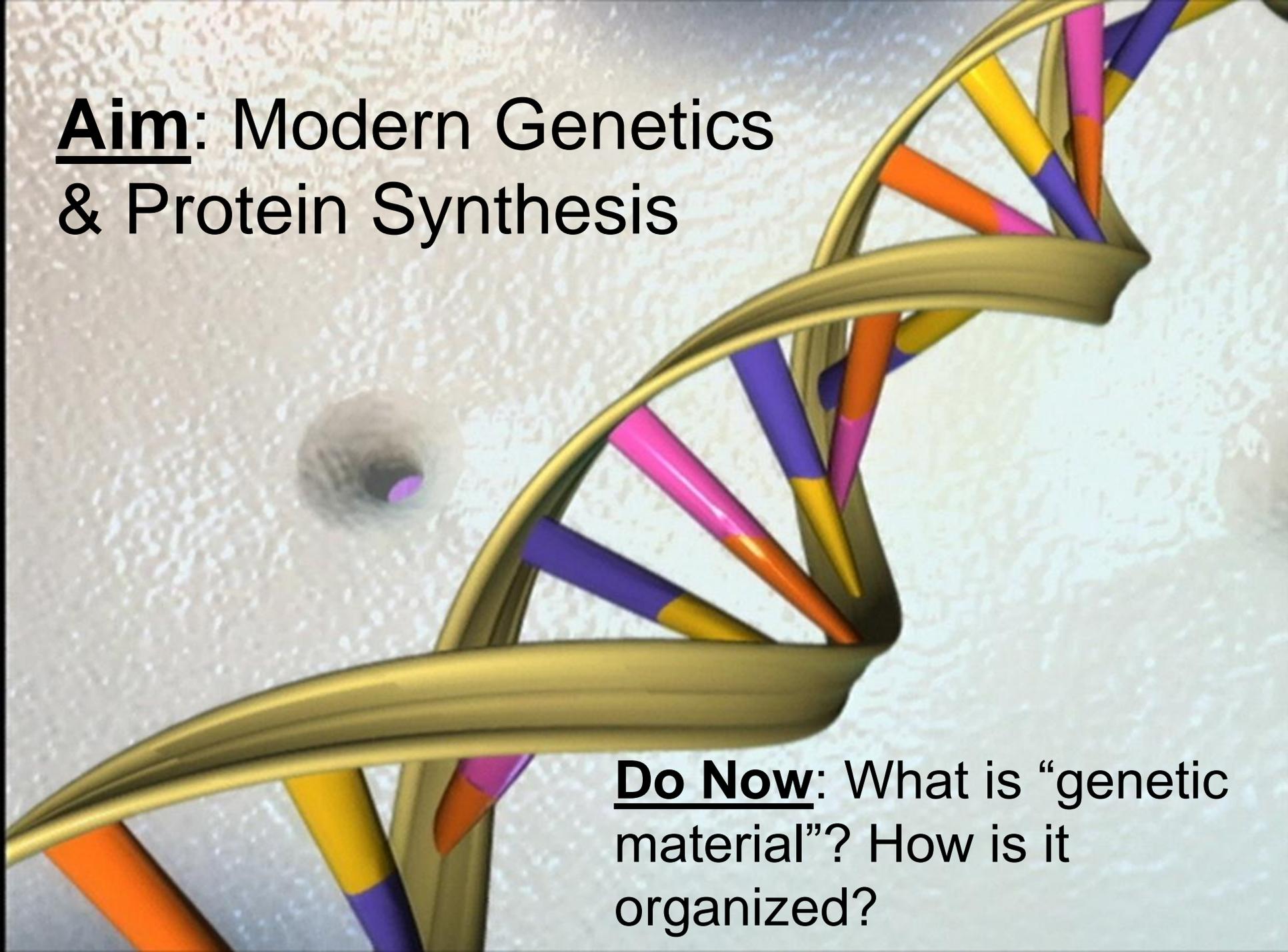


# Aim: Modern Genetics & Protein Synthesis

Do Now: What is “genetic material”? How is it organized?



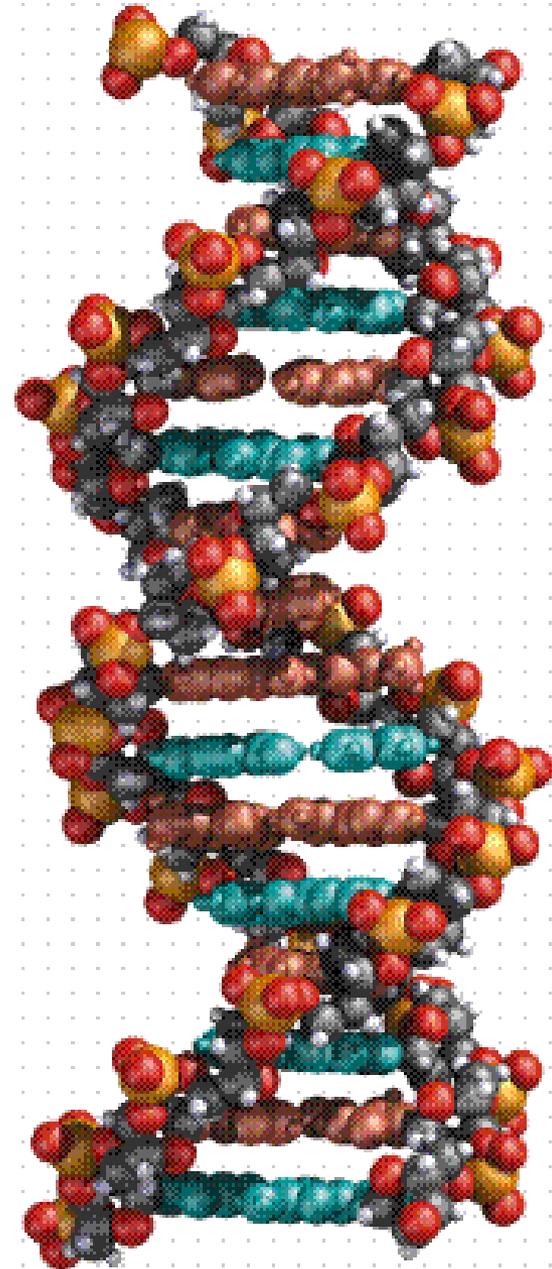


# Genetic Material = DNA

- Chromosomes consist of **proteins & DNA**
- DNA (**D**eoxyribo**N**ucleic **A**cid)→ **genetic material**
- A **gene** is a portion of the chromosome
- Gene → Chromosome→ Nucleus
- In some viruses, RNA (ribonucleic acid)→ is the genetic material

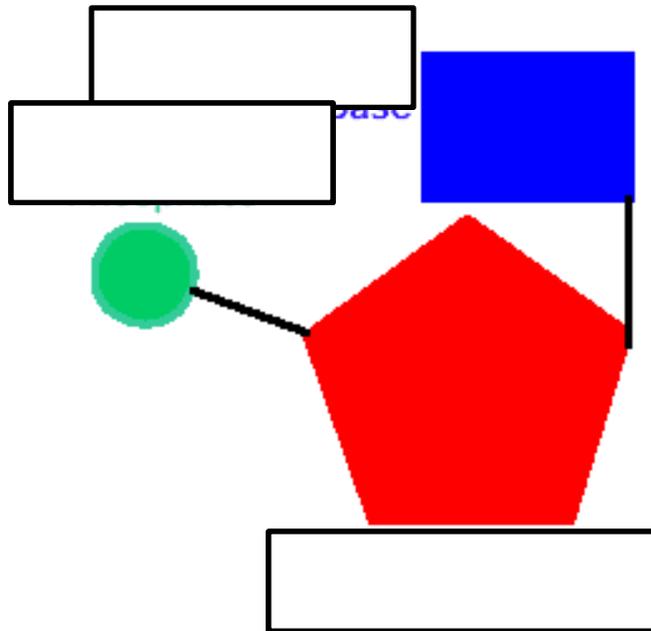
# DNA

- Chemical Structure of DNA:
- DNA is a **polymer**:  
A large molecule consisting of thousands of repeating units, called.....
- Nucleotides: 3 parts
  1. Phosphate group
  2. Deoxyribose sugar molecule (5 Carbon)
  3. Nitrogenous base: 4 types – adenine, thymine, guanine, & cytosine
    - (A, T, C, G)

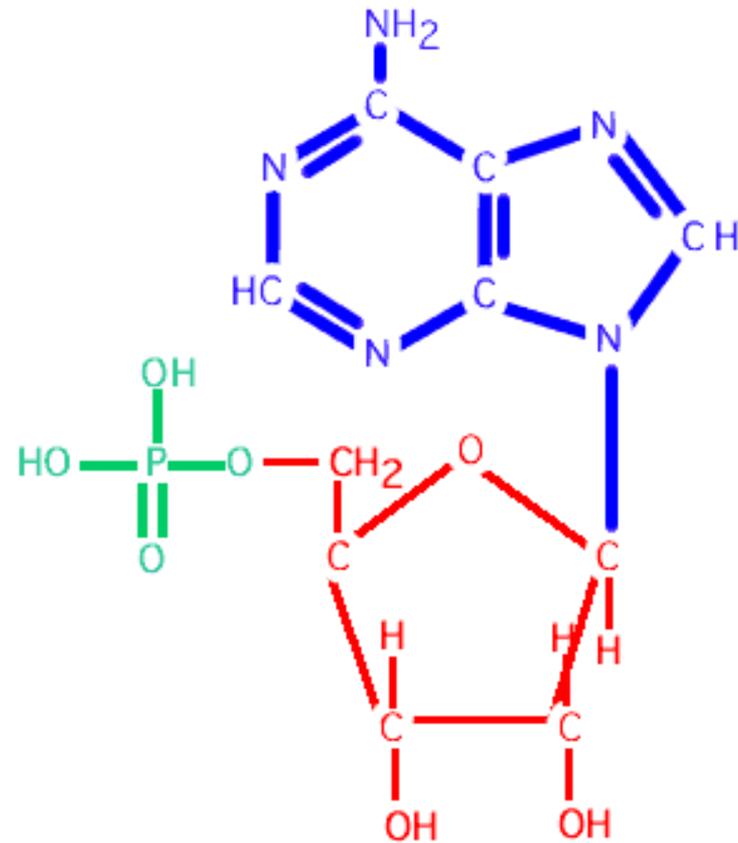


# Nucleotides

## Basic Nucleotide Structure

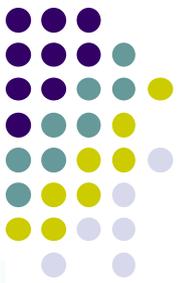


## Example

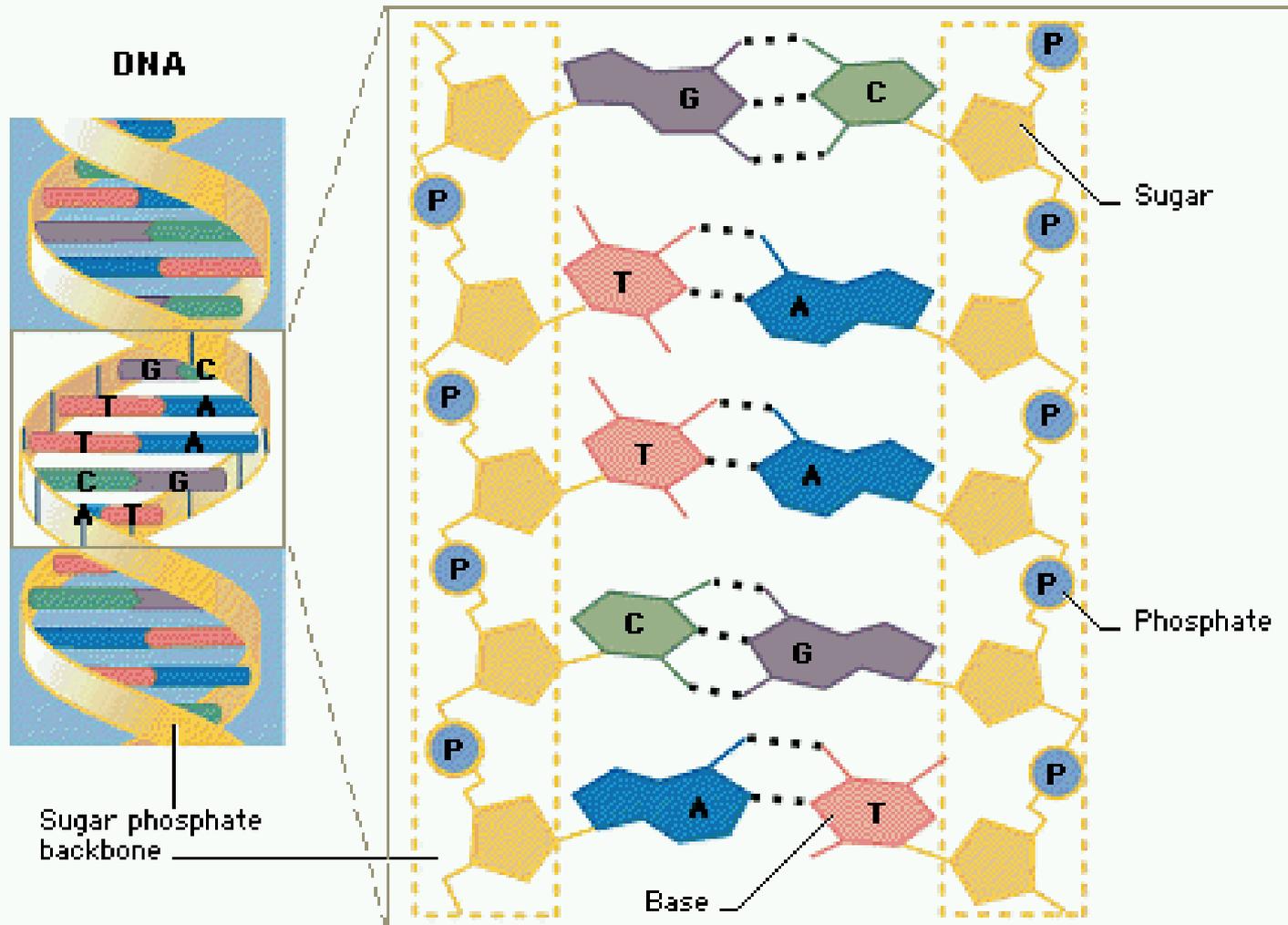


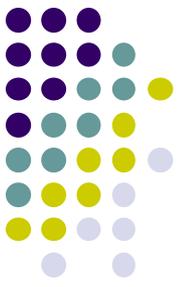
Adenosine 5' phosphoric acid





# Nucleotides in DNA

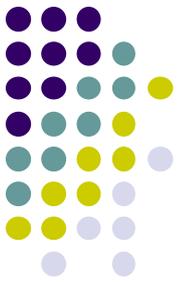




# Nucleotides

- Watson and Crick model of DNA molecule:
- DNA consist of **2** chains of ***nucleotides*** (arranged in a Double Helix shape)
- Sides of the ladder are alternating **phosphates & deoxyribose** sugars
- Base pairs (in the middle of the double helix) are attached by **weak** hydrogen bonds
  - Adenine (A) pairs with Thymine (T)
  - Cytosine (C) pairs with Guanine (G)

# Practice: Base Pairs in double-stranded DNA

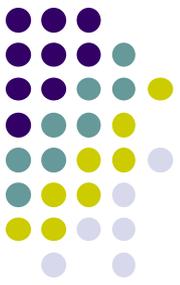


- Write the base pair sequence for the following single-strands of DNA:

ACGTTACCAAGTTG

GGCTATTGCGCAG

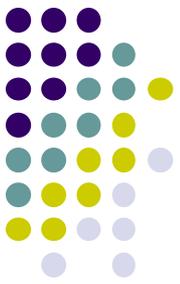
# DNA Discoverers



**Left: Rosalind Franklin, Right: Watson and Crick**

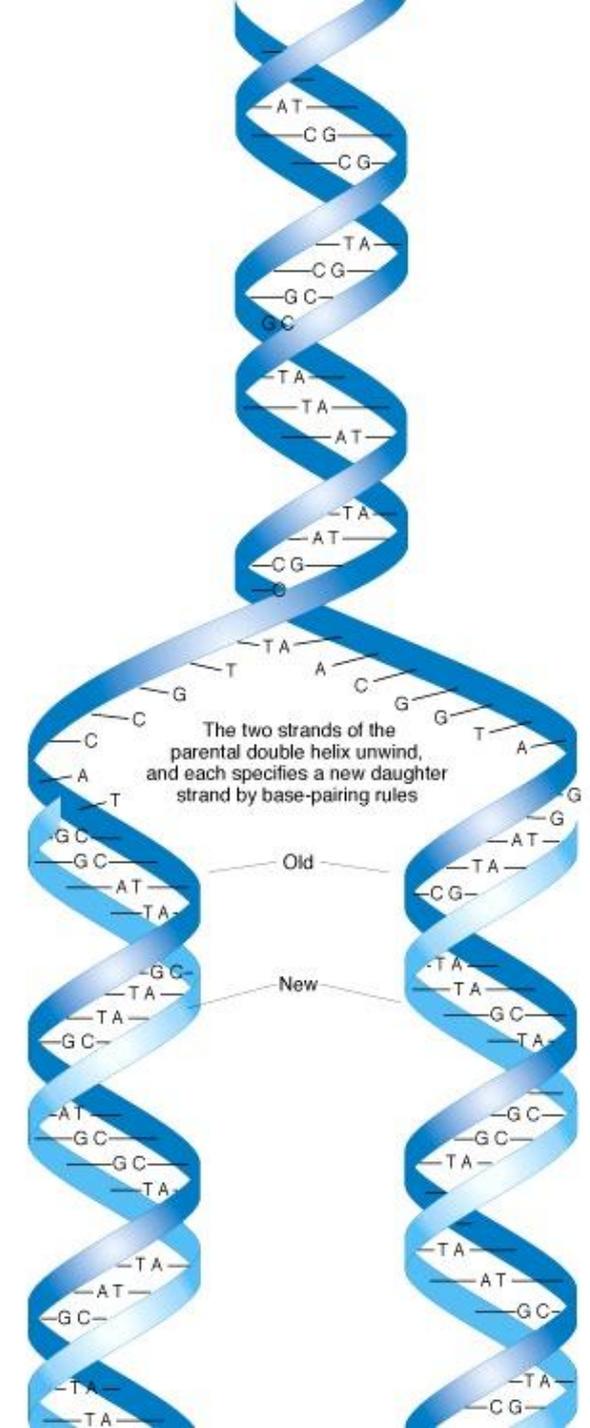
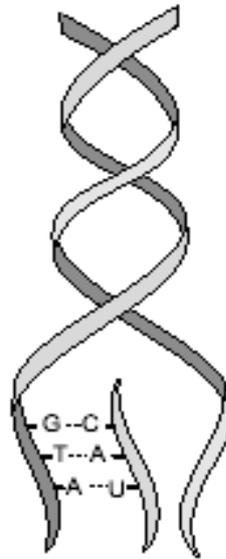
# How does DNA replicate?

- DNA Replication:
  - During Interphase of mitosis and meiosis, DNA molecule *replicates*:
    1. The double-stranded DNA molecule unzips along the hydrogen bonds
    2. The 2 strands of DNA separate
    3. Nitrogenous bases pair up
    4. 2 identical DNA molecules are produced



# DNA Replication

- Free nucleotides inside the nucleus attach themselves by new hydrogen bonds to the newly exposed bases.
  - (A-T) and (C-G)
- The new, replicated double-stranded molecules are **IDENTICAL** to the original molecule.



# Gene Control of Cellular Activity

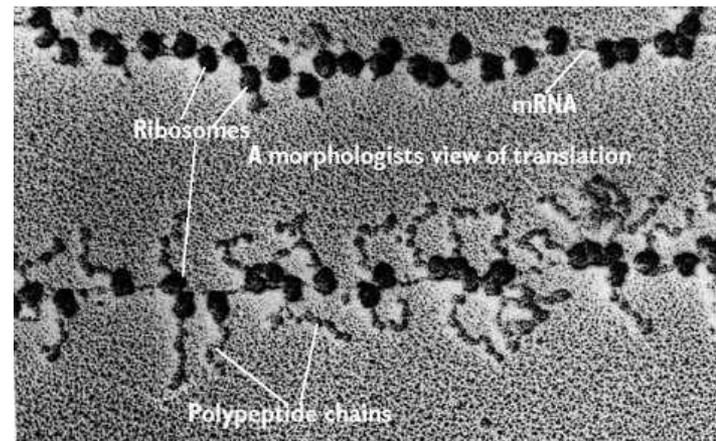
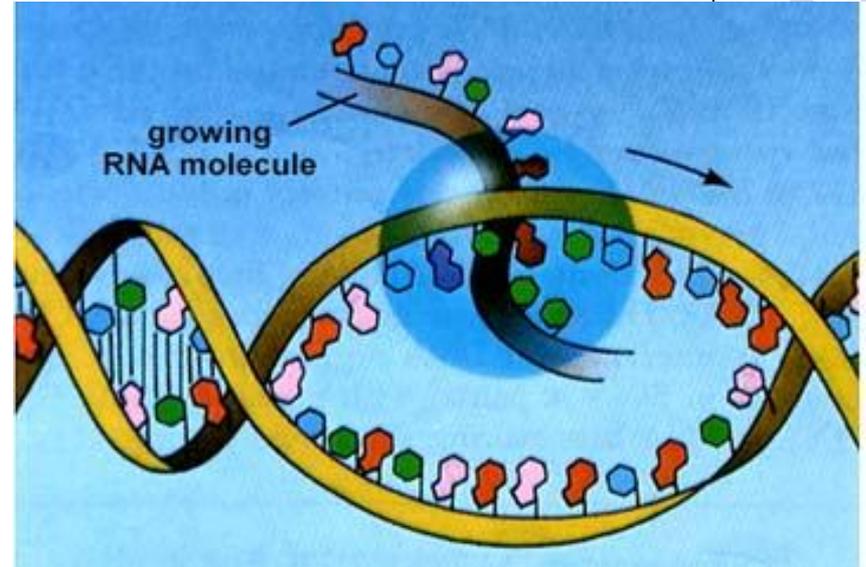


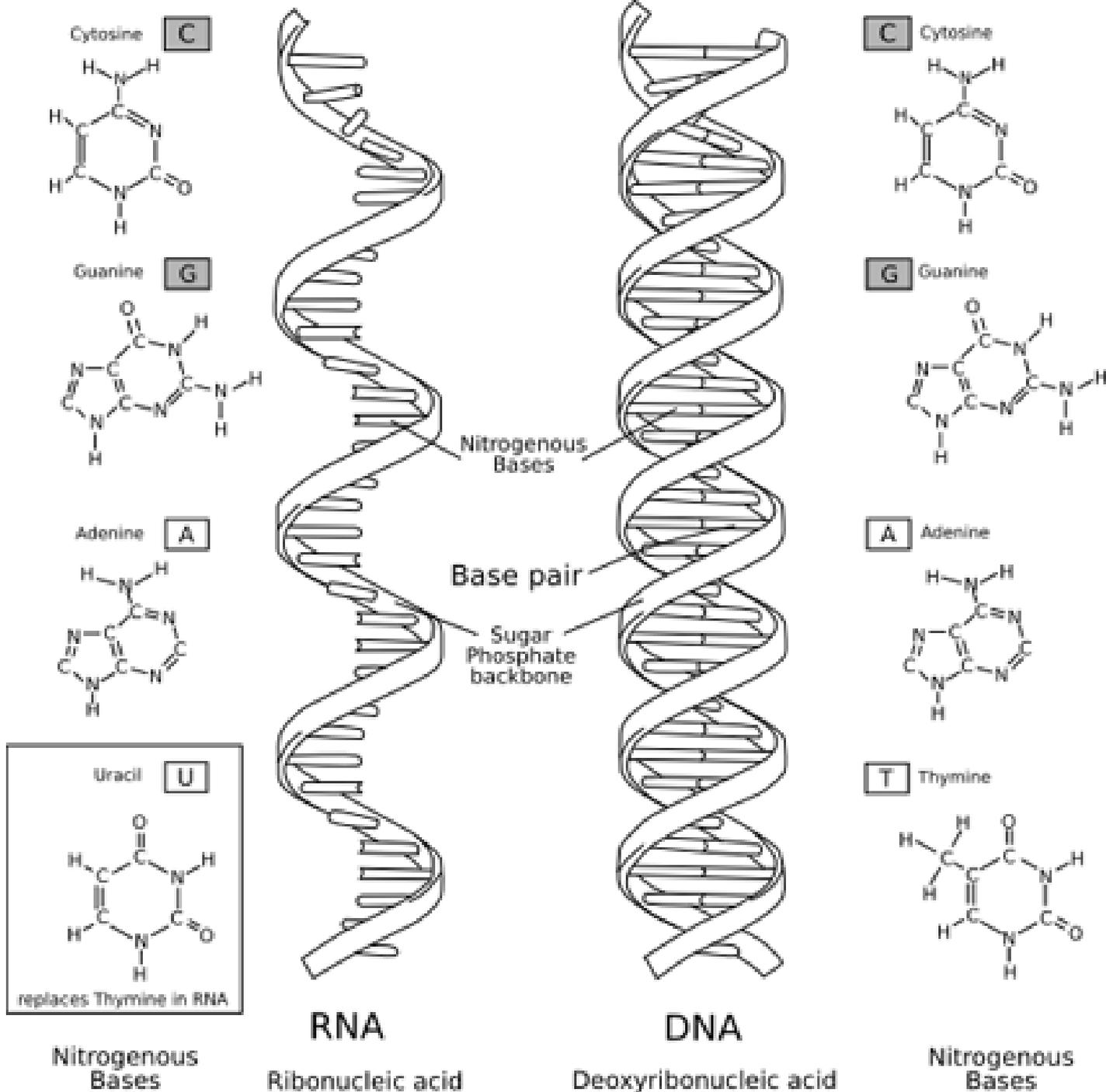
- *DNA helps to make the proteins that control all of the activities in a cell*
- Genes control cellular activities by specifying a protein to be made in the cytoplasm
- The hereditary information is in the sequence of the nucleotides in the DNA molecules
- The genetic control of protein synthesis involves RNA & DNA

# RNA (ribonucleic acid)



- Polymer formed by a sequence of nucleotides
- Single strand
- Sugar molecule in RNA is **ribose**
- The base **Uracil (U)** takes the place of thymine
- **Adenine (A)-Uracil (U)**
- Cytosine (C) –Guanine (G)
- 3 Types of RNA:  
messenger RNA (mRNA),  
transfer RNA (tRNA), and  
ribosomal RNA.





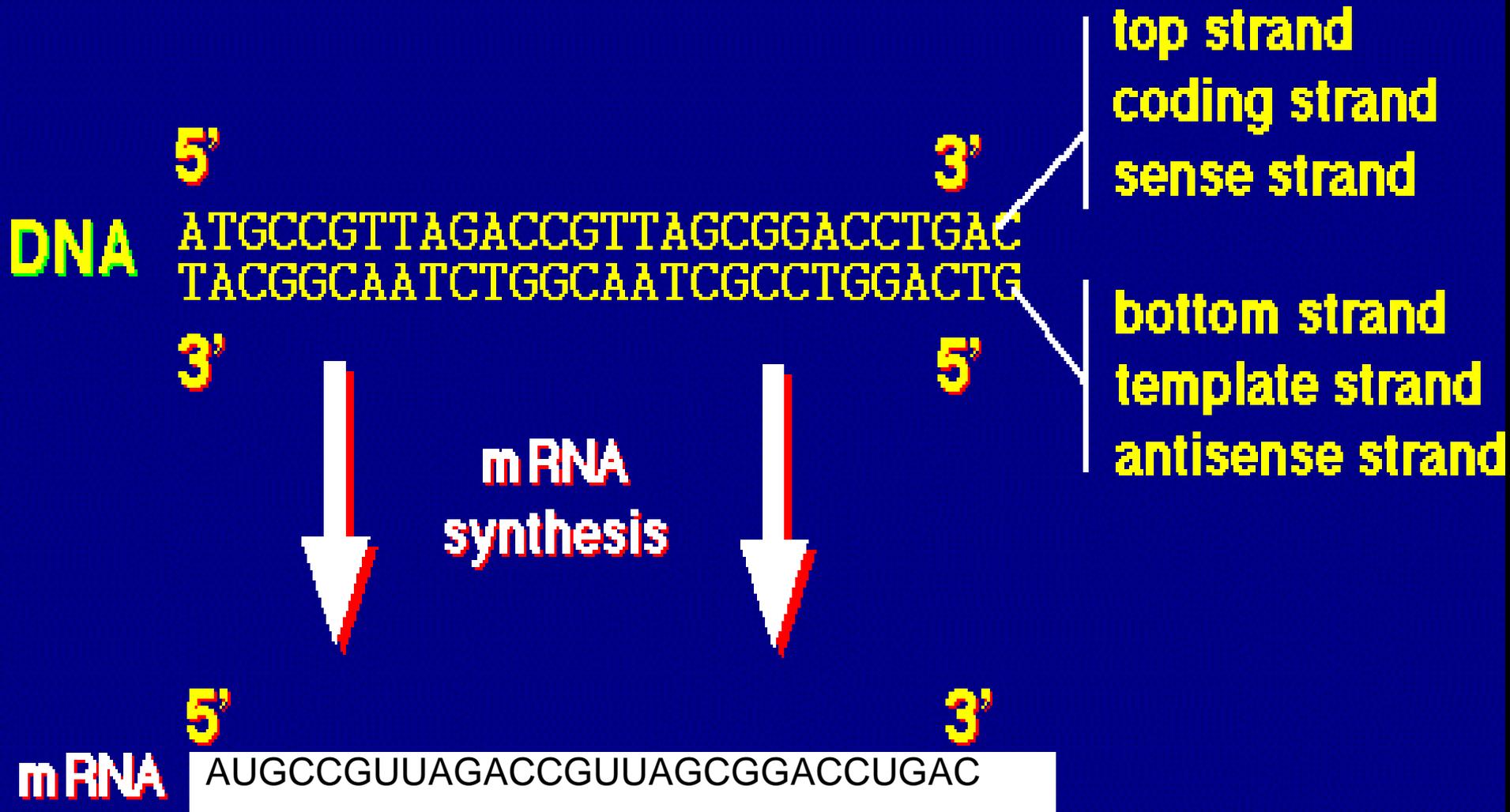
# Step 1 of Protein Synthesis



- **TRANSCRIPTION**
- Synthesis of mRNA
- Occurs **inside** the nucleus
- The double-helix of DNA separates (“unzips”) at the nitrogenous bases
- Base-pairing occurs = match up the bases
- A mRNA (messenger RNA) strand has now been made
- Practice: Make a mRNA strand from the following unzipped DNA strand: \*(In RNA, U replaces T!!!)

**GCTTACAAGGCGAATACT**

# TRANSCRIPTION





# TRANSCRIPTION

DNA

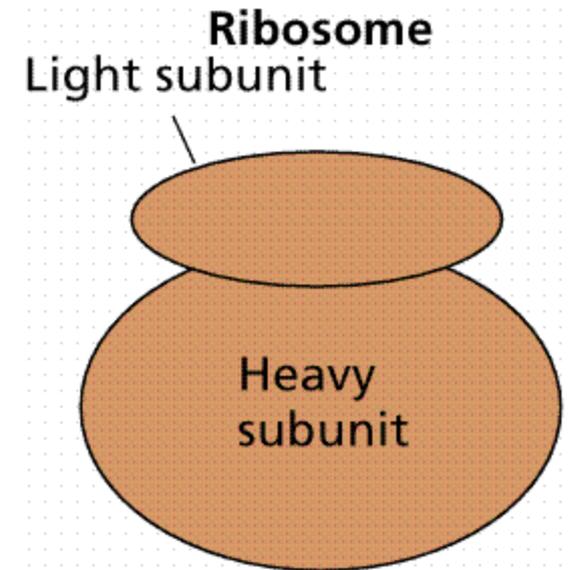
- Once the mRNA strand is complete, the original DNA strand “re-zips”
- Transcription is complete!
- New mRNA strand we just created:  
CGAAUGUUC CGCUUAUGA
- Each sequence of 3 nitrogenous bases → **Codon (triplet code)**
- These codons will be interpreted (or “translated”) in the next step of protein synthesis.....

# We have mRNA. Now what?

## Step 2 of Protein Synthesis



- **TRANSLATION**
- This is when Protein Synthesis actually occurs using the mRNA made in Transcription
- Messenger RNA moves to the cytoplasm and attaches to ribosome: (site of protein synthesis)
- At the ribosome, tRNA (transfer RNA) brings an amino acid to match the codons of the mRNA sequence





# How are codons translated into amino acids?

By using the “Universal Genetic Code Chart”

First Letter	Second Letter				Third Letter
	U	C	A	G	
<b>U</b>	phenylalanine	serine	tyrosine	cysteine	<b>U</b>
	phenylalanine	serine	tyrosine	cysteine	<b>C</b>
	leucine	serine	stop	stop	<b>A</b>
	leucine	serine	stop	tryptophan	<b>G</b>
<b>C</b>	leucine	proline	histidine	arginine	<b>U</b>
	leucine	proline	histidine	arginine	<b>C</b>
	leucine	proline	glutamine	arginine	<b>A</b>
	leucine	proline	glutamine	arginine	<b>G</b>
<b>A</b>	isoleucine	threonine	asparagine	serine	<b>U</b>
	isoleucine	threonine	asparagine	serine	<b>C</b>
	isoleucine	threonine	lysine	arginine	<b>A</b>
	(start) methionine	threonine	lysine	arginine	<b>G</b>
<b>G</b>	valine	alanine	aspartate	glycine	<b>U</b>
	valine	alanine	aspartate	glycine	<b>C</b>
	valine	alanine	glutamate	glycine	<b>A</b>
	valine	alanine	glutamate	glycine	<b>G</b>

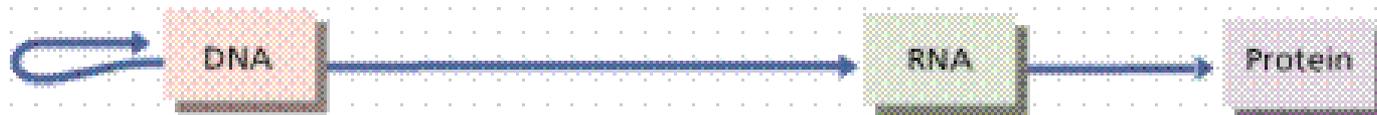
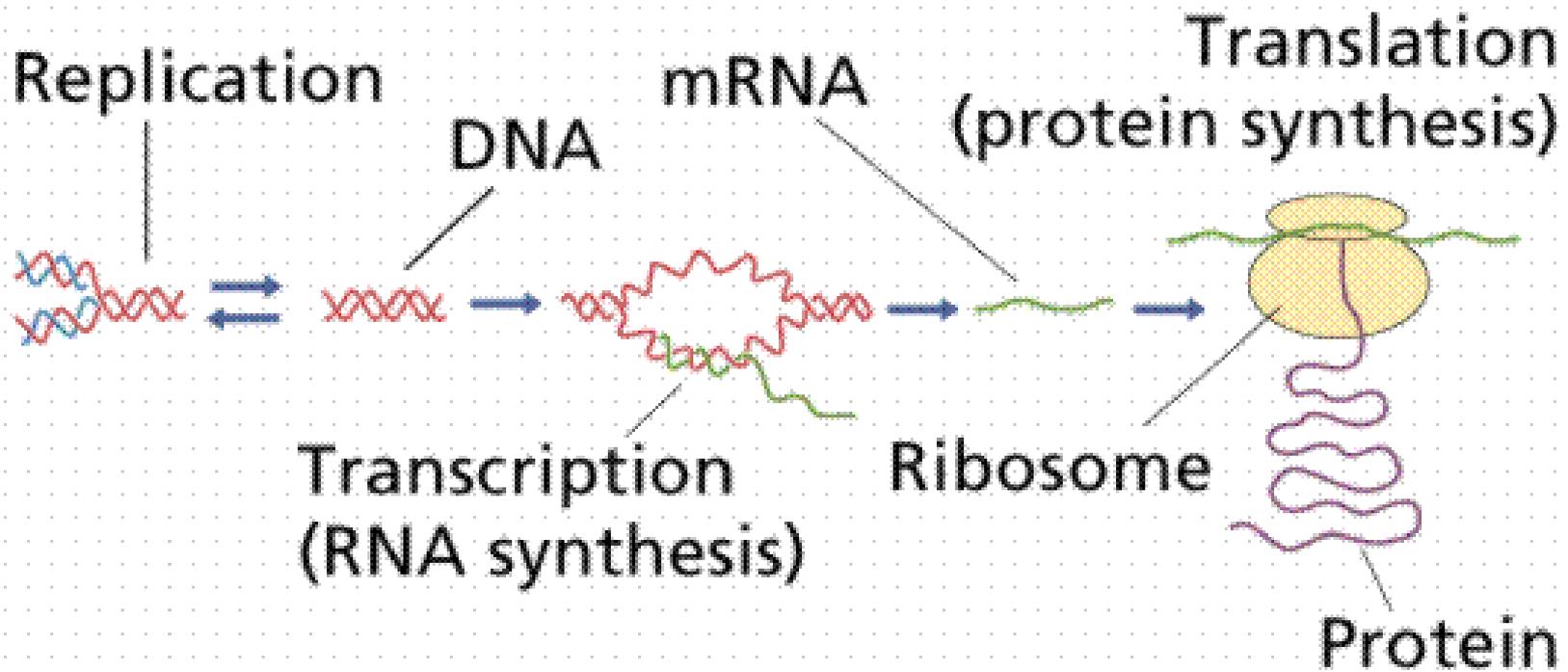
# Using the Universal Genetic Code

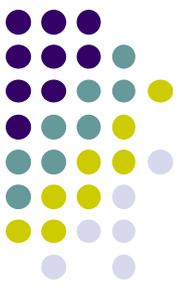


- <http://learn.genetics.utah.edu/content/begin/dna/transcribe/>

# TRANSLATION

- The amino acids are then **TRANSLATED** into long chains of **PROTEINS** (polypeptides)





# Maybe This Will Help 😊

<b>PROTEIN SYNTHESIS</b>	<b>CANDY FACTORY</b>
<p>(1) mRNA transcribed from DNA</p> <p>(2) mRNA exits through nuclear pore to cytoplasm/ribosomes</p> <p>(3) tRNA binds to amino acids</p> <p>(4) loaded tRNA bonds mRNA at ribosomes</p> <p>(5) polypeptide chain grows in response to mRNA codons</p> <p>(6) completed protein either used by cell or is packaged and exported</p>	<ul style="list-style-type: none"><li>• boss gives recipe to messenger</li><li>• messenger leaves office through door; goes to factory floor and to workstations</li><li>• workers pick up ingredients</li><li>• workers assemble ingredients at workstation</li><li>• ingredients are combined according to recipe</li><li>• candy assembly finished; workers eat some, rest is wrapped for shipment</li></ul>

# Aim: How do errors occur in the inheritance of traits?

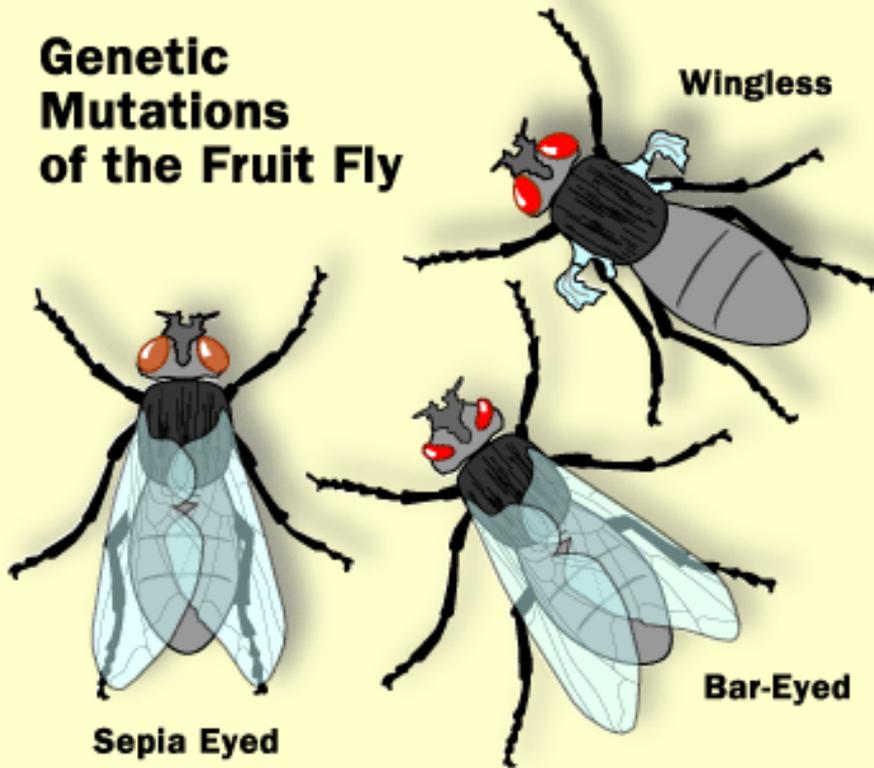


- Mutations: Any change in the genetic material (DNA) of a cell.
- *Types of Mutations*:
  1. Inheritable mutations: occurs in the formation of gametes (sperm or egg) of an organism and **can be** inherited by offspring and passed on.
  2. Nonheritable mutations: occurs in body cells (somatic cells) and may spread in that organism if cell multiplies. (cannot be inherited) Why?

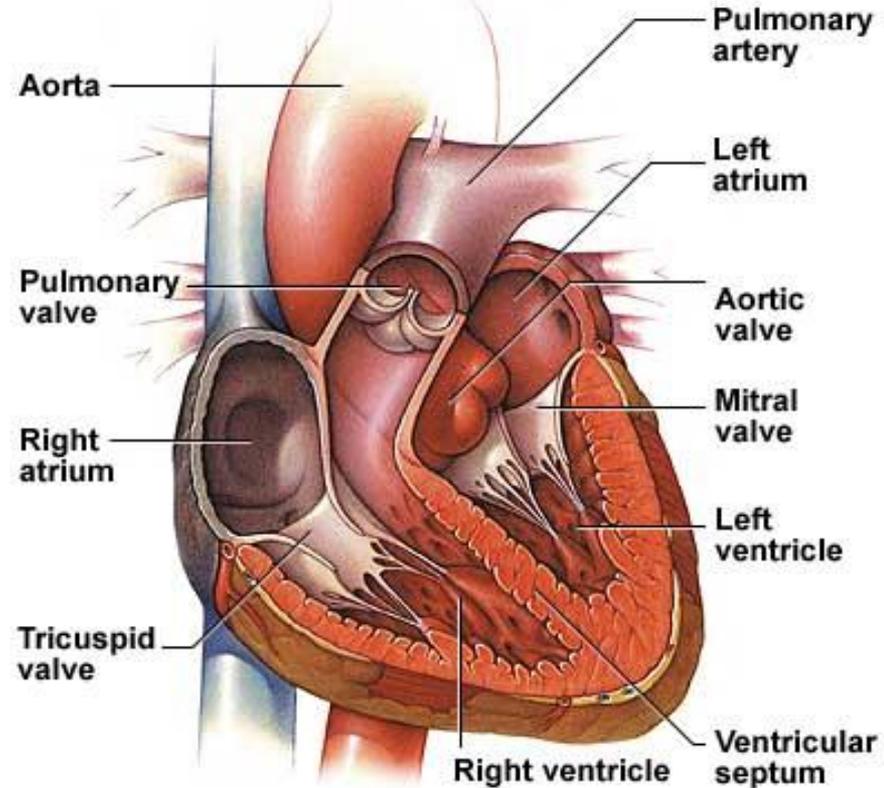
# Inheritable Mutation – received from parents



## Genetic Mutations of the Fruit Fly



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# Noninheritable Mutations

- Affects body cell: why can't this affect the next generation?
- Because the mutation did not occur in the gamete!



Asymmetry

Border  
irregularity

Color

Diameter:  
 $\frac{1}{4}$  inch or  
6mm

# Types of Mutations

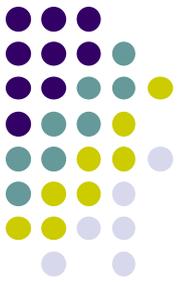


- *Types of mutations:*

1. **Chromosomal mutations:**

- Any change in 1) the number OR 2) the structure of chromosomes in a cell.
- Changes in chromosomal number:
  - Nondisjunction: failure of **homologous** chromosomes to separate during meiosis (Anaphase II). Results in **gametes** with one more or one fewer chromosome
  - Ex: Down's Syndrome (3 chromosome #21)

# Gene Mutation



2. **Gene Mutation**: change in the **chemical** structure of the **DNA**.
  - Ex: Albinism (absence of skin **pigment**).
  - Mutations can be **disadvantageous** to individuals in their normal environment
  - Some are beneficial because they cause shifts in the **gene** pool (VARIATION) of the species resulting in **evolution of a species**.

# Mutations



Albino Alligator

# Mutagenic Agents = Mutagens (something that causes mutations)



1. *Radiation*: X-rays, ultraviolet (UV), cosmic rays, radiation from radioactive substances.
2. *Chemicals*: Benzene, formaldehyde, and asbestos.
3. *Tobacco*



# Chemical: mutagenic agents



In Cigarettes:  
ammonia,  
formaldehyde,  
caffeine, ethyl  
alcohol, lactic  
acid, CO,  
arsenic