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.

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

Image: Compound microscope objectives, T. Port

Molecular Genetics

DNA Replication

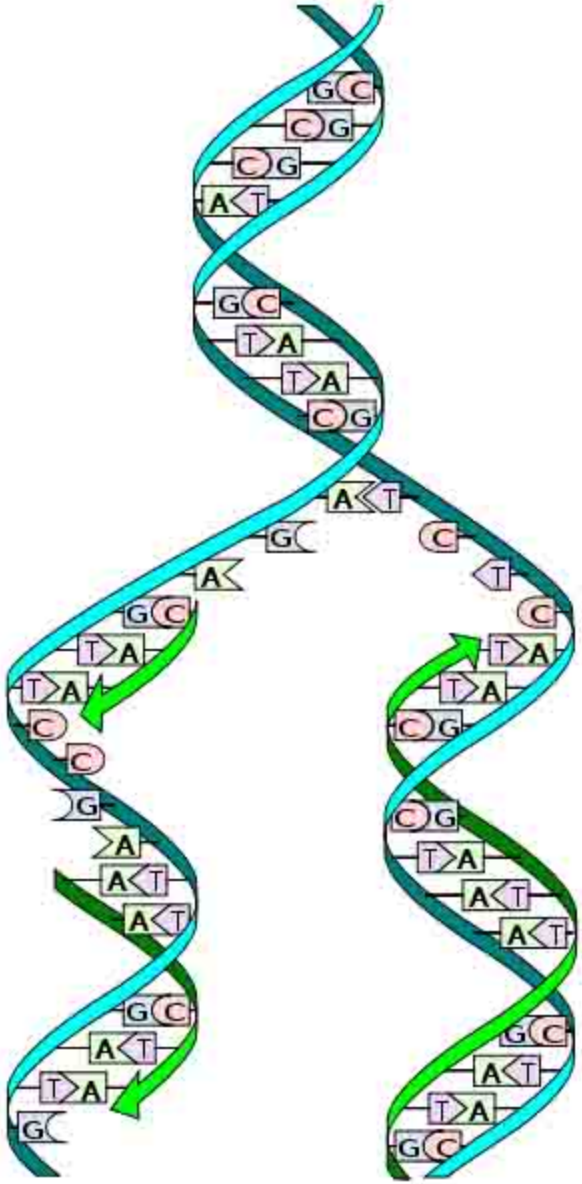
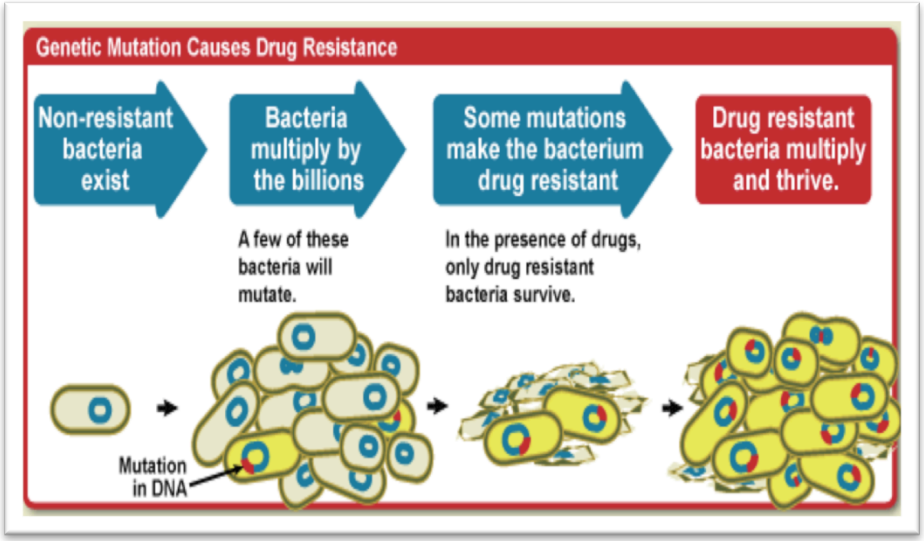


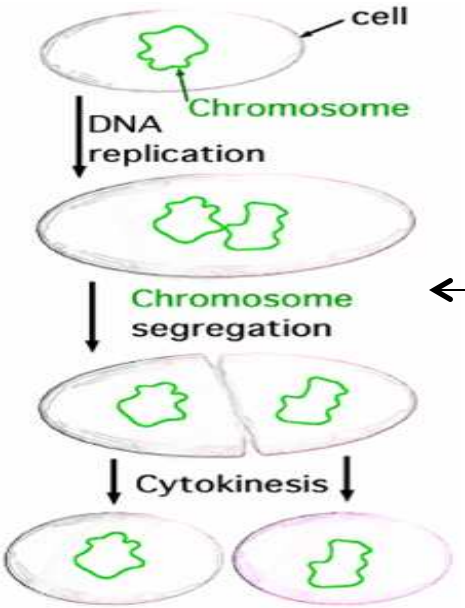
Image: Replication Diagram: Madprime

Everyday Biology

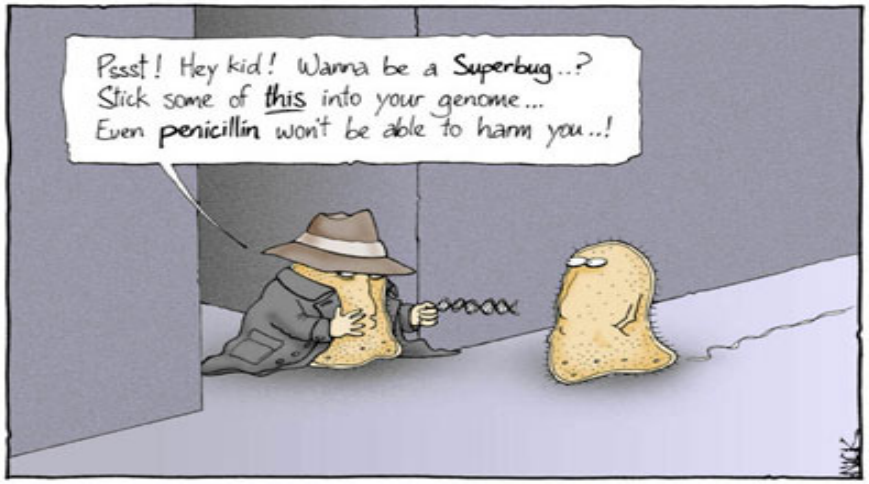
How do bacteria become resistant to antibiotics?



Genes for antibiotic resistance arise through DNA **mutations** (mistakes when copying DNA).



These resistance genes spread as resistant **bacteria multiply** *and* **through horizontal gene transfer**.



Q: How would overuse and incorrect use of antibiotics contribute to antibiotic resistance in bacteria?

Images: Drug resistance, NIAID; Binary Fission, JW Schmidt; Bacterial conjugation by Adenosine

Prokaryotic Genomes

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

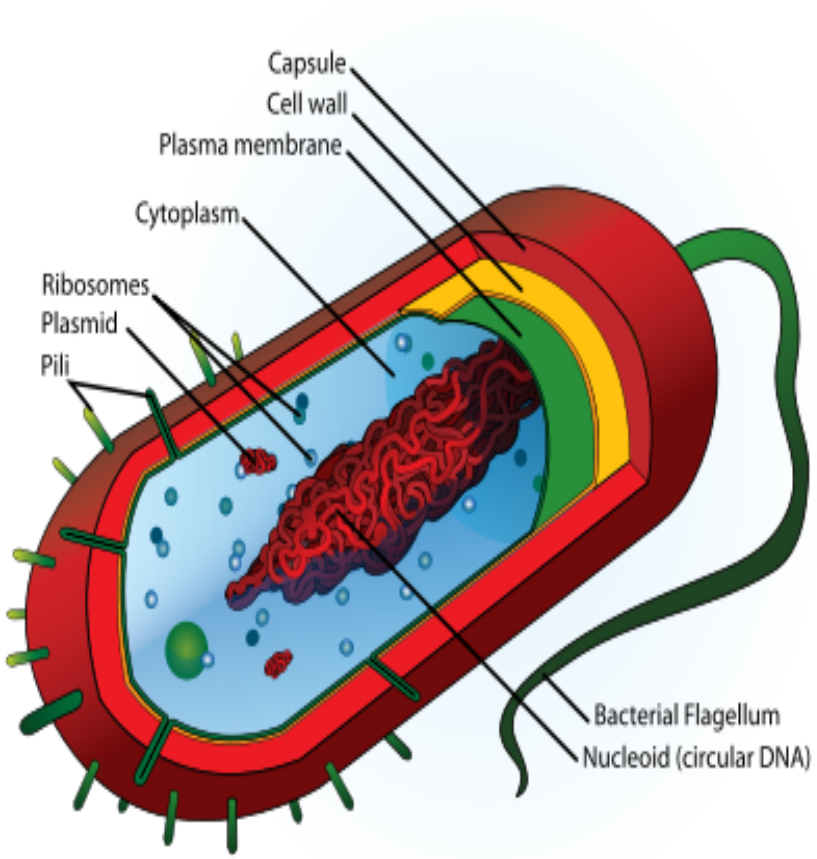


Image: Prokaryotic Cell Diagram: Mariana Ruiz

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?)

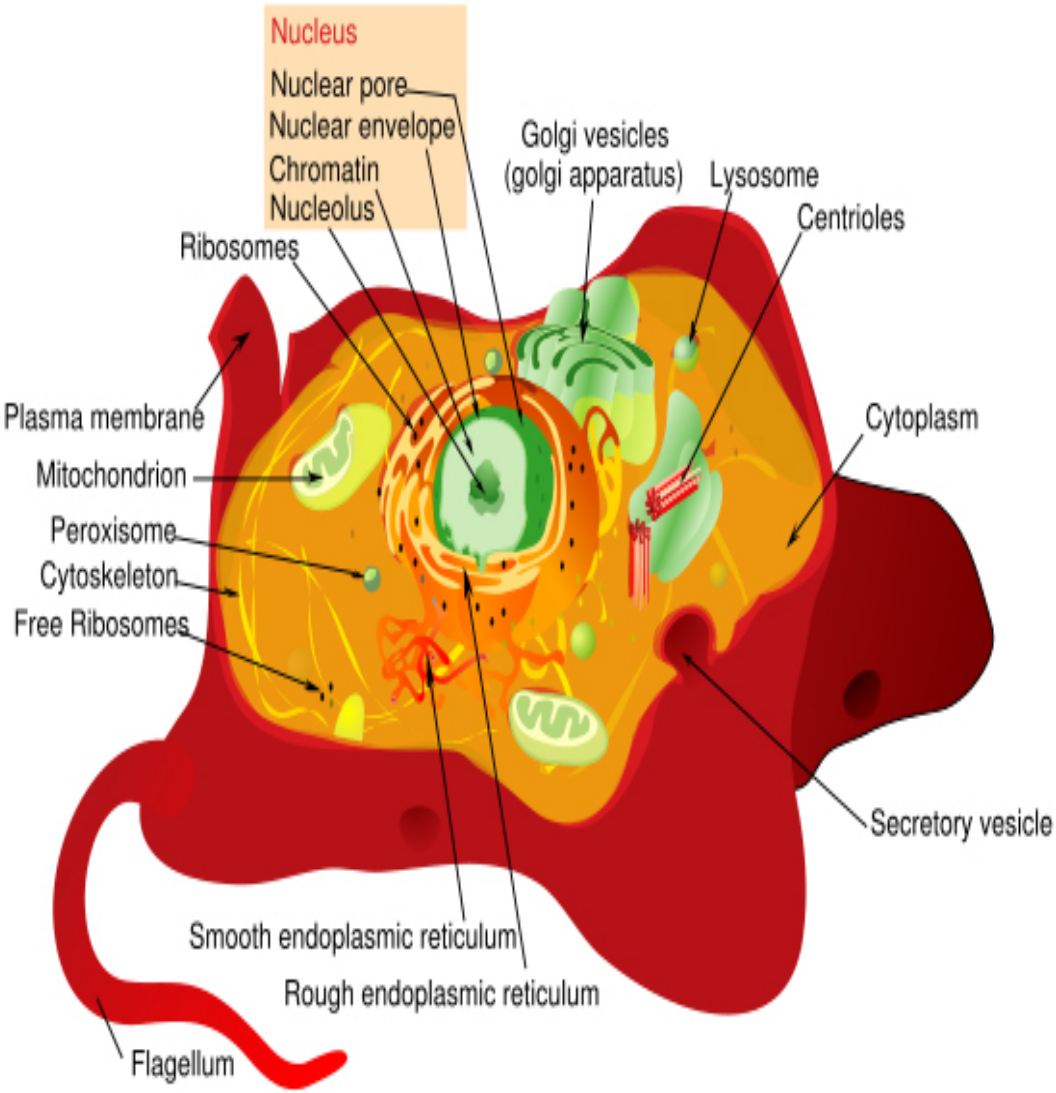
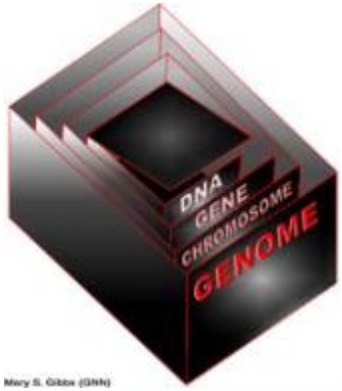


Image: Eukaryotic Cell Diagram, Mariana Ruiz

Chromosomes & Genes

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



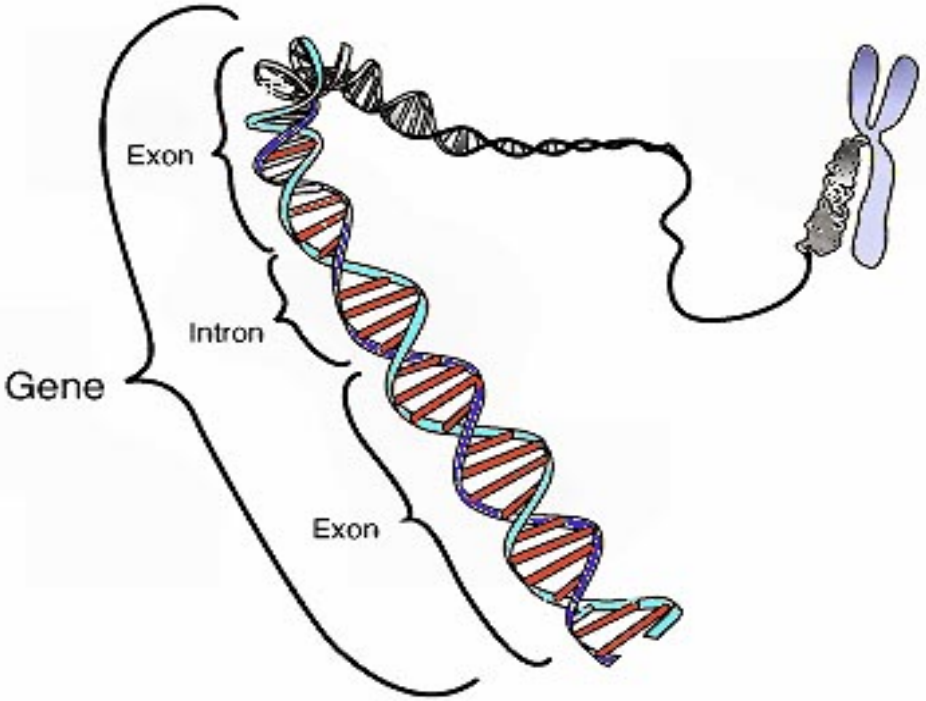


Image: Chromosome & gene, Graham Colm, National Human Genome Research Institute

From the Virtual Cell Biology Classroom on ScienceProfOnline.com

Nucleotides and Nucleic Acids

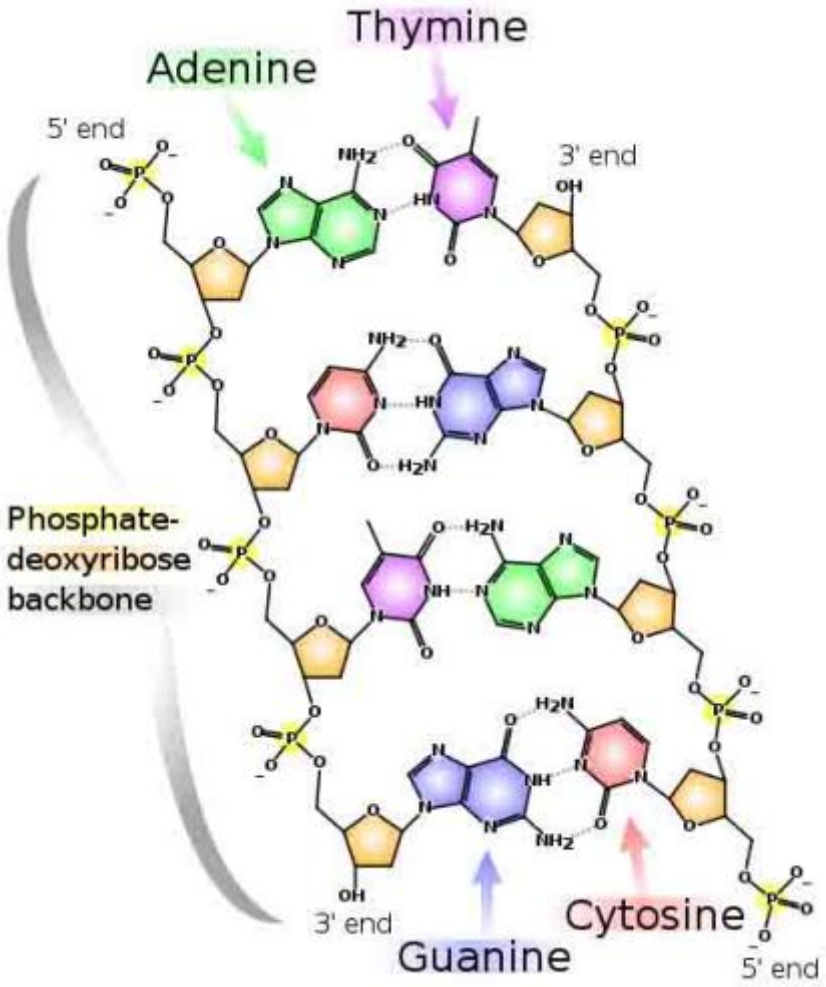


Image: DNA Detail Diagram: Madprime

Nucleic Acids

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

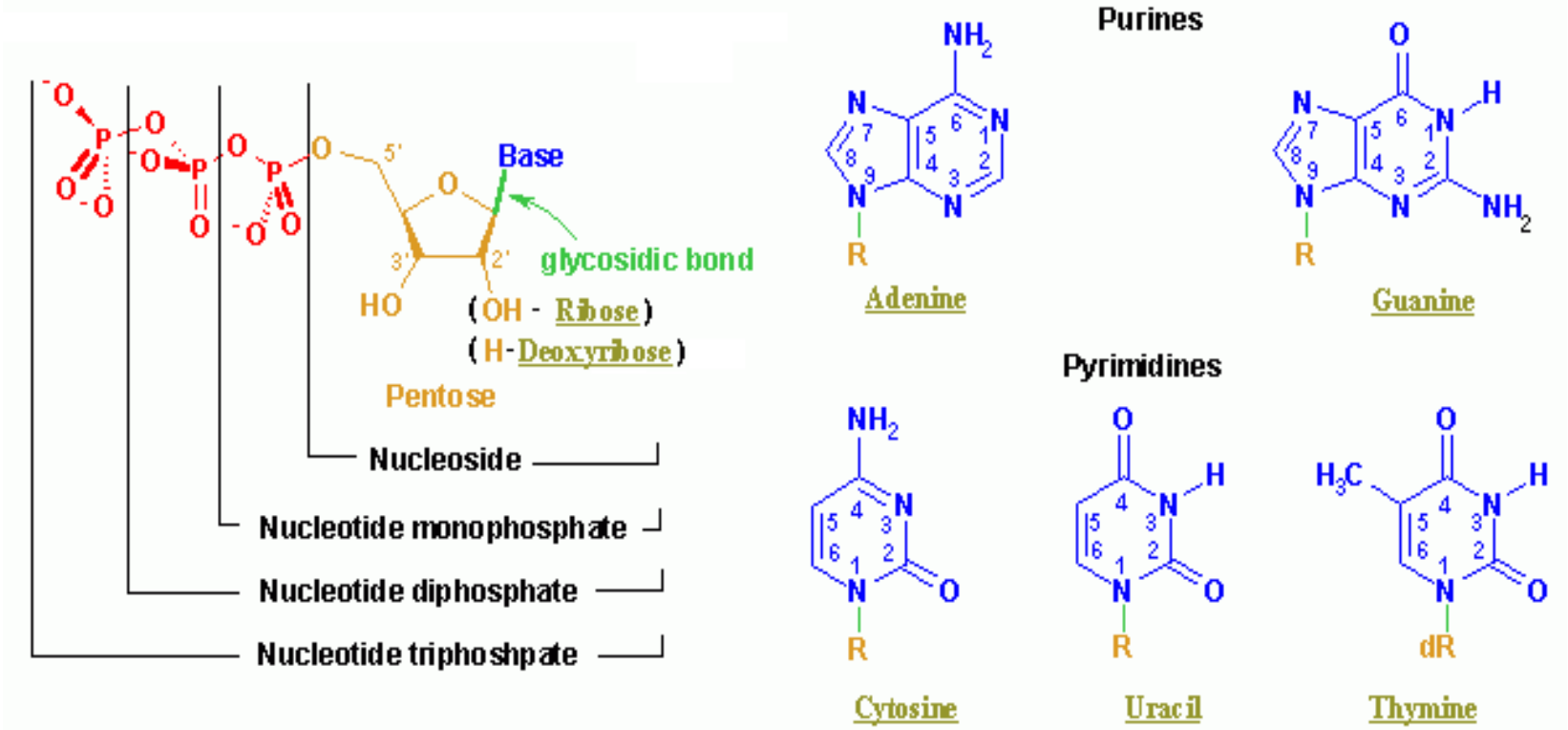


Image: Nucleotide Structure, Wikipedia

DNA Structure

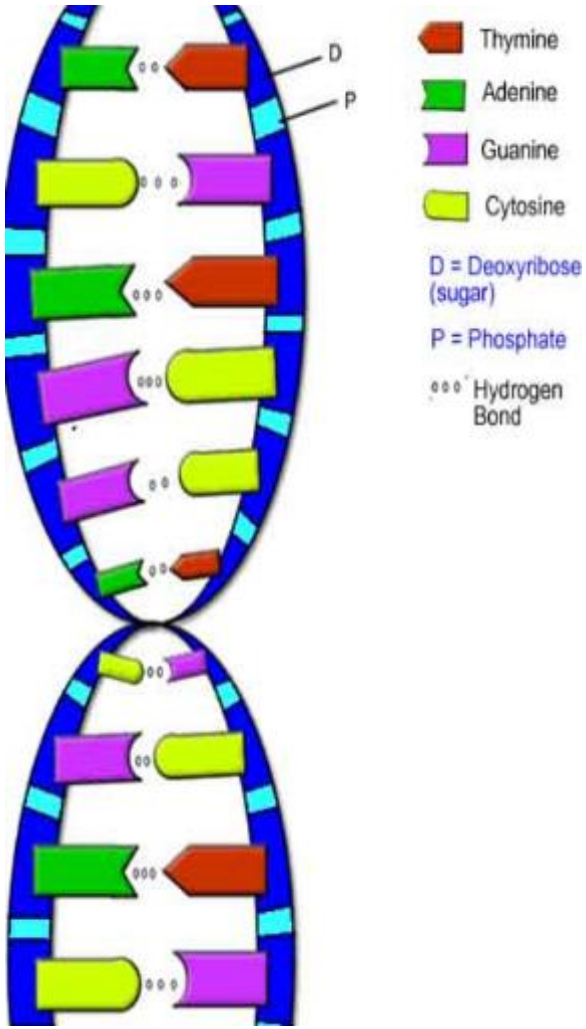
- Double stranded molecule, analogous to a spiral staircase:

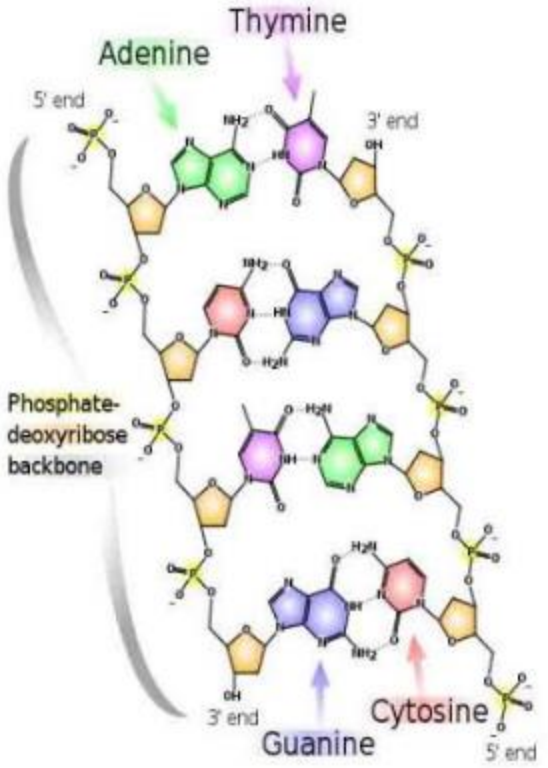
  - two deoxyribose-phosphate chains as the "**side rails**"

  - 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

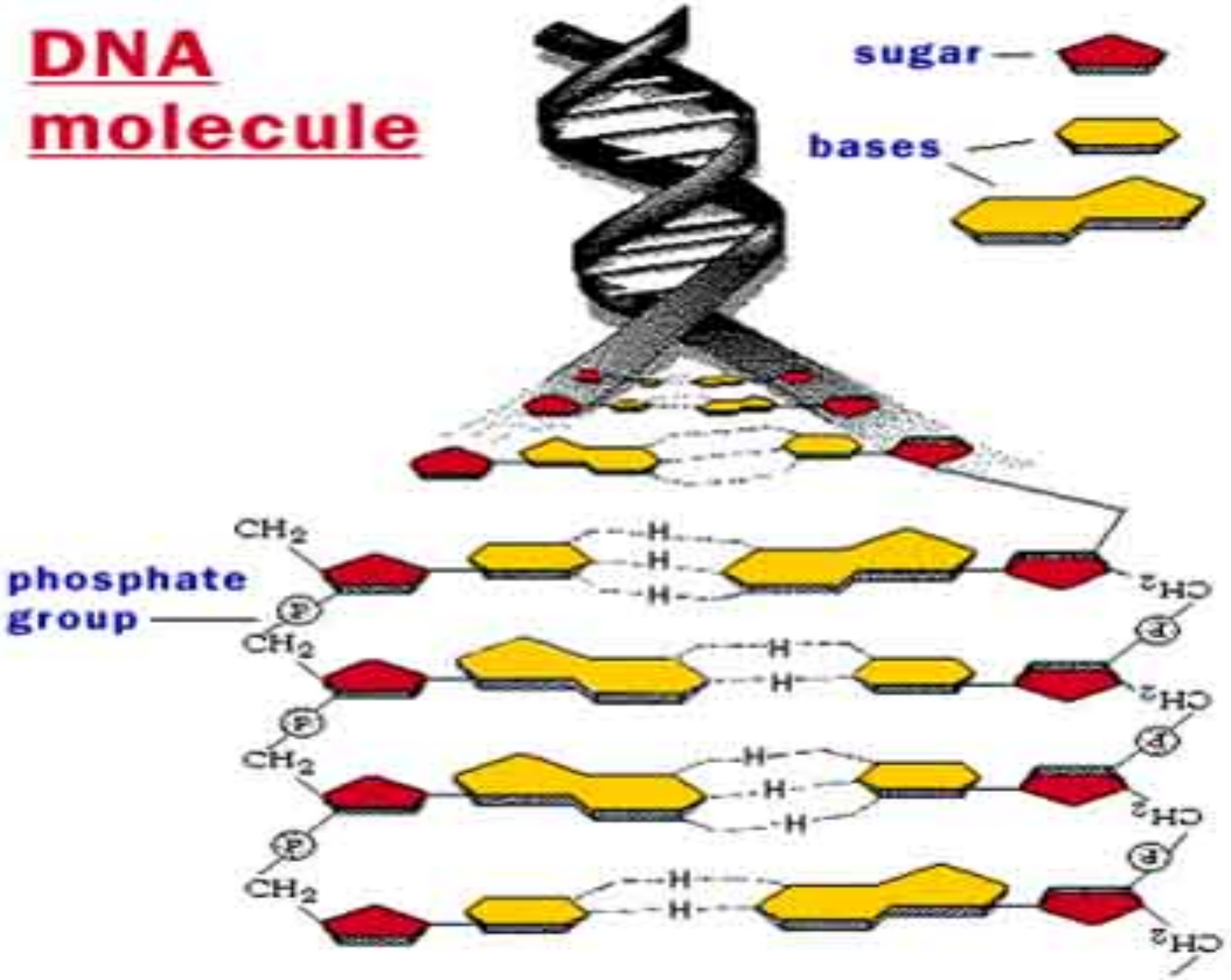


Image: DNA molecule, Why Files, NSF

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?**

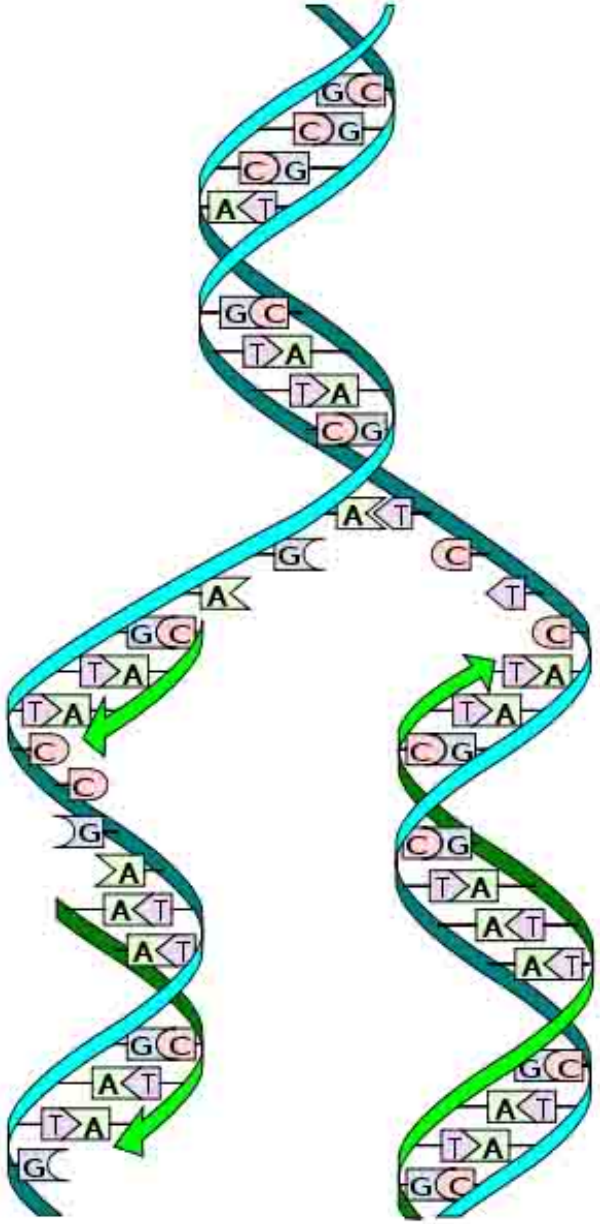
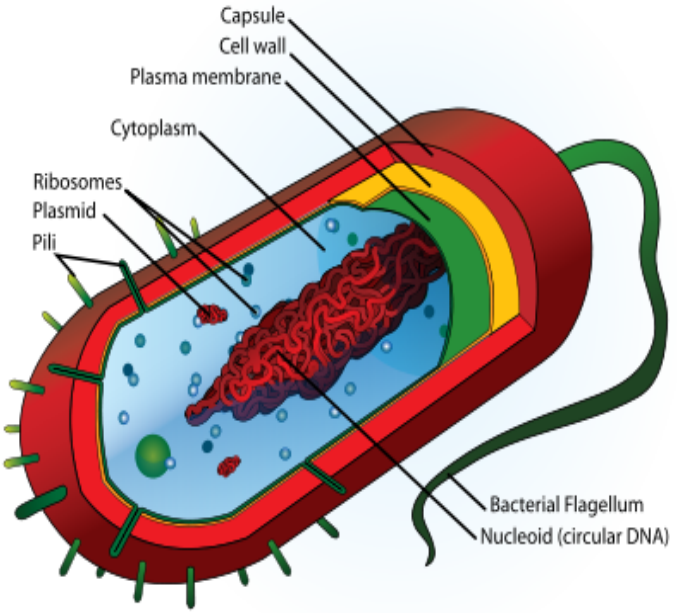


Image: Replication Diagram: Madprime, Wiki

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.

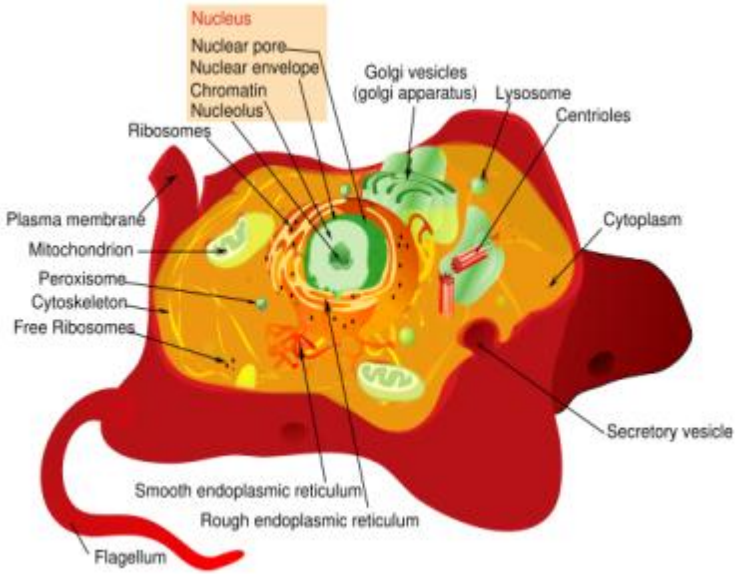
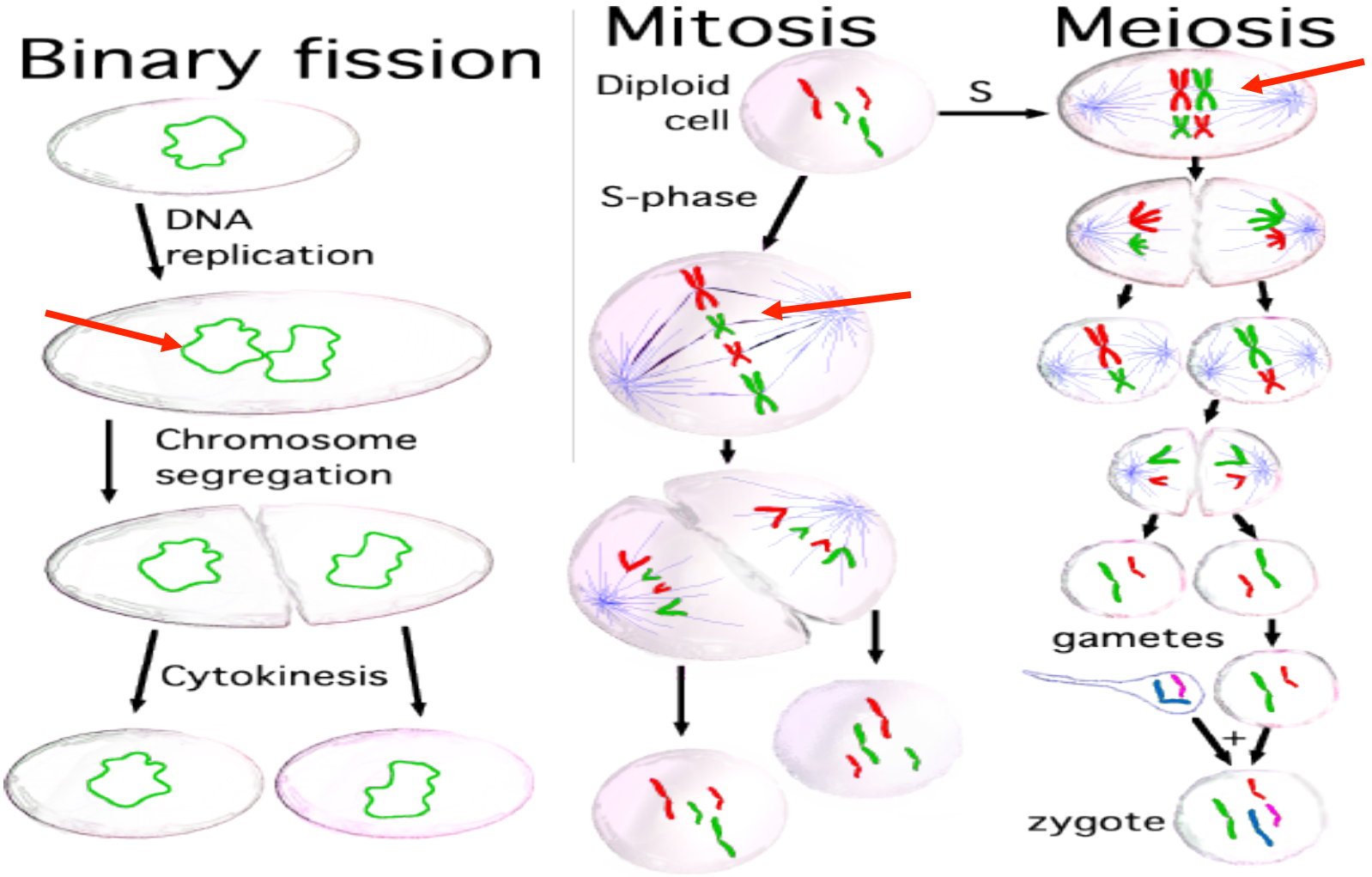


Image: Prokaryotic Cell Diagram & Eukaryotic Cell Diagram, Mariana Ruiz

DNA Replication

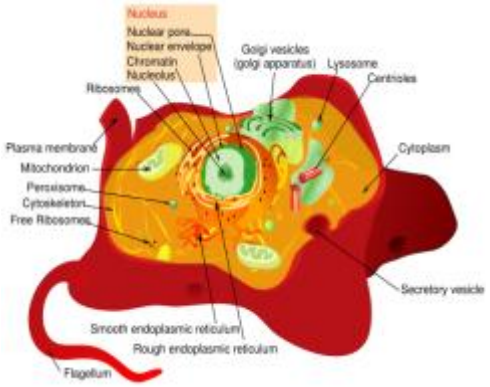


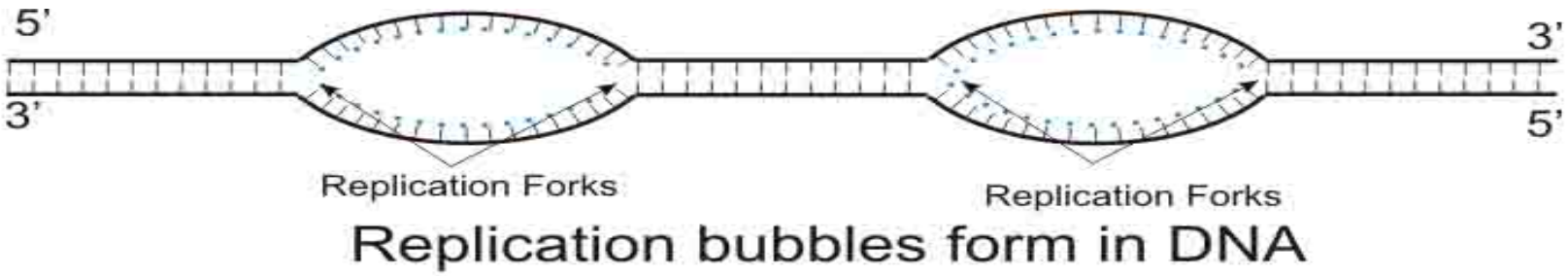
From the Virtual Cell Biology Classroom on ScienceProfOnline.com

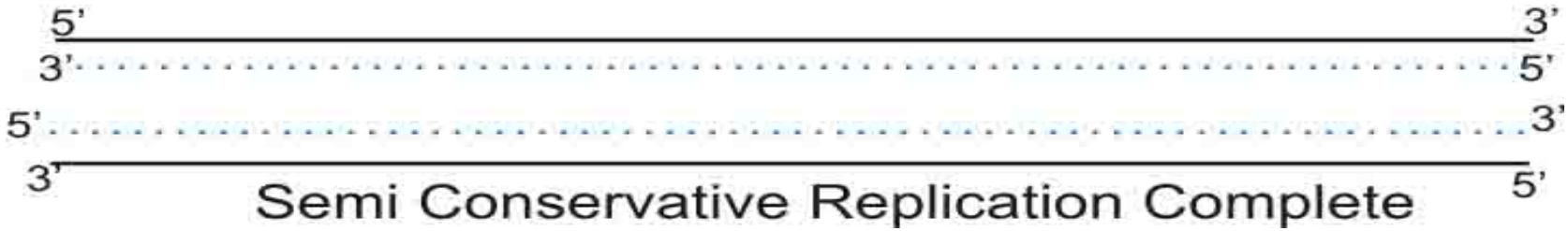
Image: Types of Cell Division, Saperaud Wiki

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.



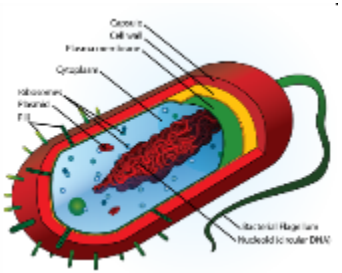




From the Virtual Cell Biology Classroom on ScienceProfOnline.com

Image: Eukaryotic Cell Diagram, Mariana Ruiz; Replication Bubbles Boumphreyfr, Wiki

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.

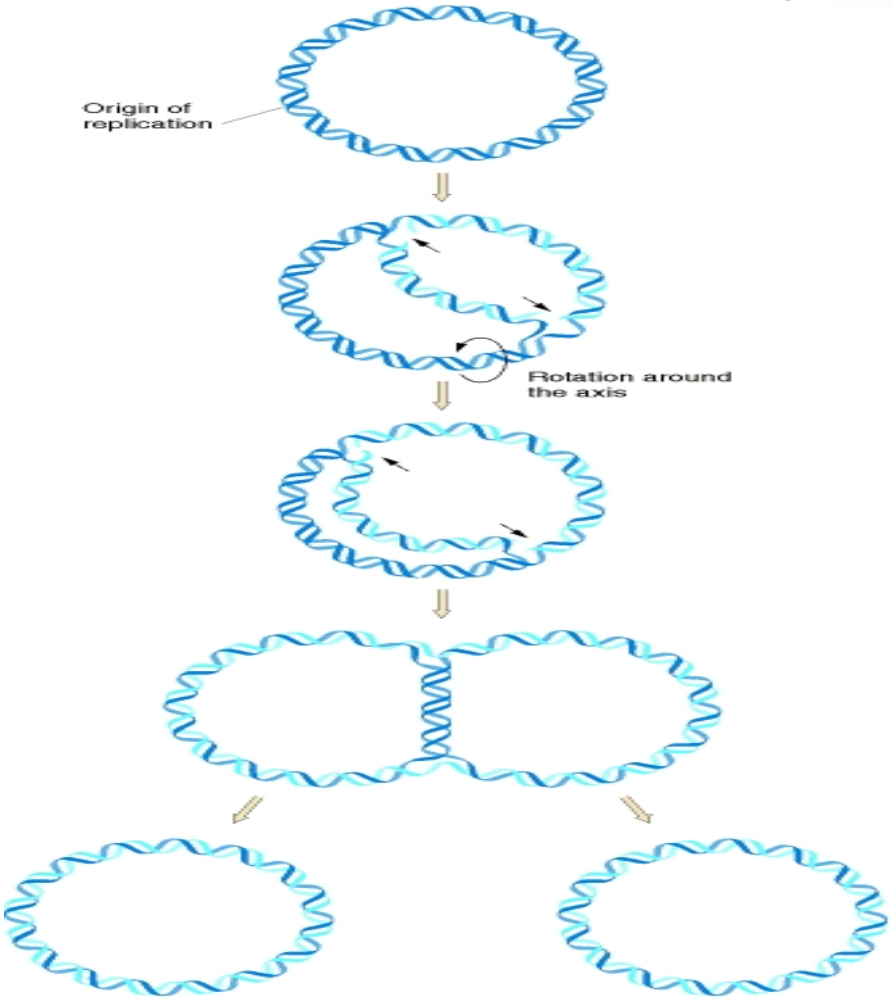


Image: Prokaryotic Replication, U.S. National Library of Medicine

How Do Nucleotides Put Themselves Together Into Nucleic Acids?

- An **anabolic polymerization** process.

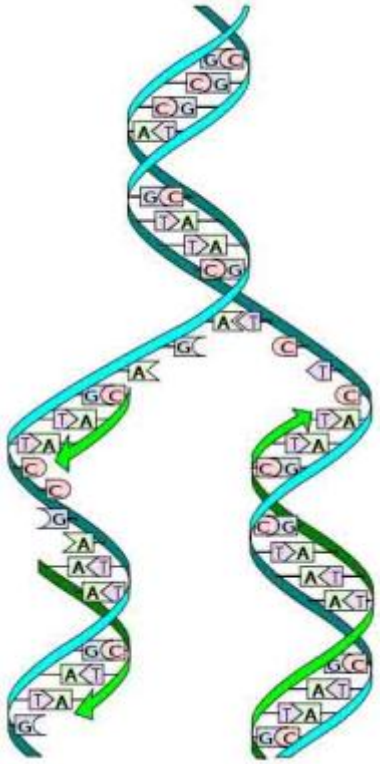
  Q: Anabolic or Anabolism is….? _____

  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.



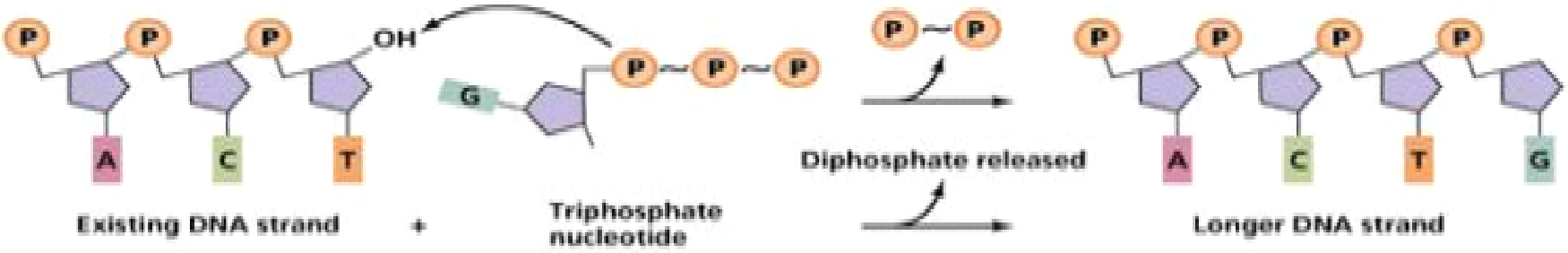


Image: Replication Diagram: Madprime, Wiki

DNA Replication: Anti-parallel Nature of DNA

- Sugar/phosphate backbone runs in opposite directions.
- One strand runs 5′ to 3′, while the other runs 3′ to 5′.
- ***DNA polymerase***: enzyme that facilitates addition of nucleotides in building the new DNA strand.
- Can only adds nucleotides at the free 3′ end.

Q: Why is this important?

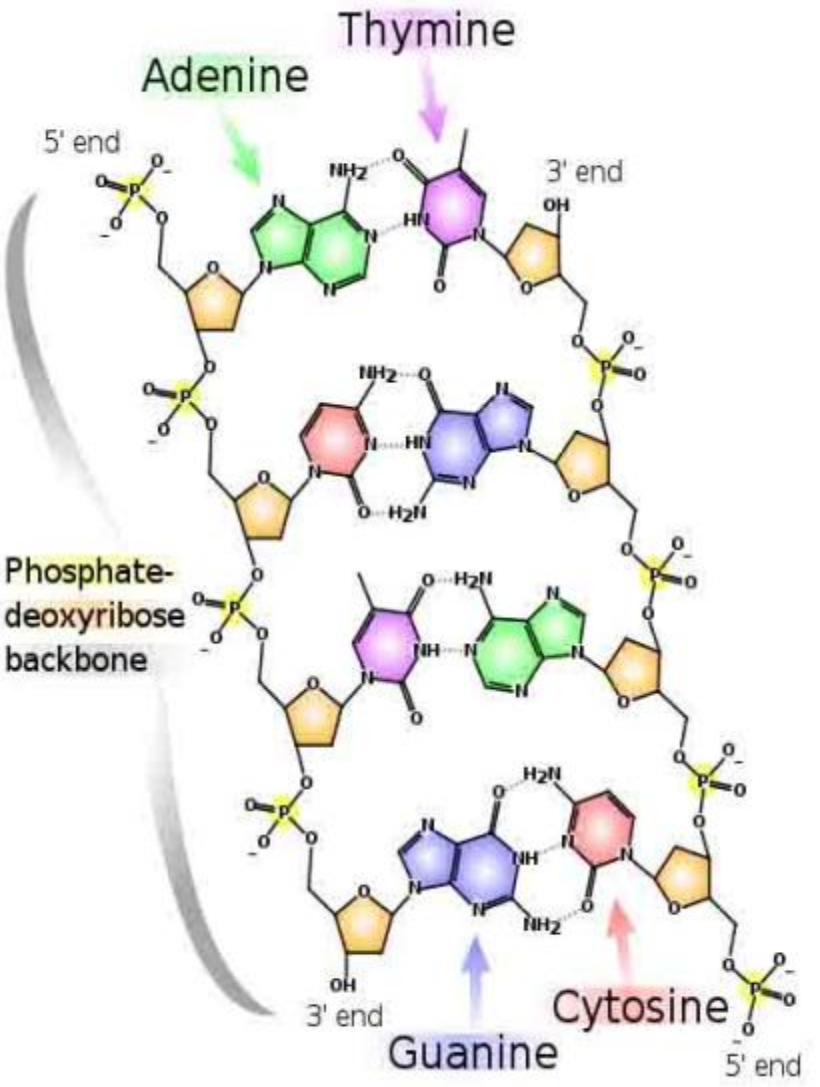


Image: DNA Detail Diagram: Madprime

From the Virtual Cell Biology Classroom on ScienceProfOnline.com

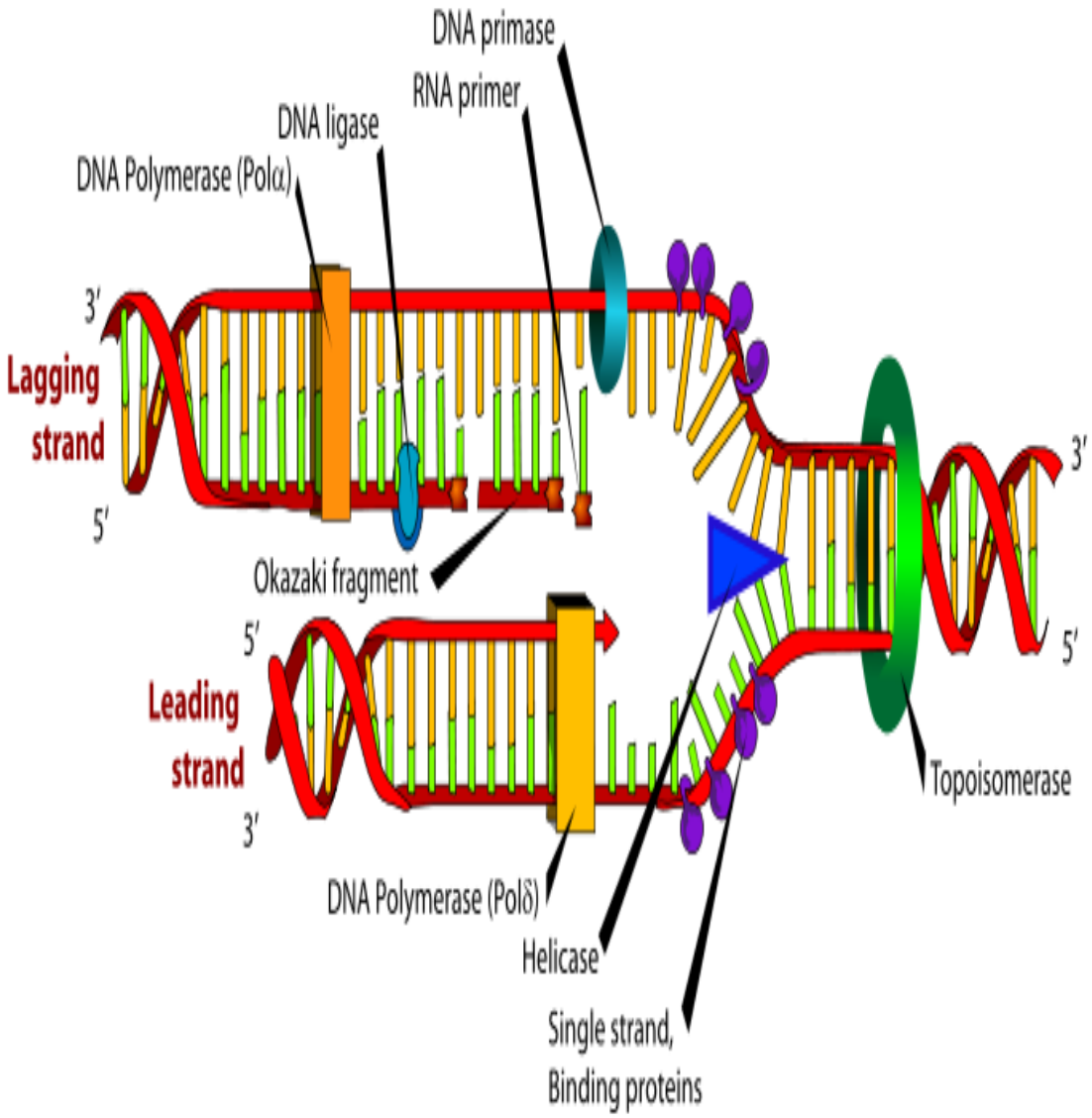
DNA Replication: Leading & Lagging Strand

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

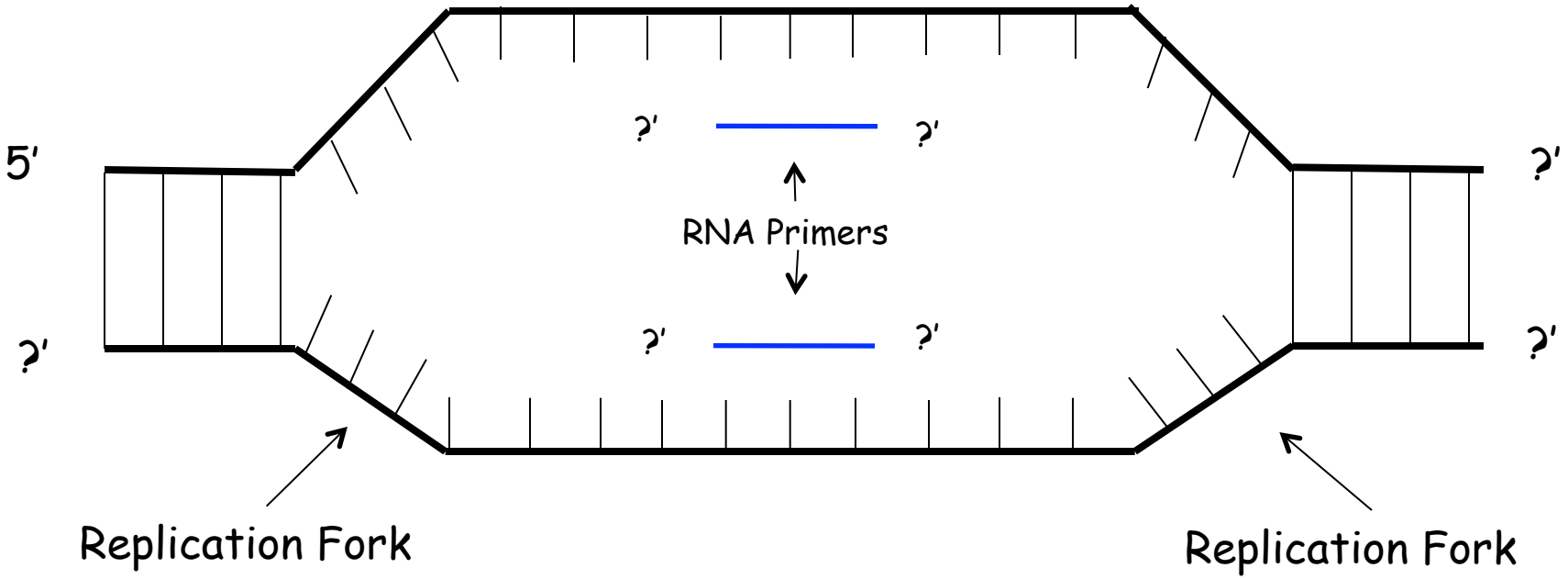
DNA Replication Animations
from McGraw-Hill

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".

Replication Fork Diagram: Mariana Ruiz

From the Virtual Cell Biology Classroom on ScienceProfOnline.com

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



Now lets 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.

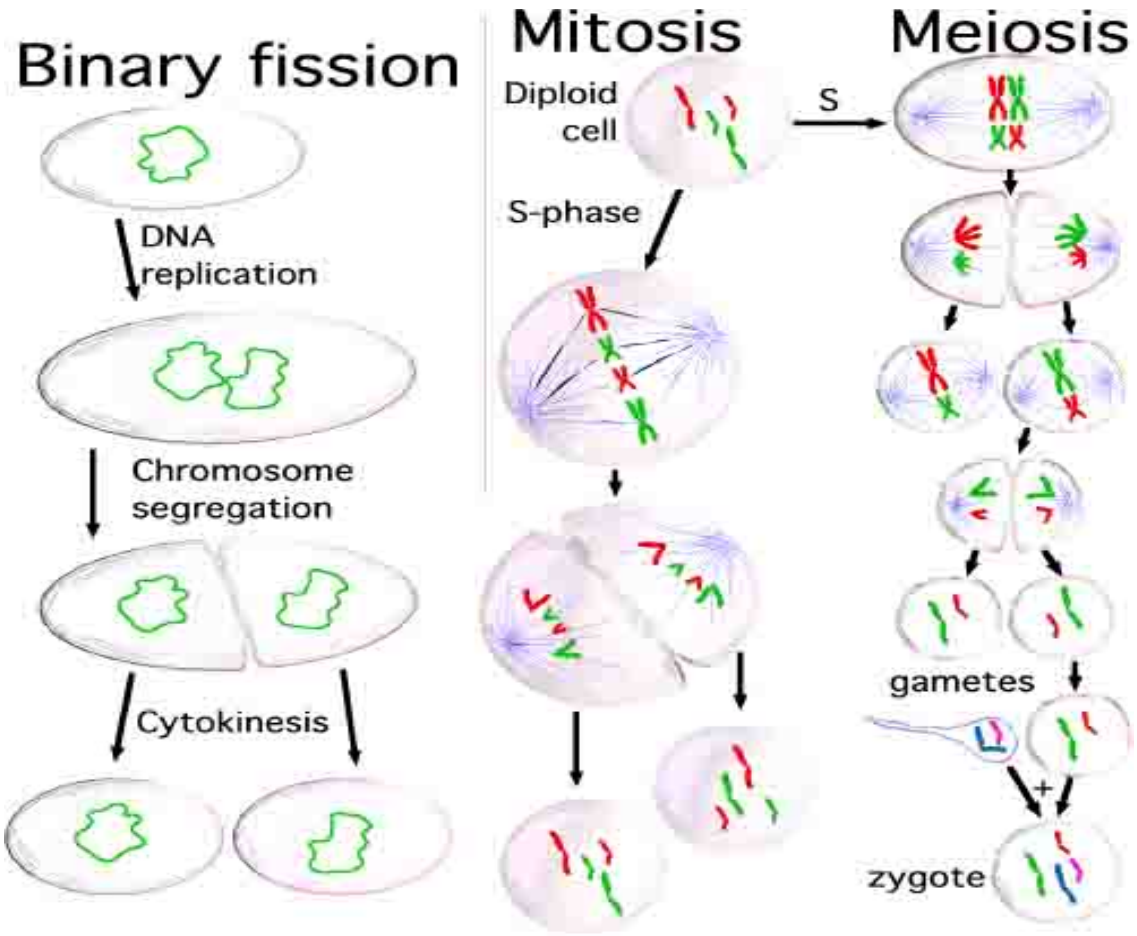
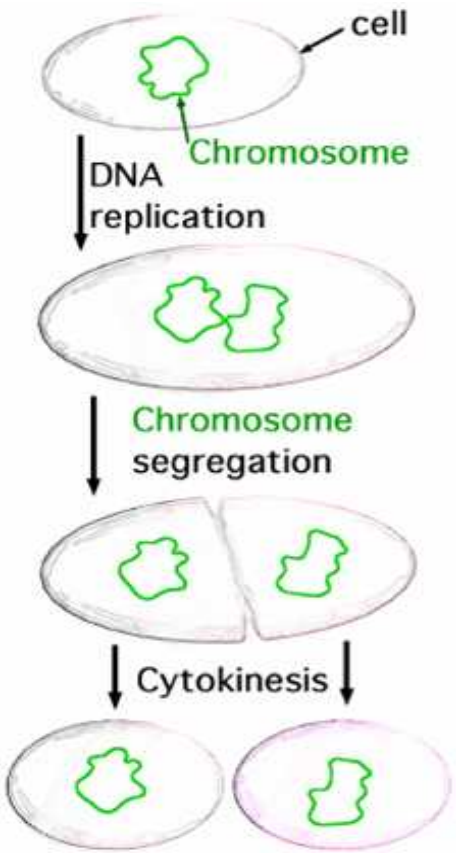


Image: Types of Cell Division, Saperaud Wiki

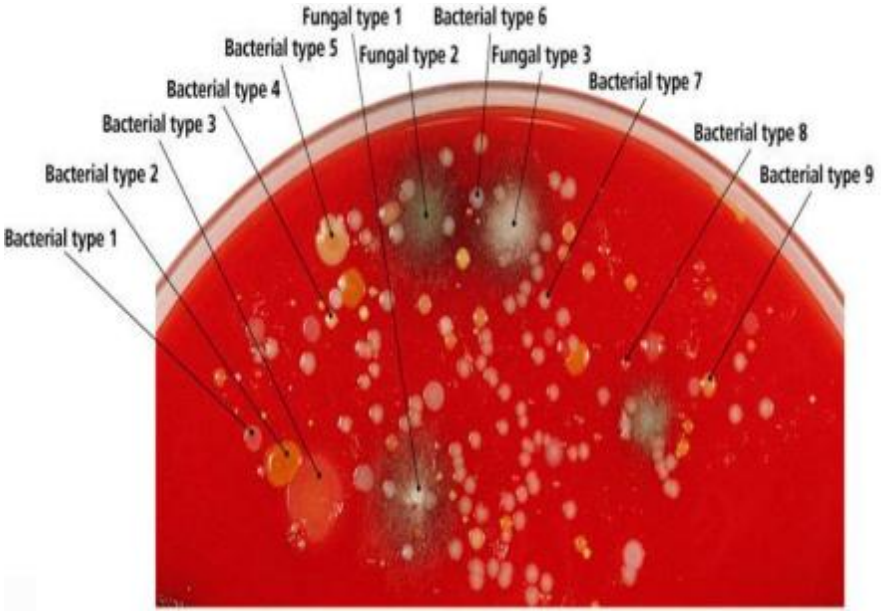
Genetic Diversity in Prokaryotes

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)?**



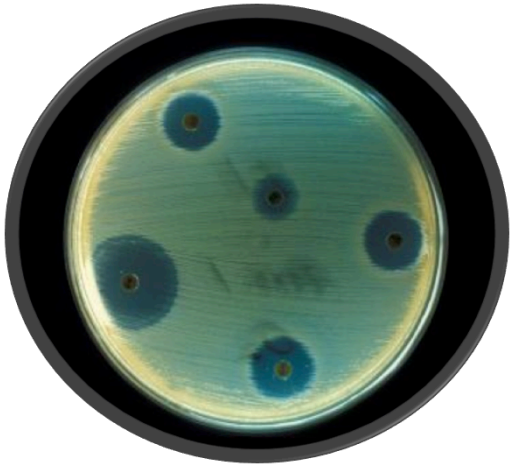
Images: Binary Fission, JW Schmidt

Replication Mistakes: Mutations of Genes

- Change in the nucleotide base sequence of a genome; rare.
- Almost always bad news, but...
- Rarely leads to a protein having a novel property that improves ability of organism and its descendants to survive and reproduce.

Images: Blinky & Bart, Matt Groening

Mutation and Bacterial Change



- _____ _____= **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

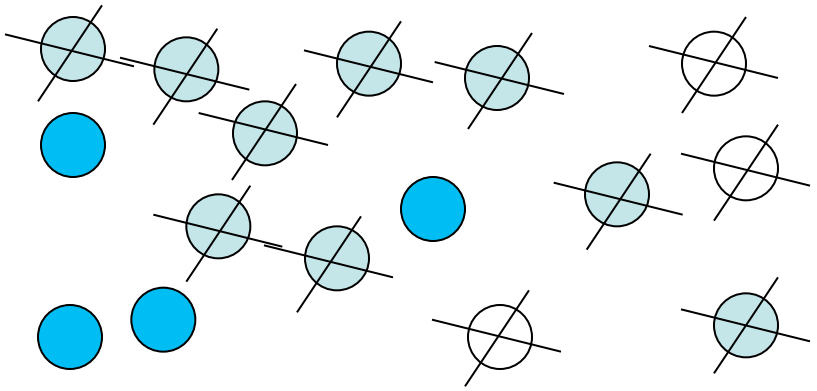


Image: *Staphylococcus aureus* on antibiotic test plate, PHIL #2641

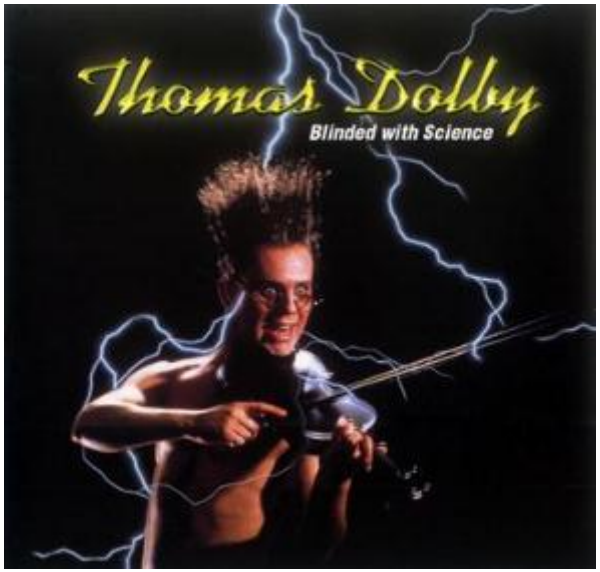
Confused?

Here are links to fun resources that further explain genetic replication:

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.
- "Bio Rad GTCA Song" musical advertisement for SsoFast™.
- animation by John Kyrk.
- "She Blinded Me With Science" music video Thomas Dolby.

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



Are you feeling blinded by science?

Do yourself a favor. Use the…

Virtual Cell Biology Classroom *(VCBC)* !

The VCBC is full of resources to help you succeed, including:

- practice test questions
- review questions
- study guides and learning objectives
- PowerPoints on other topics

You can access the Virtual Cell Biology Classroom by going to the Science Prof Online website **www.ScienceProfOnline.com**

Images: Blinded With Science album, Thomas Dolby; Endomembrane system, Mariana Ruiz, Wiki