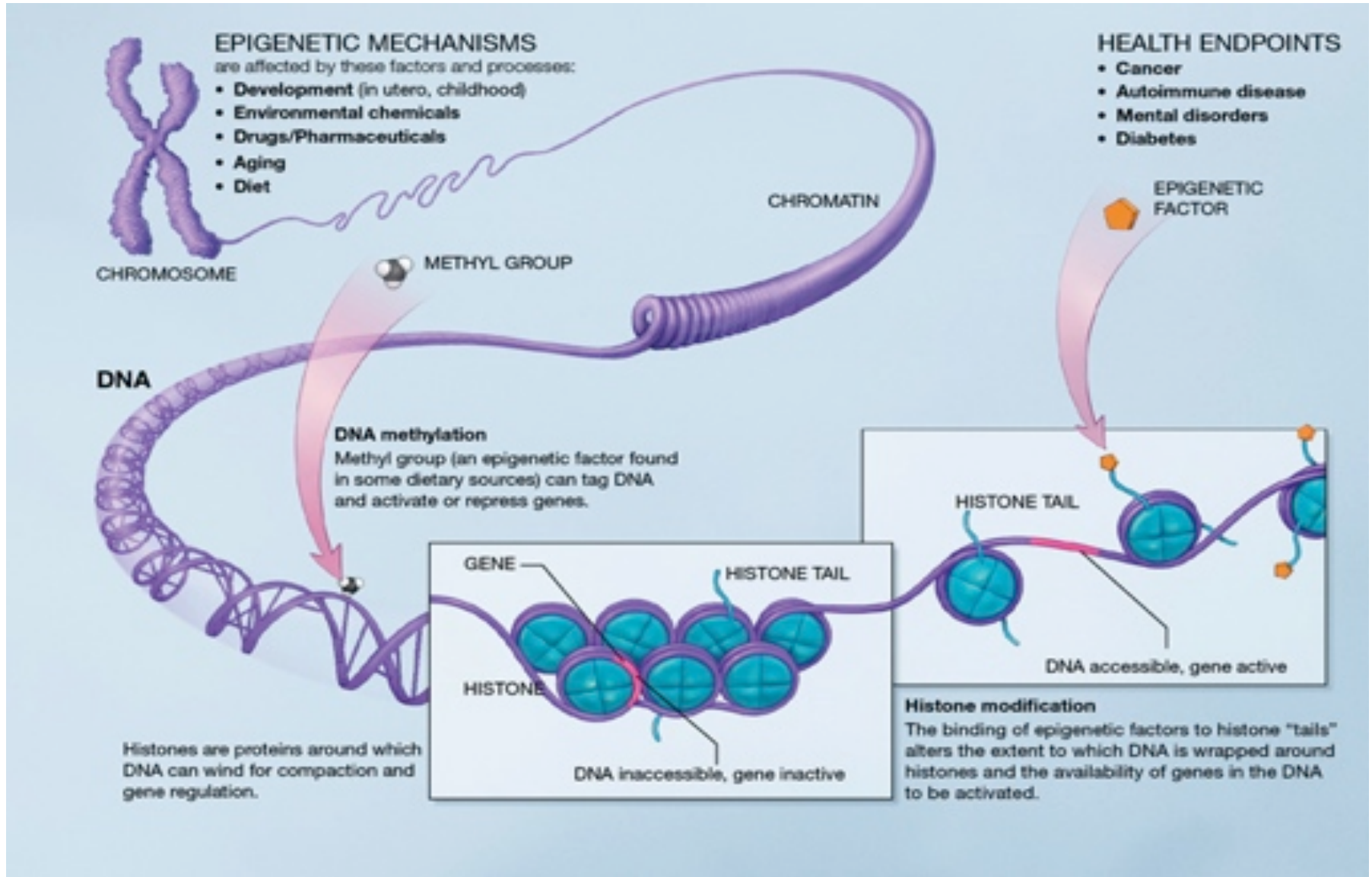
Heritable changes in gene expression that do not involve changes to the DNA sequence

A change in **phenotype** without a change in **genotype**.

Epigenetic change can be influenced by several factors including age, environment, lifestyle, and disease.



What is Epigenetics?



Confused?

Here are links to fun resources that further explain genetic transcription & translation:

Smart Links



- [Molecular Genetics: Replication](#) Main Page on the Virtual Cell Biology Classroom of [Science Prof Online](#).
- ["That Spells DNA"](#) song by Jonathan Coulton.
- [DNA Structure](#) Cell Biology Animation from John Kyrk.
- [Build a DNA Molecule](#) from University of Utah.
- [DNA Replication](#) animation and review questions.
- [DNA Replication Process](#) animated video by FreeScienceLectures.com.
- [DNA Replication](#) step-through animation by John Kyrk.
- [Transcription & Translation](#) Main Page on the Virtual Cell Biology Classroom of [Science Prof Online](#).
- [DNA Transcription](#) step-through animation by John Kyrk.
- [Transcribe & Translate a Gene](#), from University of Utah.
- [DNA Transcription and Protein Assembly](#) animated movie by RedAndBrownPaperBag.
- [Transcription and Translation](#) animated movie from PBS production "DNA: The Secret of Life."

(You must be in PPT slideshow view to click on links.)