



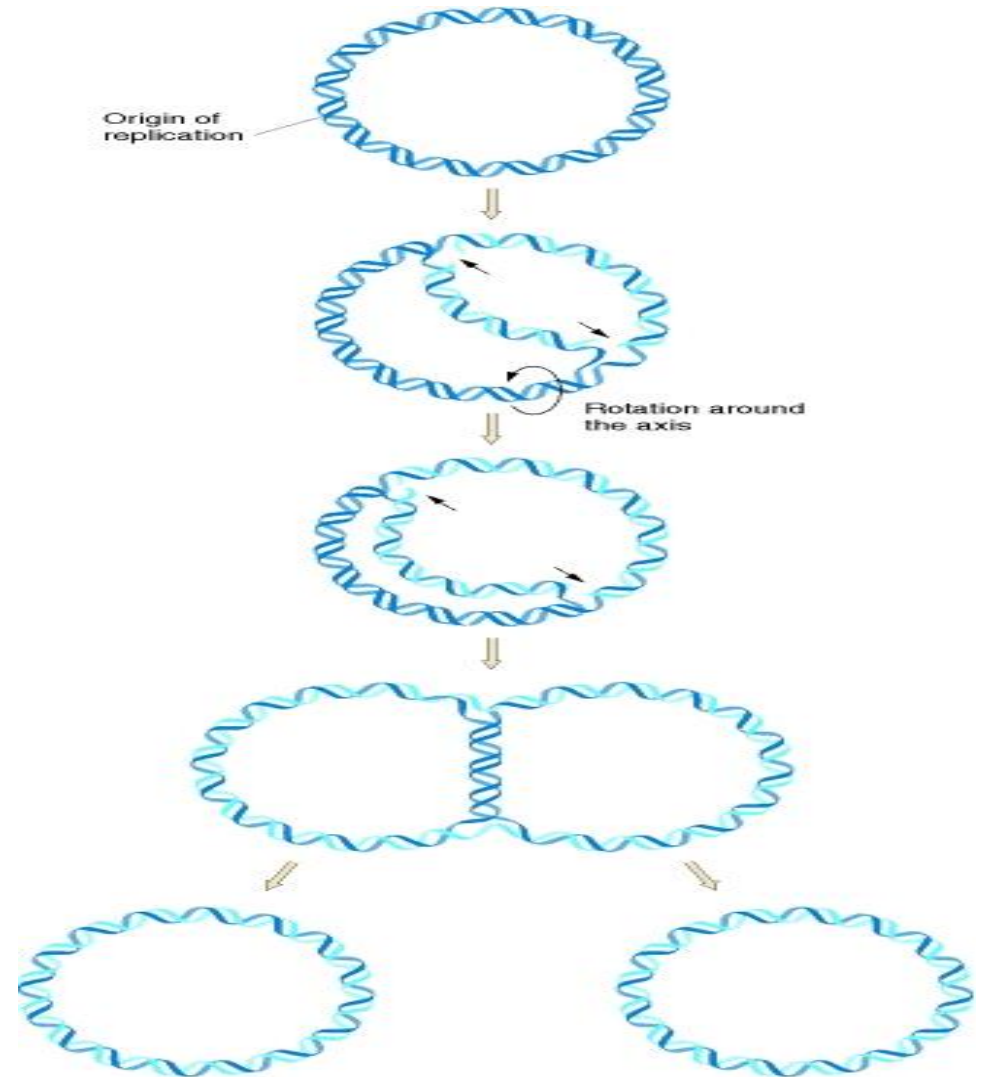
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- The SPO Virtual Classrooms offer many educational resources, including practice test questions, review questions, lecture PowerPoints, video tutorials, sample assignments and course syllabi. New materials are continually being developed, so check 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 (.ppt), as well as uneditable versions in smaller file sizes, such as PowerPoint Shows (.pps) and Portable Document Format (.pdf), for ease of printing. The font "Jokerman" is used frequently in titles. It has a microbiology feel to it. If you do not have this font, some titles may appear odd, oversized and off-center. Find free downloads of Jokerman by Googling "download jokerman font microsoft".
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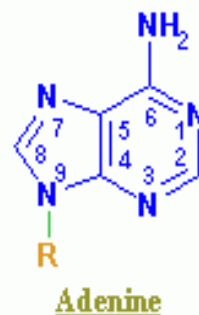
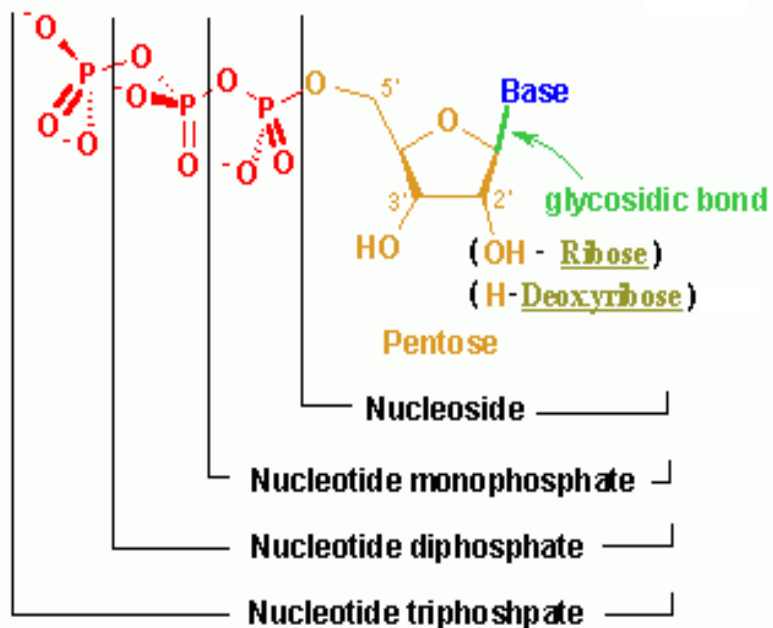
Tami Port, MS  
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# Microbial Genetics

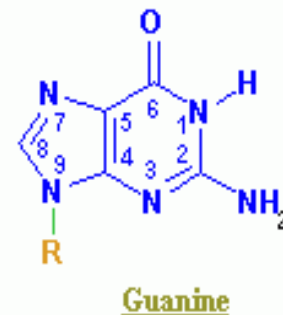


# Nucleic Acids

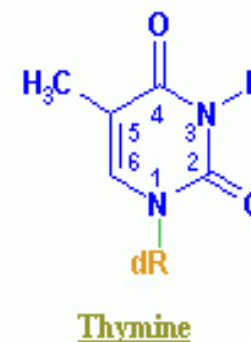
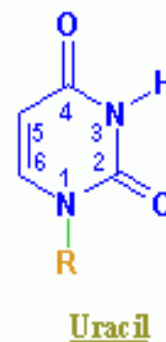
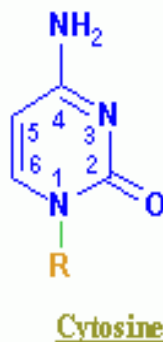
Made of monomer building blocks called nucleotides.



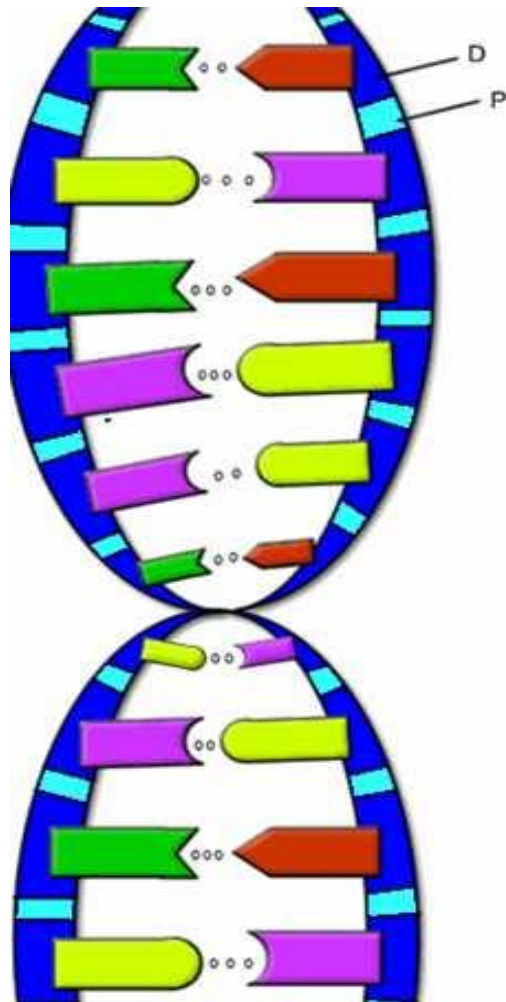
Purines



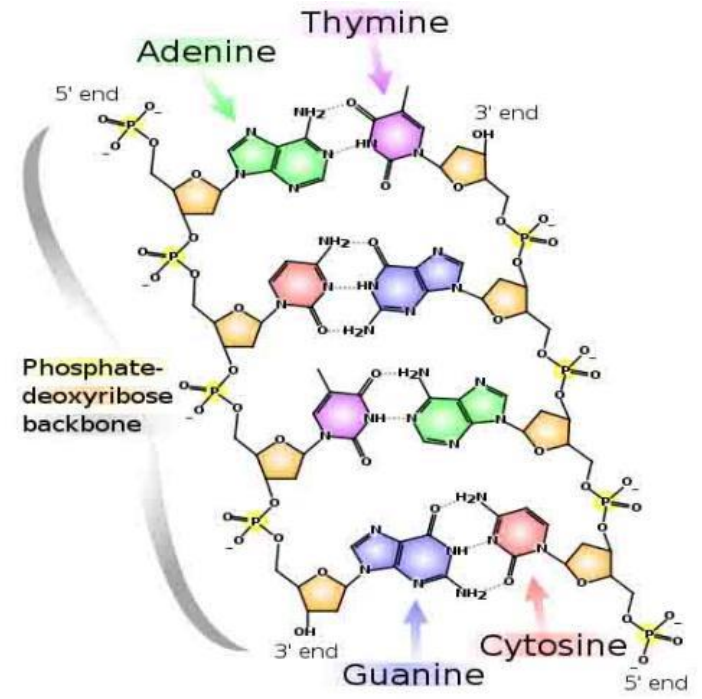
Pyrimidines



# Nucleic Acids: DNA Structure

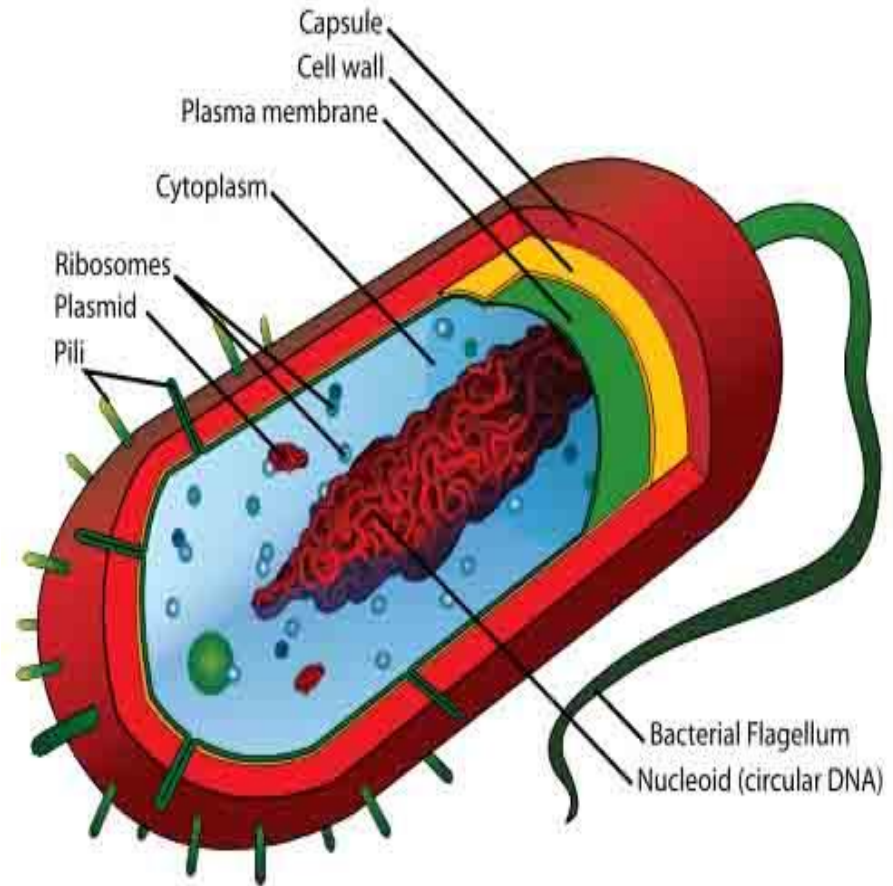


- ▬ Thymine
  - ▬ Adenine
  - ▬ Guanine
  - ▬ Cytosine
- D = Deoxyribose (sugar)  
P = Phosphate  
○○○ Hydrogen Bond



# Prokaryote Genetics

- **Q:** What is the specific name for the prokaryotes chromosome?
- DNA floats freely within cytoplasm.
- Prokaryotic DNA is packaged (coiled) differently than eukaryotic DNA. That is why some antibiotics can target prokaryotic nucleic acid while not hurting the DNA of our cells (selective toxicity).
- **Q:** Prokaryotic DNA may be found in what other structure?



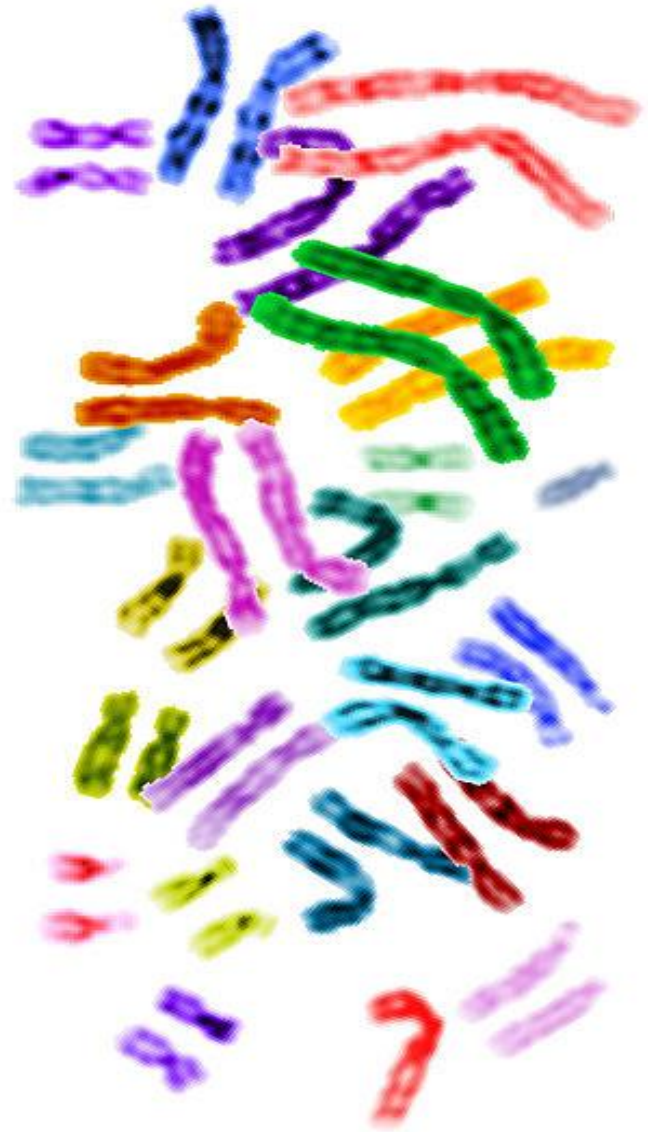
# Eukaryote Genetics

- Like prokaryotes, insofar as genome is also made of DNA.
- May include several to many linear chromosomes within a membrane-bound nucleus.

**Q:** How many chromosomes do humans have?

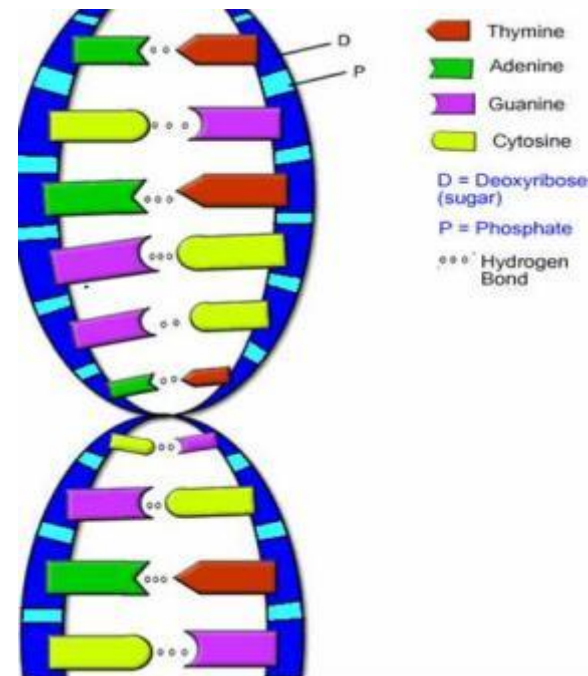
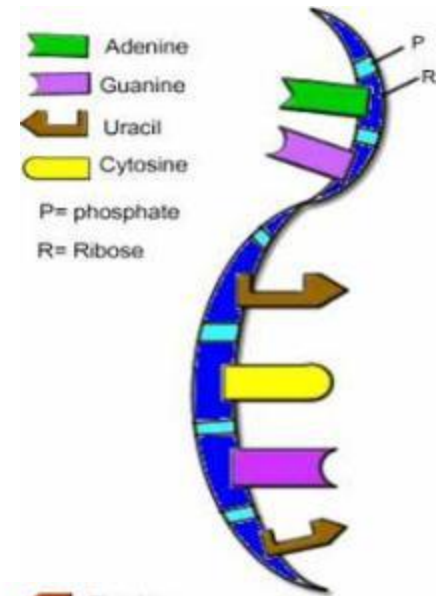
- Two locations of eukaryotic DNA
  - 1. Nuclear DNA
  - 2. Extranuclear DNA

**Q:** Where is the extranuclear DNA located in eukaryotic cells?



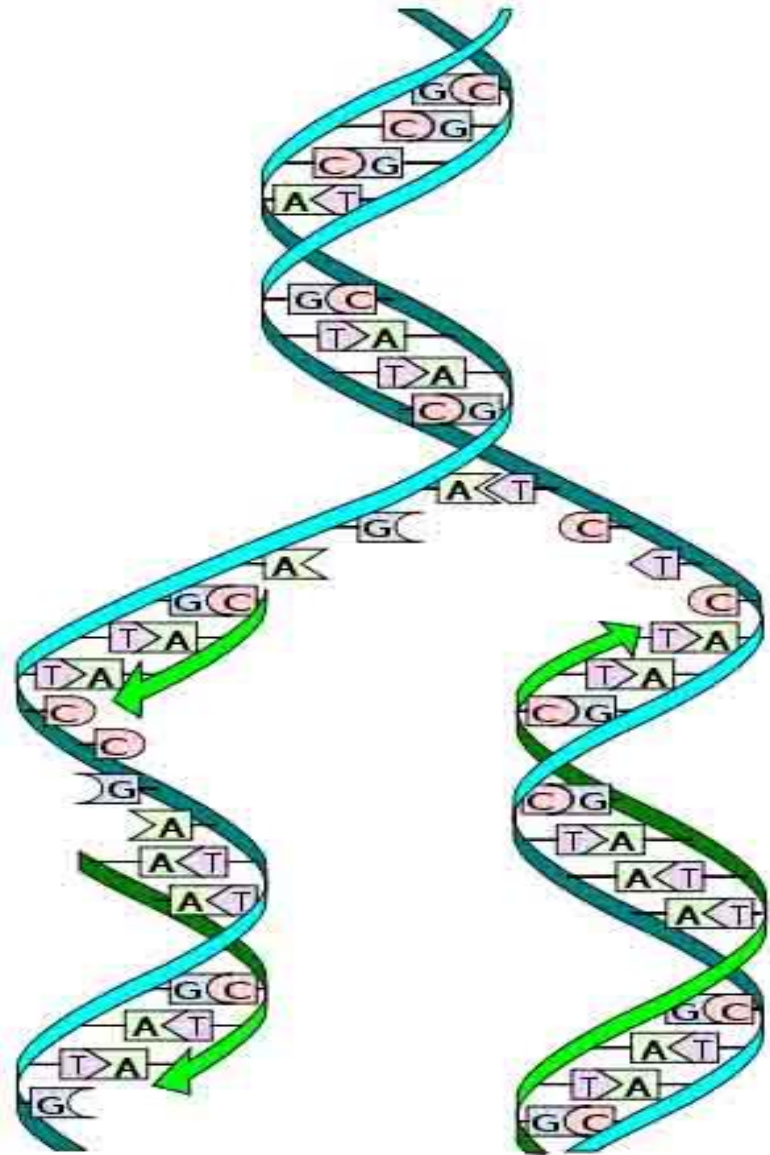
# Genetic Material of Viruses

- Show more variety in nature of their genomes than do cells.
- Can be DNA or RNA; never both.
- Primary way scientists categorize and classify viruses.
- Can be dsDNA, ssDNA, dsRNA, ssRNA.
- May be linear and composed of several segments or single and circular.
- Much smaller than genomes of cells.



# Copying DNA

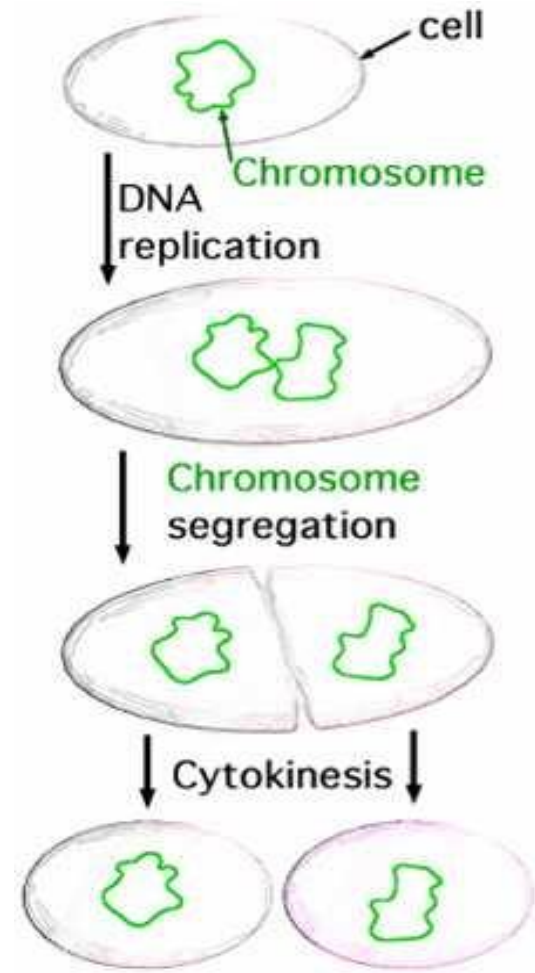
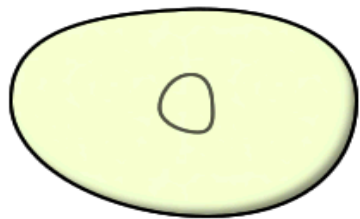
- Process of copying DNA is called replication.
- Think "duplication".
- Happens in all types of cells, prokaryotes and eukaryotes.
- **Q: Why would a cell need to copy its DNA?**



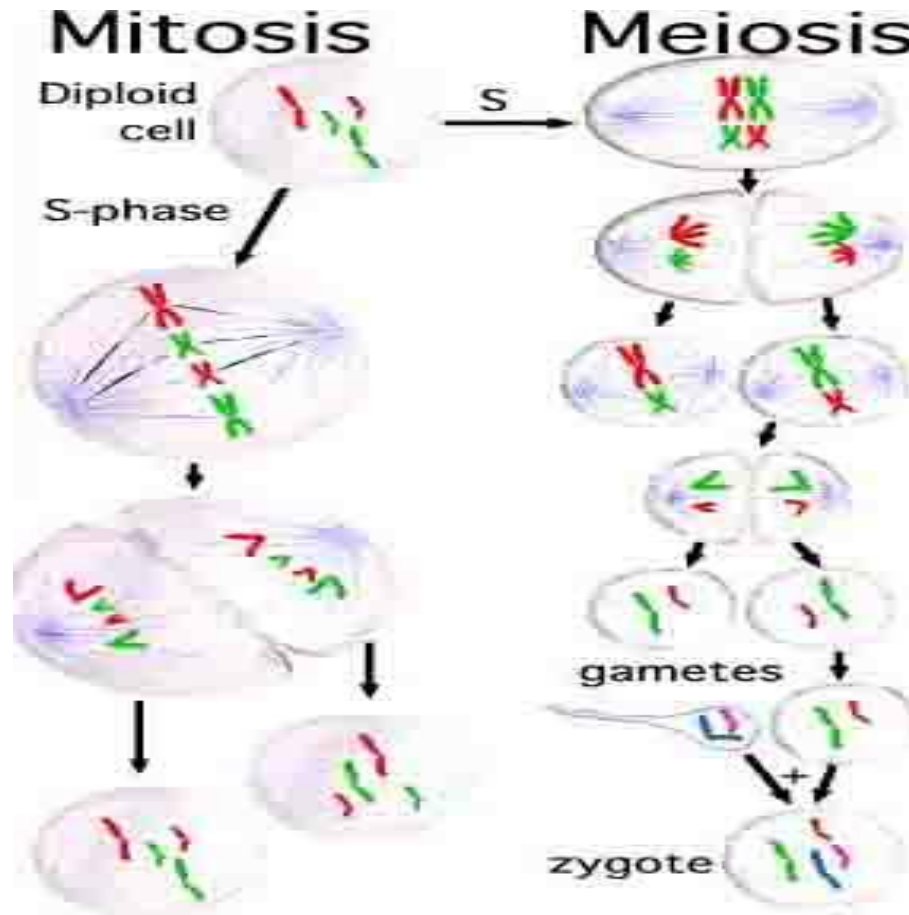


# Prokaryote Genetics - Cell Division

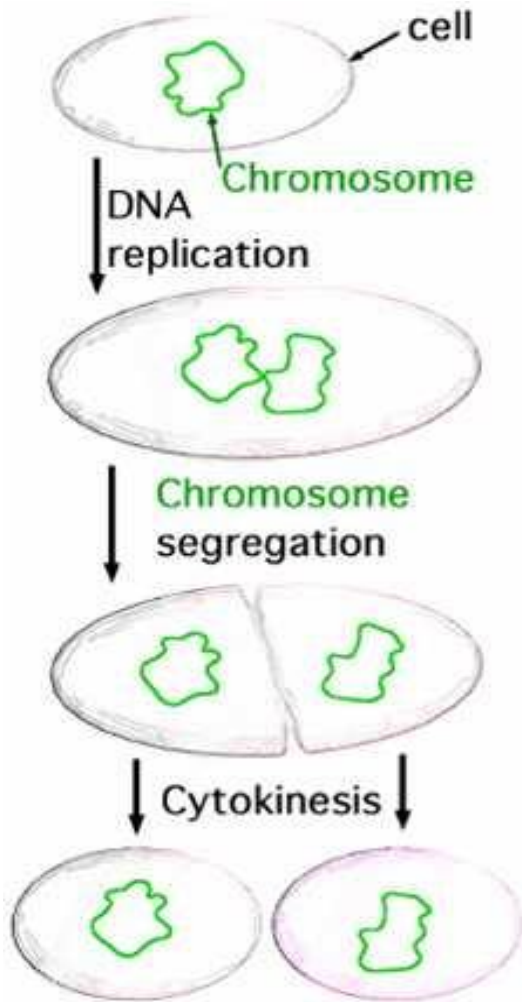
After the genetic material is copied, the prokaryotic cell divides; a process called binary fission, in which two identical daughter cells arise from one parent cell.



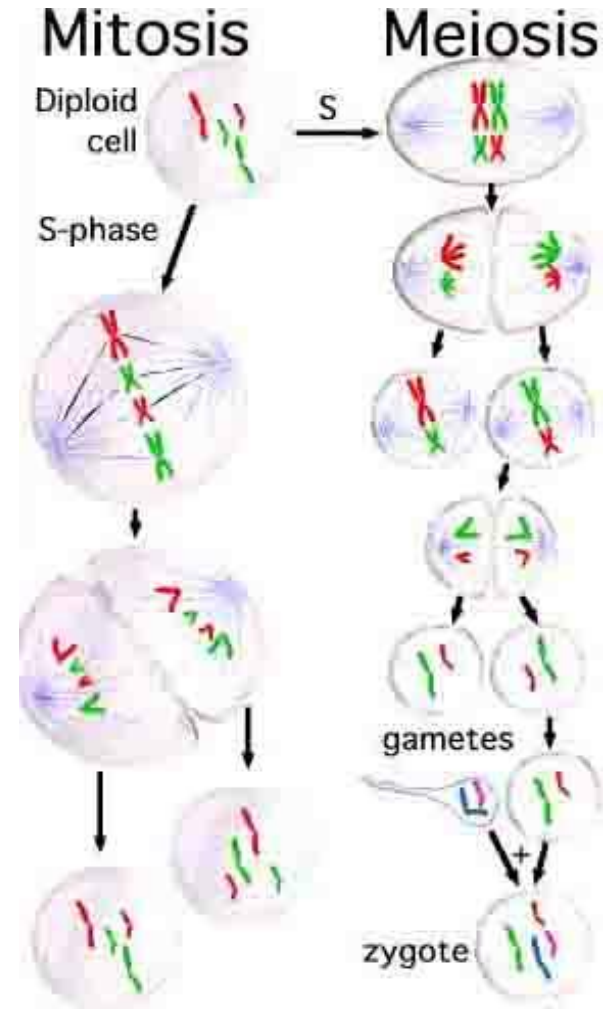
# Eukaryote Genetics - Cell Division



# REVIEW!



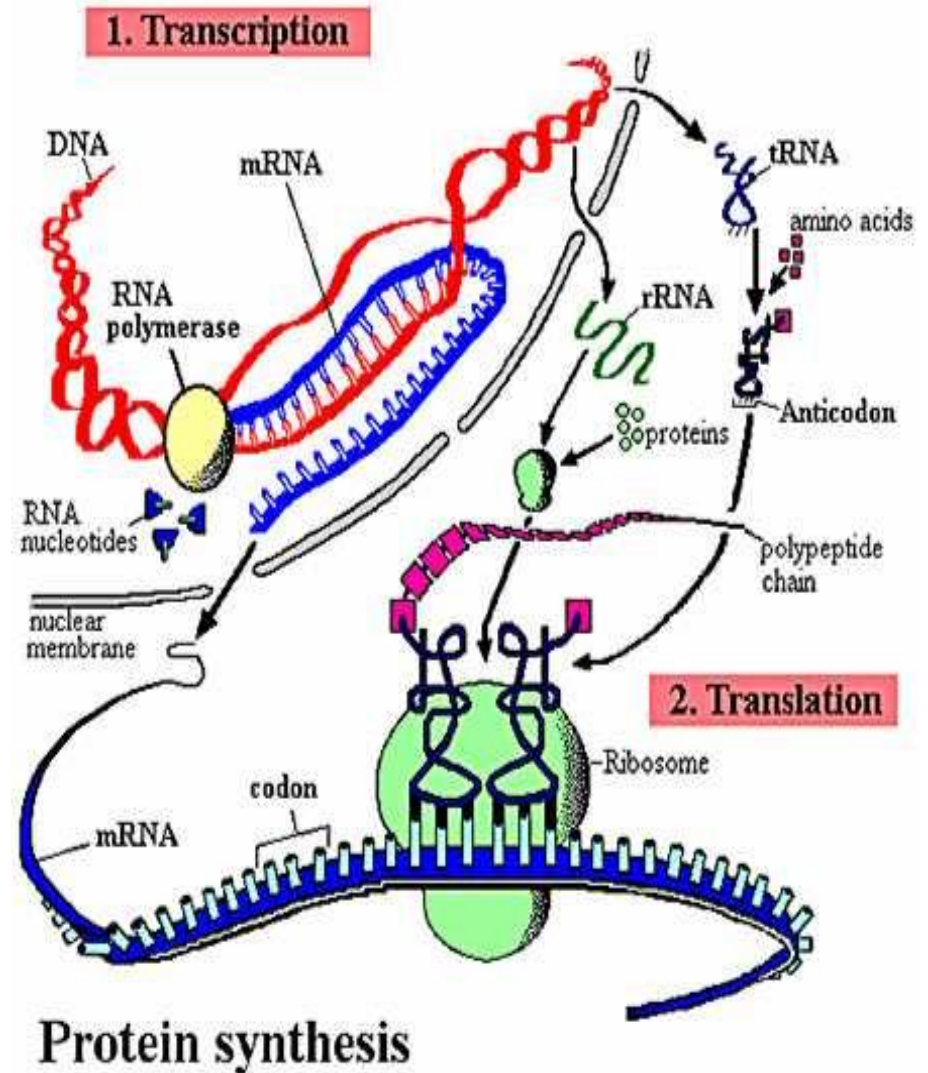
## Animated lesson on Cell Division



# Nucleic Acid Function

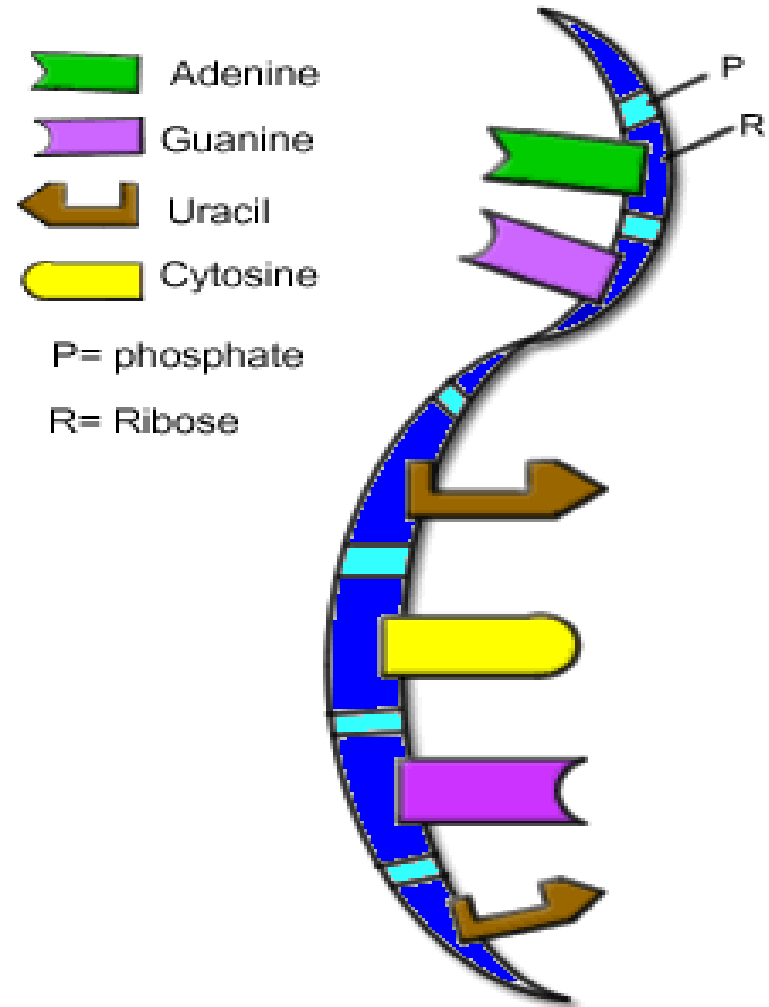
## Gene Expression:

### Transcription & Translation



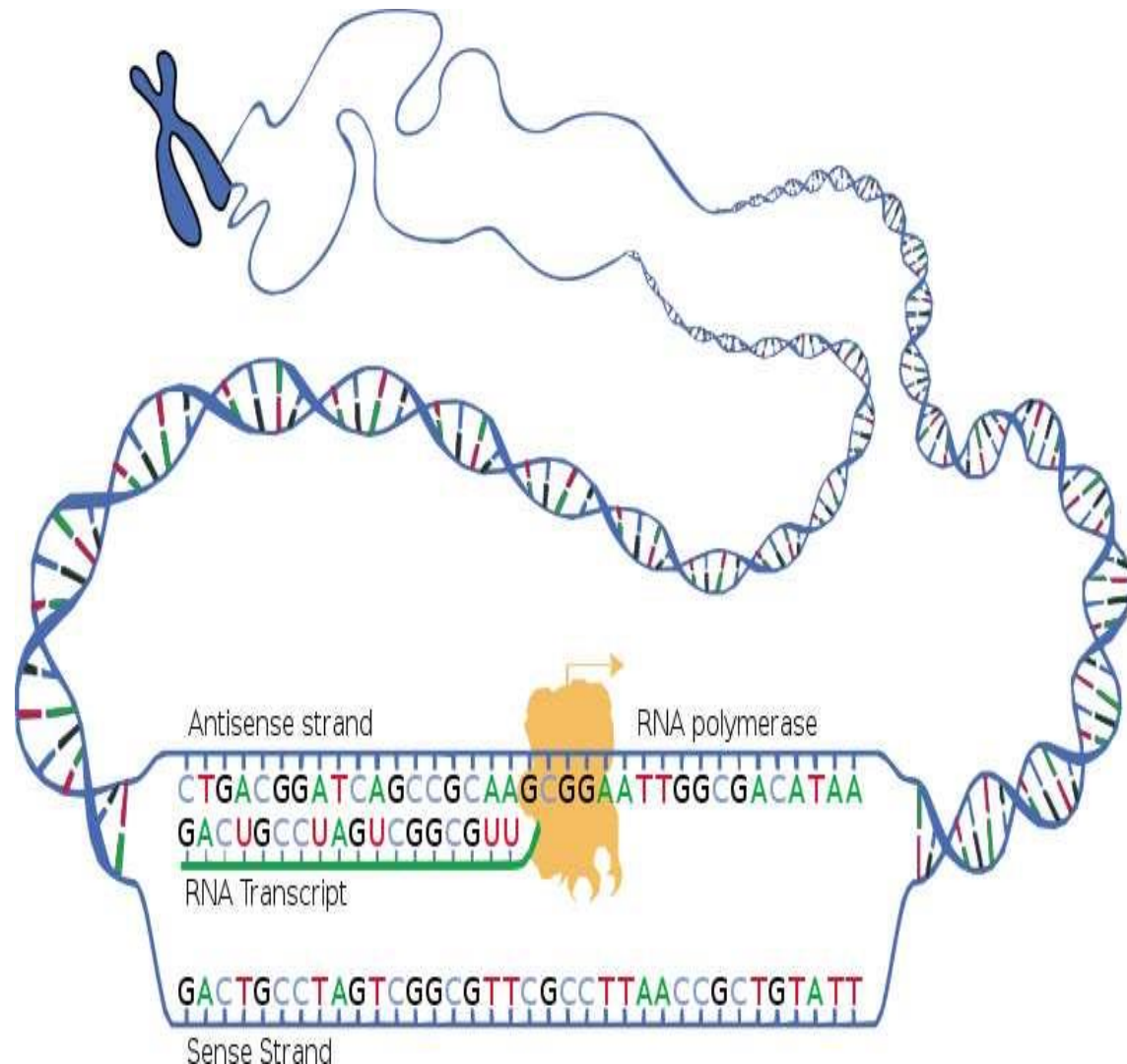
# Nucleic Acids: RNA Structure

- **RNA** is typically a single-stranded molecule.
- **Q:** What base does RNA have that DNA doesn't have?
- **Q:** What base does DNA contain that RNA Doesn't have?



# First thing to do in making a protein...

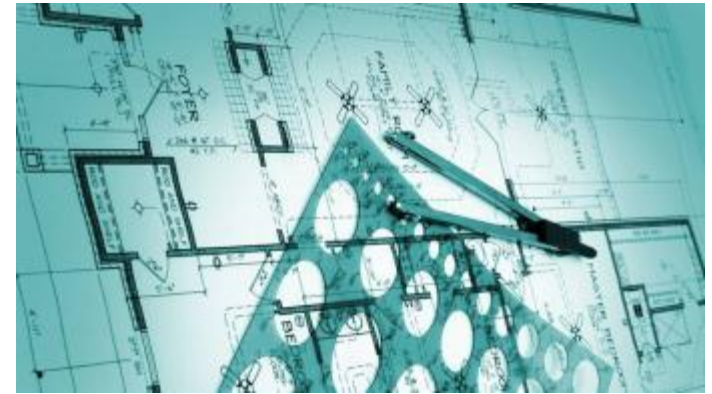
- **Make RNA**, a process called **transcription**.
- Process by which a DNA sequence is copied to produce a complementary RNA.
- In other words, it is the transfer of genetic information from DNA into RNA.
- Like **replication**, but we are making RNA.
- Beginning of the process that ultimately leads to the translation of the genetic code (via mRNA) into a peptide or **protein**.



# Types of RNA

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

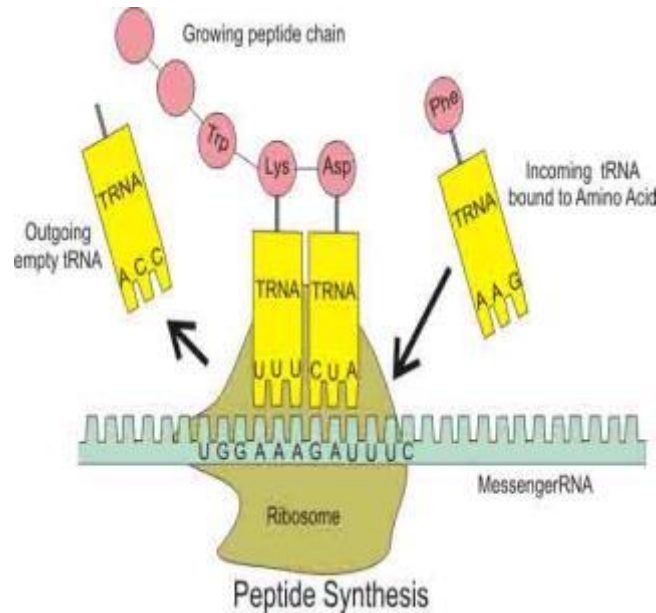
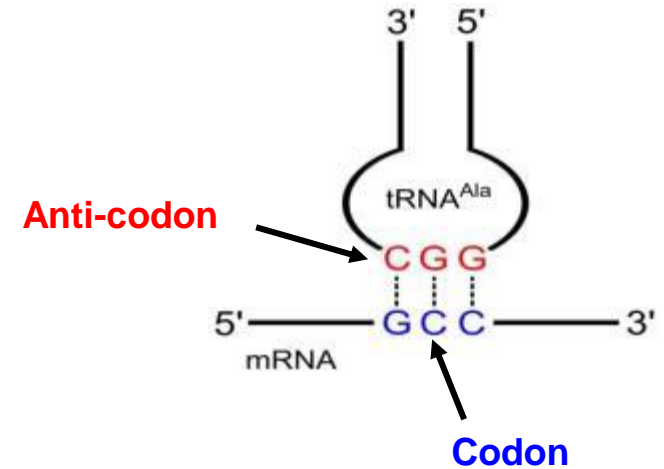
- **messenger** (mRNA) is like a Copy of information in DNA that is brought to the ribosome where the information is translated into a protein.
- **ribosomal** (rRNA) is like a The protein factories of the cells.
- **transfer** (tRNA) are like a Brings the amino acid to the ribosome.



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

# Next thing to do in making a protein...

- Use the instructions delivered by RNA to make a protein molecule, a process called translation.
- **Ribosomes** (Q: Which contain what type of RNA?) make proteins from the messages encoded in mRNA.
- The genetic instructions for a protein (polypeptide chain) are 'written' in the DNA as a series of 3-nucleotide 'words'.
- **codon** on mRNA
- **anti-codon** on tRNA
- 'U' (uracil) replaces 'T' in RNA
- This is the genetic code.
- Q: Where does translation occur in prokaryotes?
- Q: Eukaryotes?



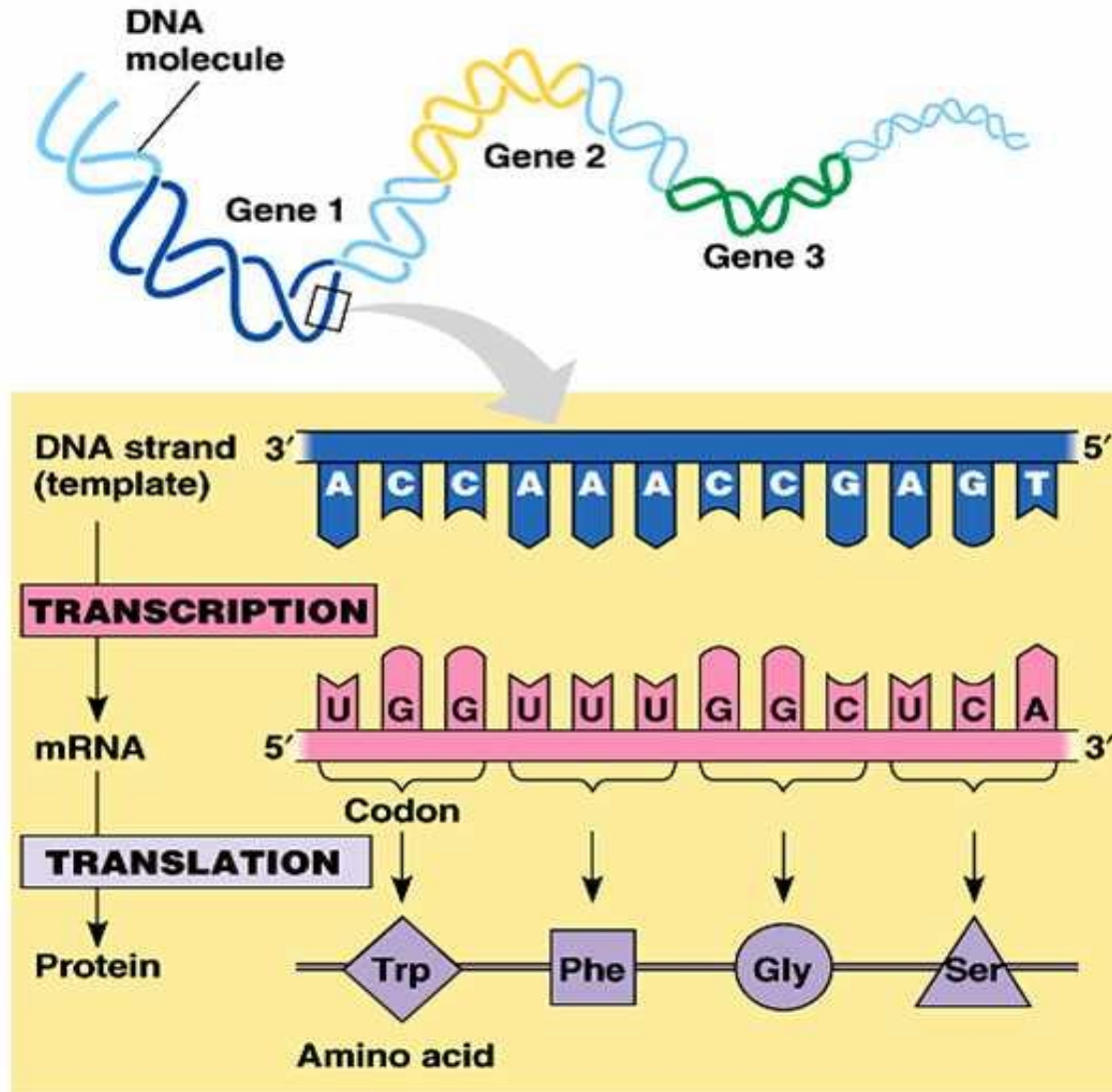
[Click here](#) for animation of a ribosome building a protein.



# Gene Expression: Transcription & Translation Overview

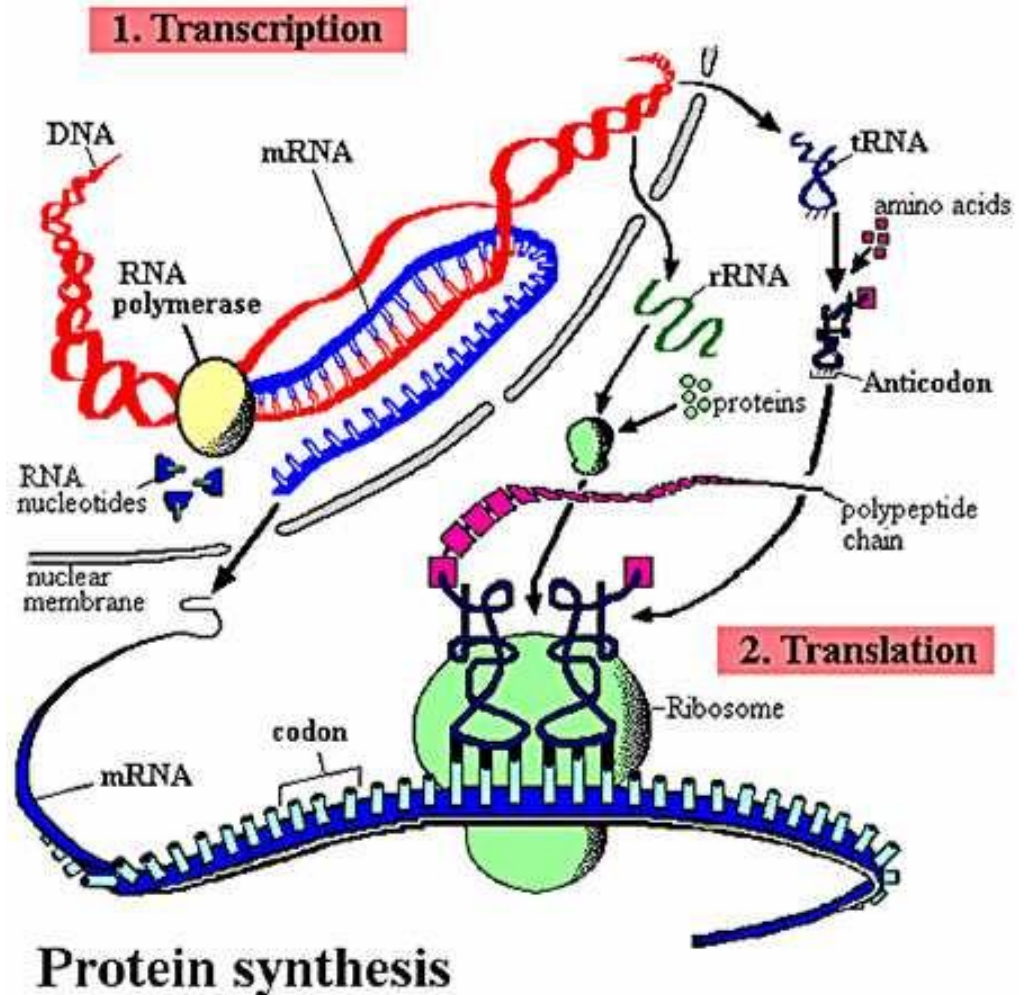
## REVIEW

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



# Gene Expression in Microbes

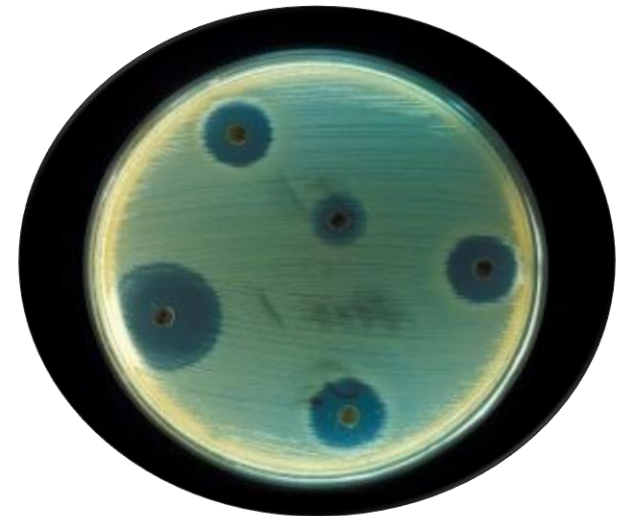
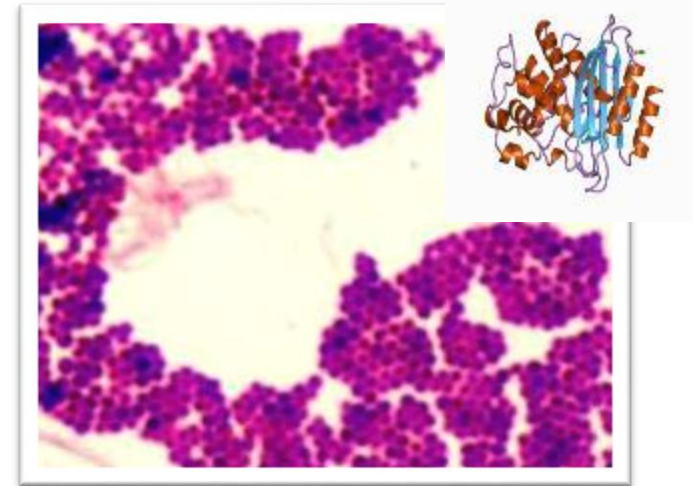
- Section of DNA (a gene) being **transcribed & translated** to produce a protein.
- Genes can be turned on and off.
- Understanding of how microbial genes are expressed (turned on and off) can help us control disease-causing bacteria.



# Using Gene Expression to Control Disease

## *Staphylococcus* & Antibiotic Resistance

- Many strains of *Staphylococcus* are now resistant to penicillin.
- One bacterial **protein** that confers penicillin resistance is called **beta-lactamase**.
- Beta-lactamase is an enzyme that cuts up and deactivates penicillin.
- Gene for beta-lactamase only expressed (turned on) in the presence of penicillin.
- When the bacteria is not exposed to penicillin, that gene is turned off and no beta-lactamase is made.
- Understanding how beta-lactamase gene is turned on/off, can help us to design a drug to disable that gene's expression (turn off the gene), making penicillin-resistant strains of *Staph* again vulnerable to penicillin.

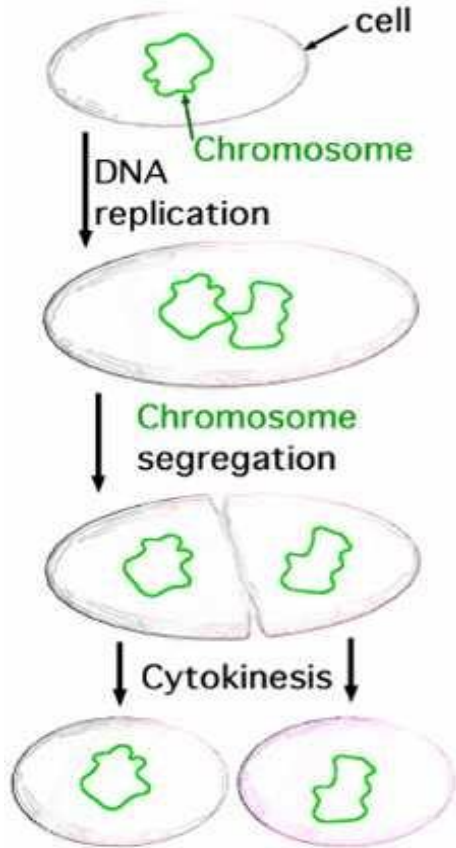


Images: [Gram stain](#) of *Staphylococcus*, T.Port; Enzyme Beta-lactamase, J. Swaminathan & MSD staff, European Bioinformatics Institute; [Staphylococcus aureus on antibiotic test](#)

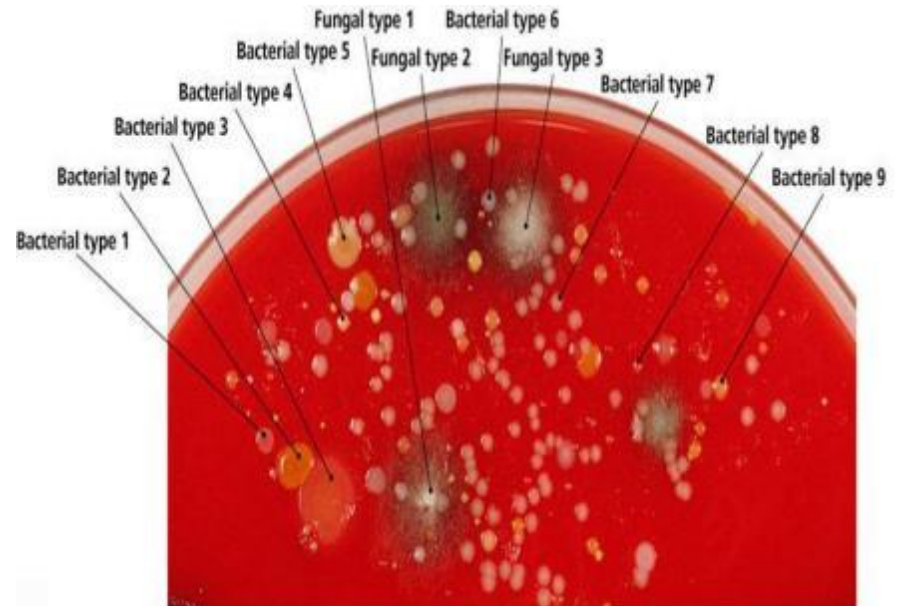
# Genetic Diversity in Prokaryotes

If binary fission creates clones...

...then:

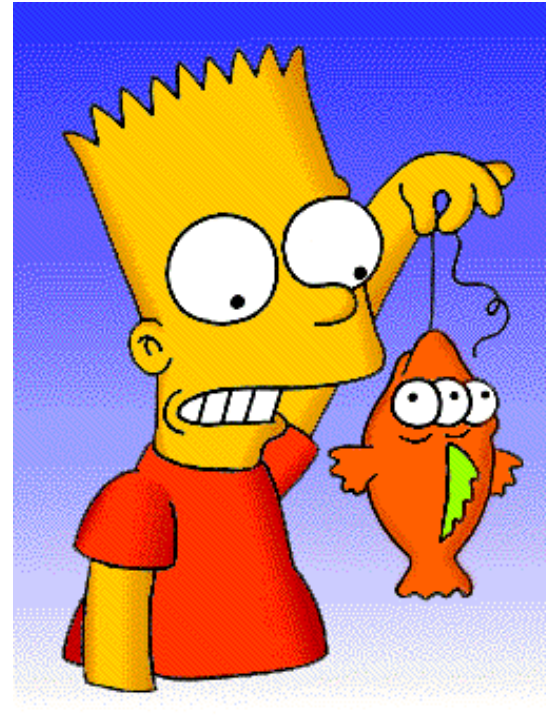


- **Q:** Why isn't there just one type of bacteria?
- **Q:** How do bacteria change (for example develop resistance to antibiotics)?



# 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.
- *Staph's* beta-lactamase gene is an example of a mutation that was advantageous.

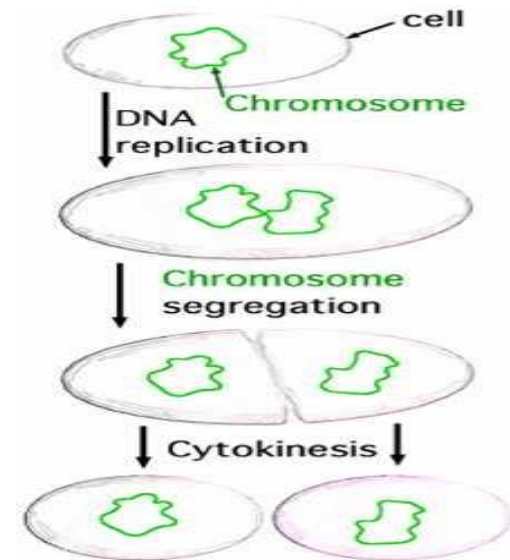


# Increasing Genetic Diversity in Prokaryotes

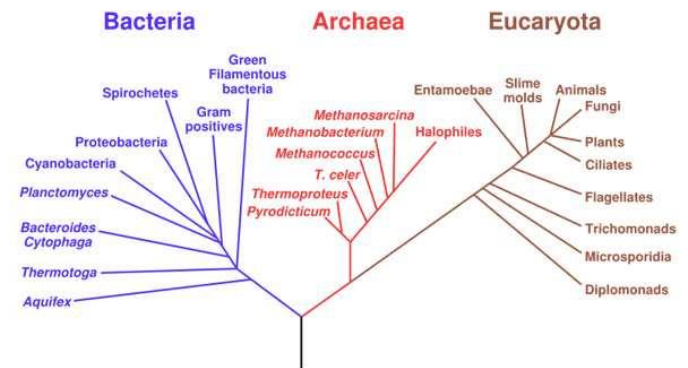
## Gene Transfer

- **Vertical gene transfer** - organisms replicate their genomes and provide copies to descendants. Passing on genes to descendants.
- **Horizontal gene transfer** - donor contributes part of genome to recipient that are not descendants; three types:

- Transformation
- Transduction
- Bacterial **Conjugation**



Phylogenetic Tree of Life



# Increasing Genetic Diversity in Prokaryotes

## Transformation

- When a recipient cell takes up **DNA** from the environment (such as DNA released from a dead organism).
- 1928 Frederick Griffith discovered this process while trying to develop a vaccine for pneumonia caused by *Streptococcus pneumoniae*.
- Griffith worked with two strains of *Strep*.
- **S Strain** had a protective capsule & caused deadly pneumonia when injected into mice.
- **R strain** were mutants that could not make the protective capsule and did not cause deadly disease (because the white blood cells of the mice could easily destroy R strain cells).

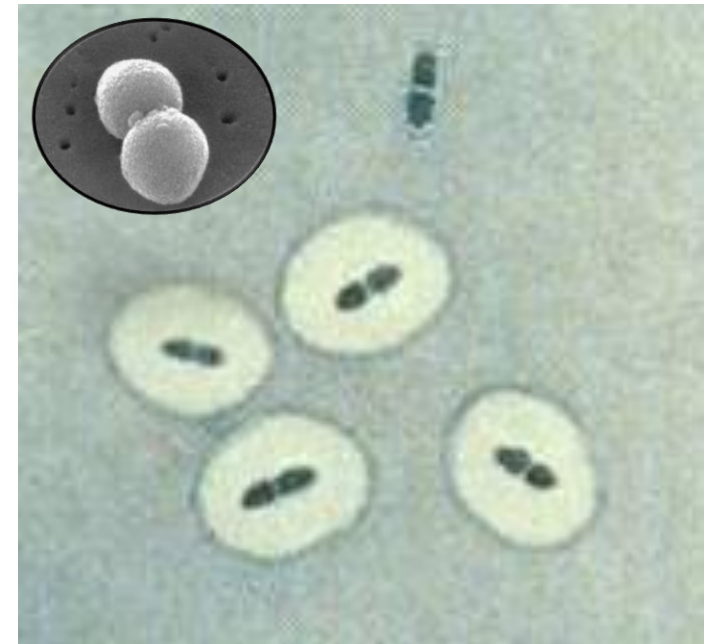
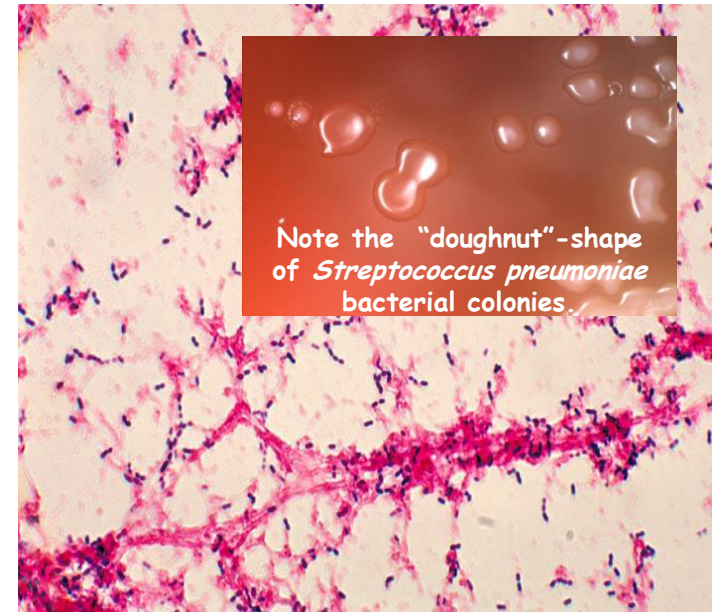


Images: [Fredrick Griffith & Bobby](#), 1936, Coburn, Alvin F.; [Pneumococcus](#), Giant Microbes; Rough (unencapsulated) and Smooth (encapsulated) [Streptococcus pneumoniae](#), Wiki.

# Meet the Microbe!

## *Streptococcus pneumoniae*

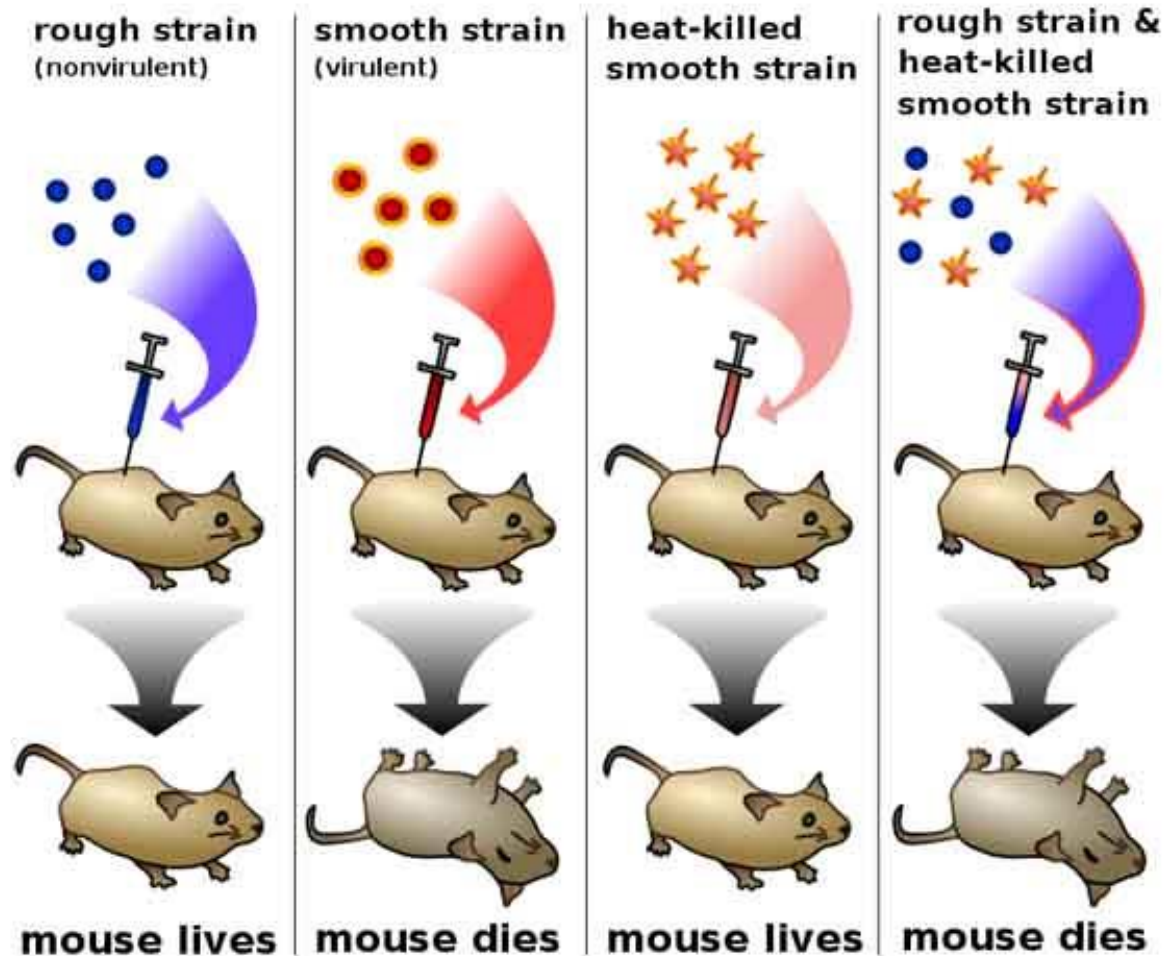
- **Gram+** cocci that occur in pairs or chains.
- **Blood agar:** alpha hemolytic under aerobic conditions and beta hemolytic under anaerobic conditions.
- 92 different *strains*, collectively called pneumococci, known to infect humans.
- **Unencapsulated strains:** Those with no capsule/glycocalyx are normal microbiota of lungs, sinuses and middle ear of 75% of people. Don't cause disease.
- **Encapsulated strains:** Cells of virulent strains of *S. pneumoniae* are surrounded by a polysaccharide *capsule* which protects them from being digested by phagocytic white blood cells.
- The virulent strain can cause:
  - Pneumococcal pneumonia (causes 85% of pneumonia cases)
  - Sinusitis and otitis media
  - Bacteremia and Endocarditis





# Increasing Genetic Diversity in Prokaryotes

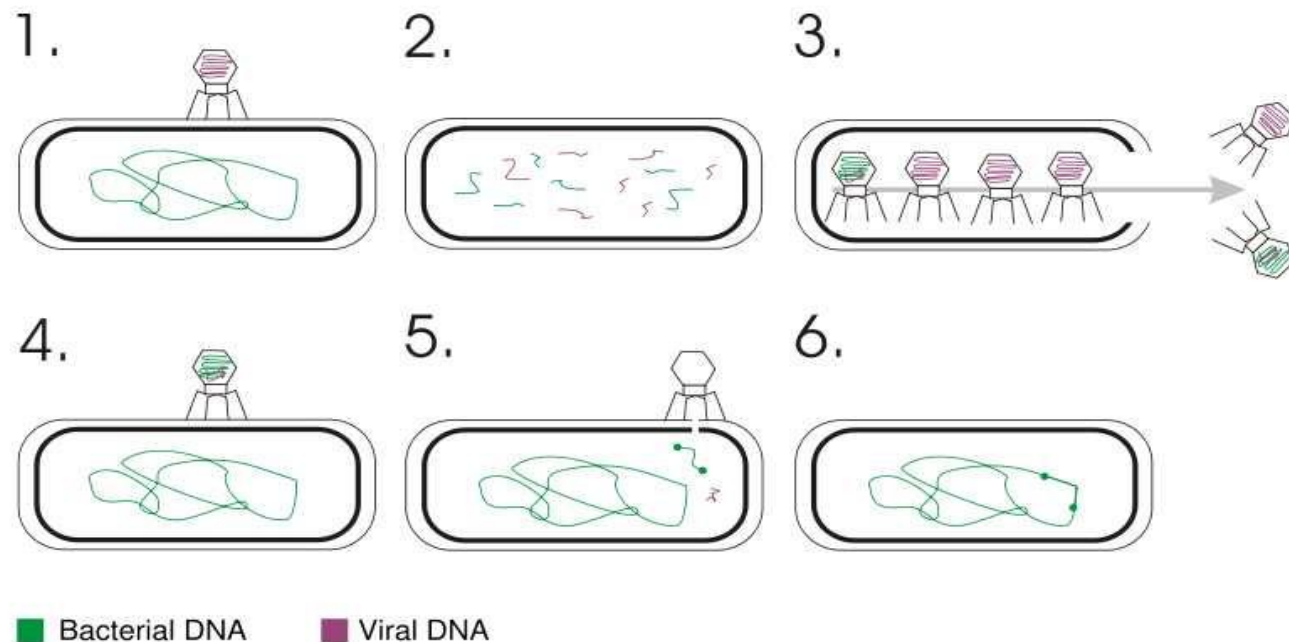
## Transformation: Griffith's Experiments



# Increasing Genetic Diversity in Prokaryotes

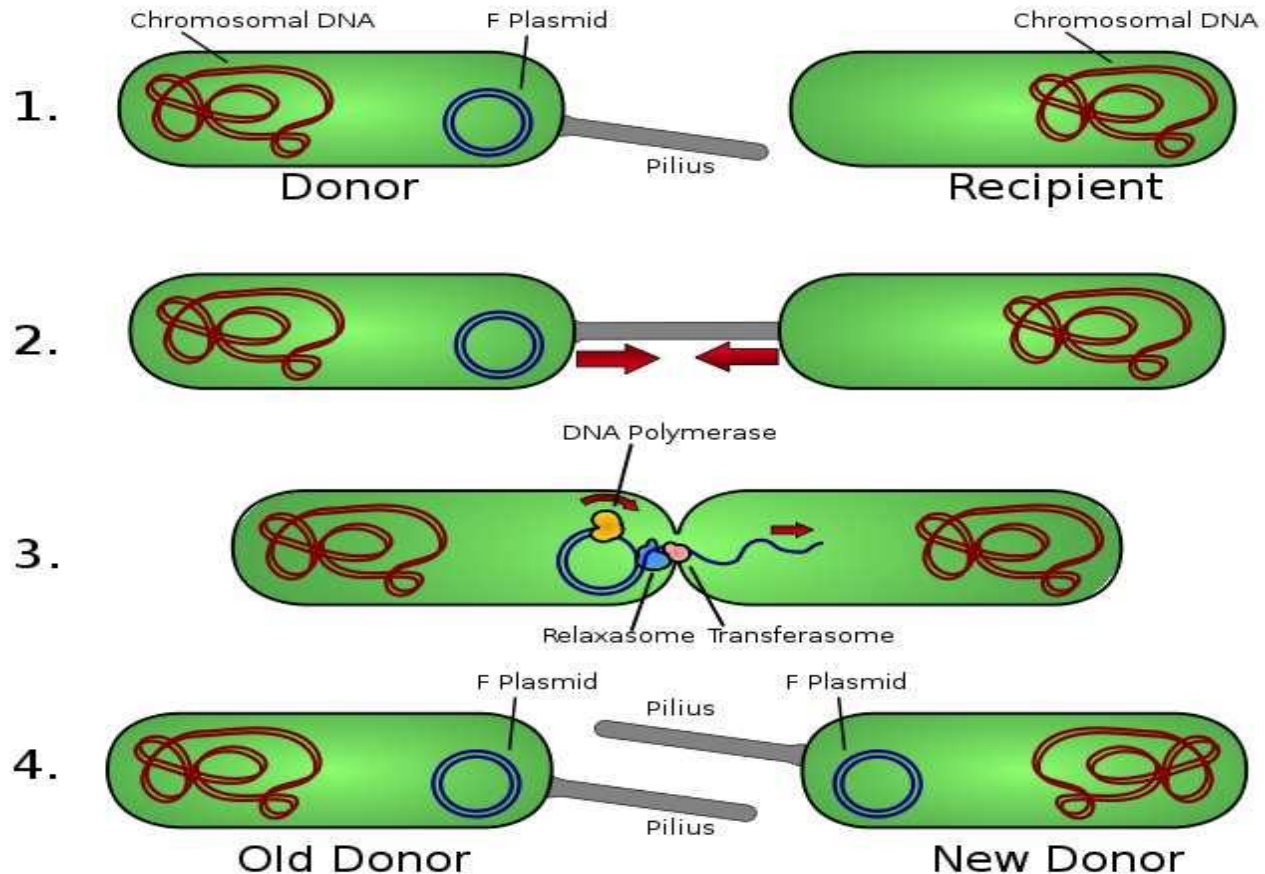
## Transduction

- Transfer of **DNA** from one cell to another via a replicating **virus** (**bacteriophage**).
- Can occur between **prokaryotic cells** or between **eukaryotic cells**. (The following is an example of transduction in bacterial cells by bacteriophage virus).



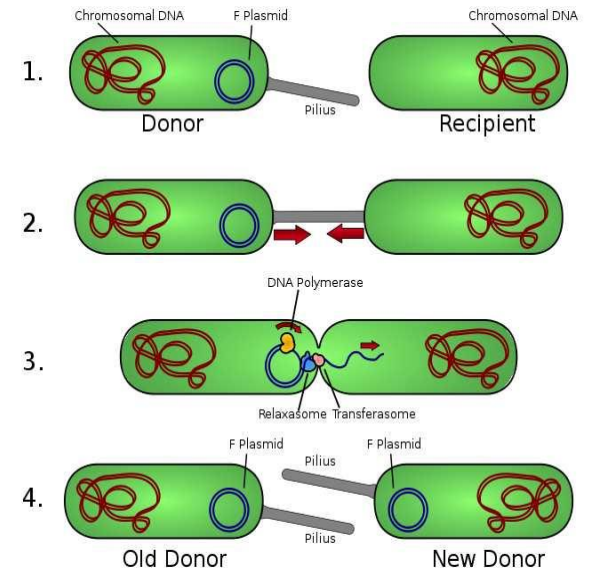
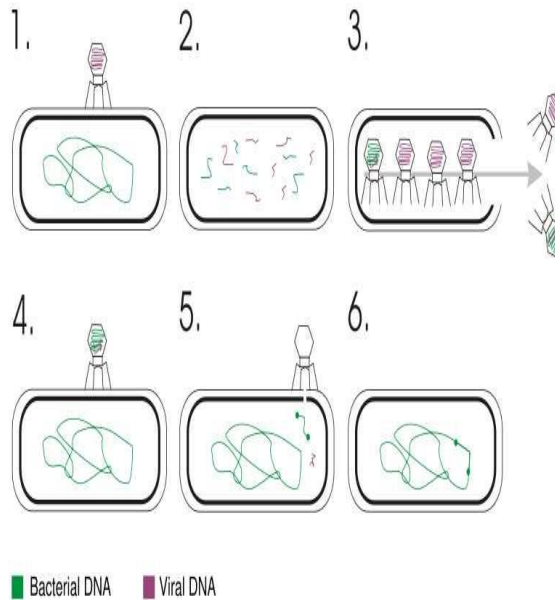
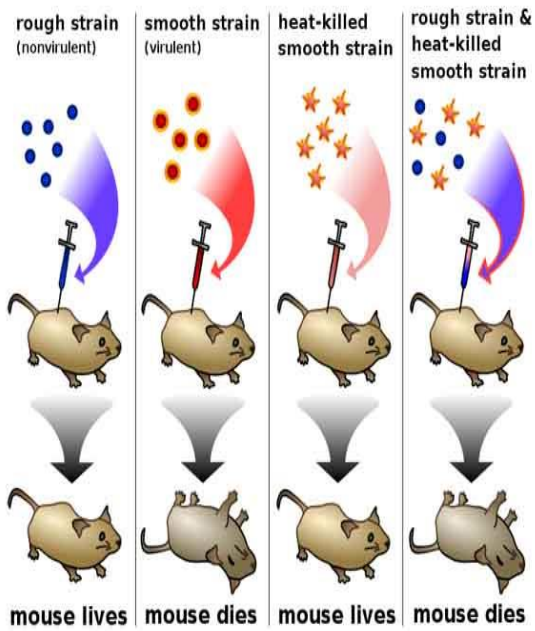
# Increasing Genetic Diversity in Prokaryotes

## Conjugation



# REVIEW!

## Animated lesson on Horizontal Gene Transfer



Images: [Griffith's experiment](#), Madprime; [Transduction](#), Geni; [Bacterial conjugation by Adenosine](#).

# Confused?

Here are links to fun resources that further explain microbial genetics.

- [Microbial Genetics Main Page](#) on the Virtual Microbiology Classroom of Science Prof Online.
- [DNA Structure Cell Biology Animation](#) from John Kyrk.
- [Build a DNA Molecule](#) from University of Utah.
- ["Rockin' Pneumonia & the Boogie Woogie Flu"](#) song by John Rivers.
- [DNA Replication](#) animation and review questions.
- [DNA Replication Process](#) animated video by FreeScienceLectures.com.
- [DNA Replication](#) step-through animation by John Kyrk.
- [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.
- ["That Spells DNA"](#) song by Jonathan Coulton.
- ["The Protein Synthesis Song"](#) by MrsPurpleMonster18.

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

Smart Links



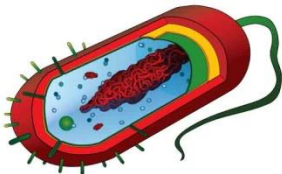
# Are microbes intimidating you?



*Do yourself a favor. Use the...*

## Virtual Microbiology Classroom (VMC) !

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



- practice test questions
- review questions
- study guides and learning objectives

You can access the [Virtual Microbiology Classroom](http://www.ScienceProfOnline.com) (VMC) on Science Prof Online website  
[www.ScienceProfOnline.com](http://www.ScienceProfOnline.com)