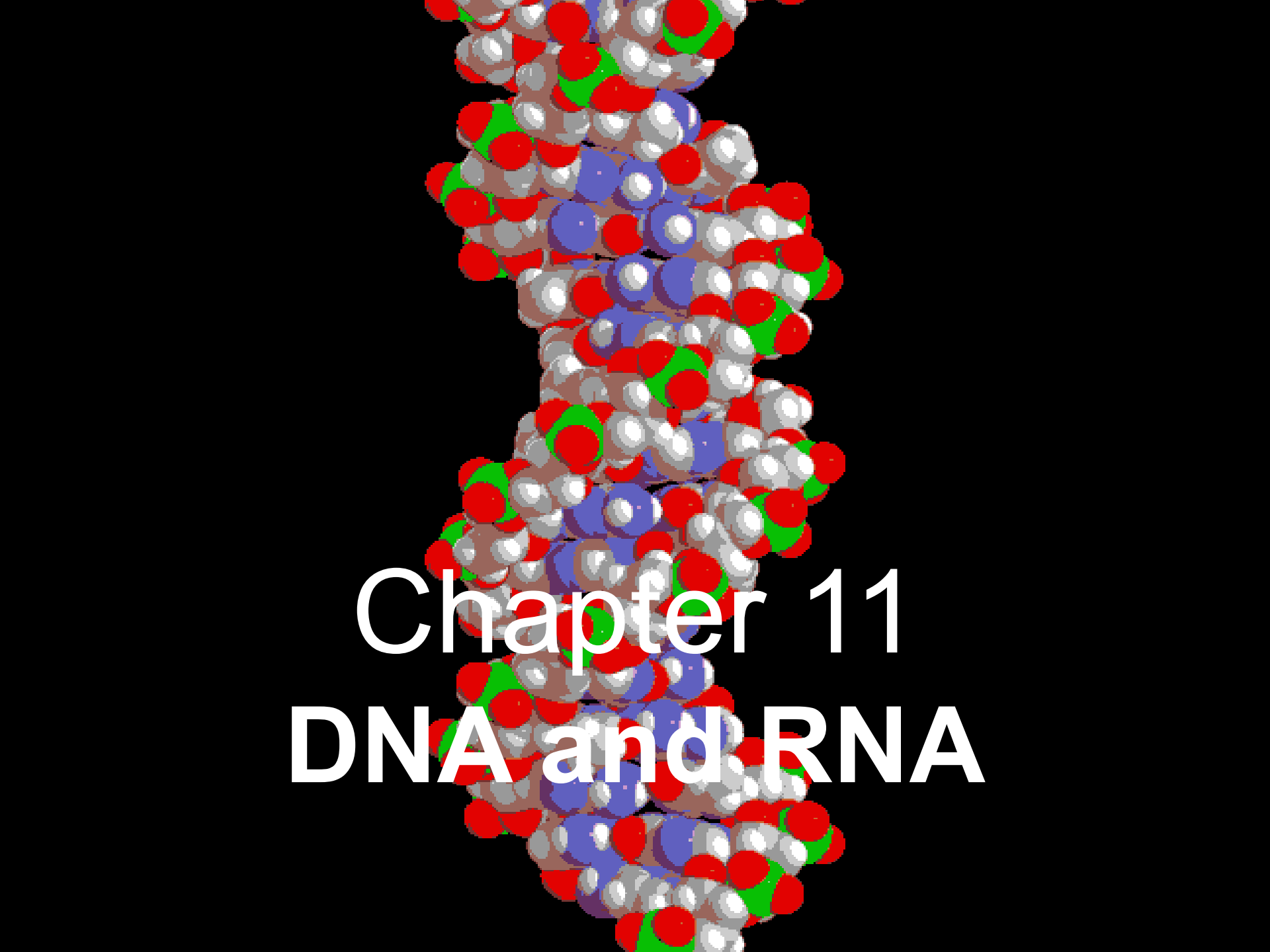


Chapter 11
DNA and RNA

DNA and RNA

I. DNA- deoxyribonucleic acid

A. History of DNA as Genetic Material "code of life"

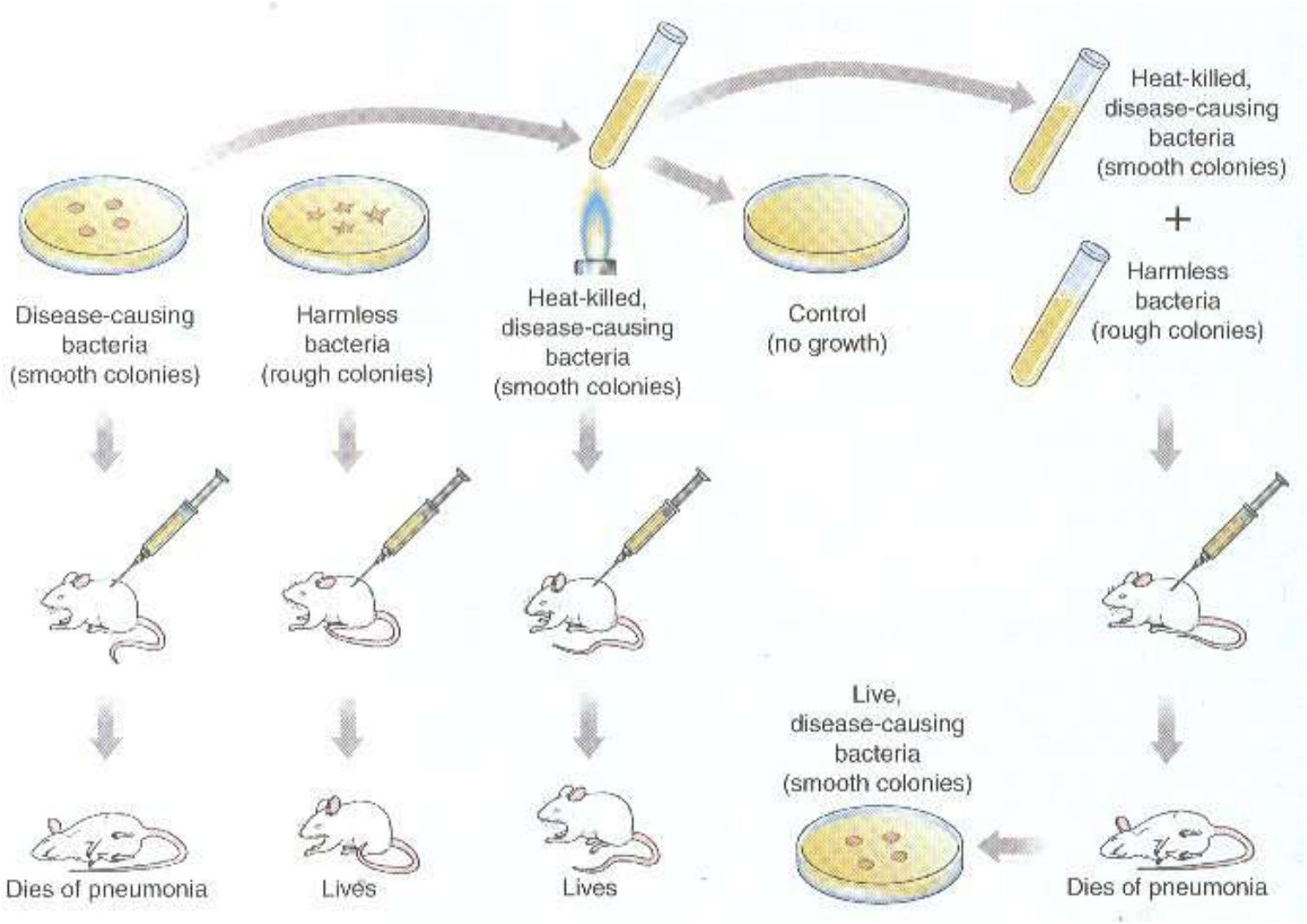
1. Griffith and Transformation

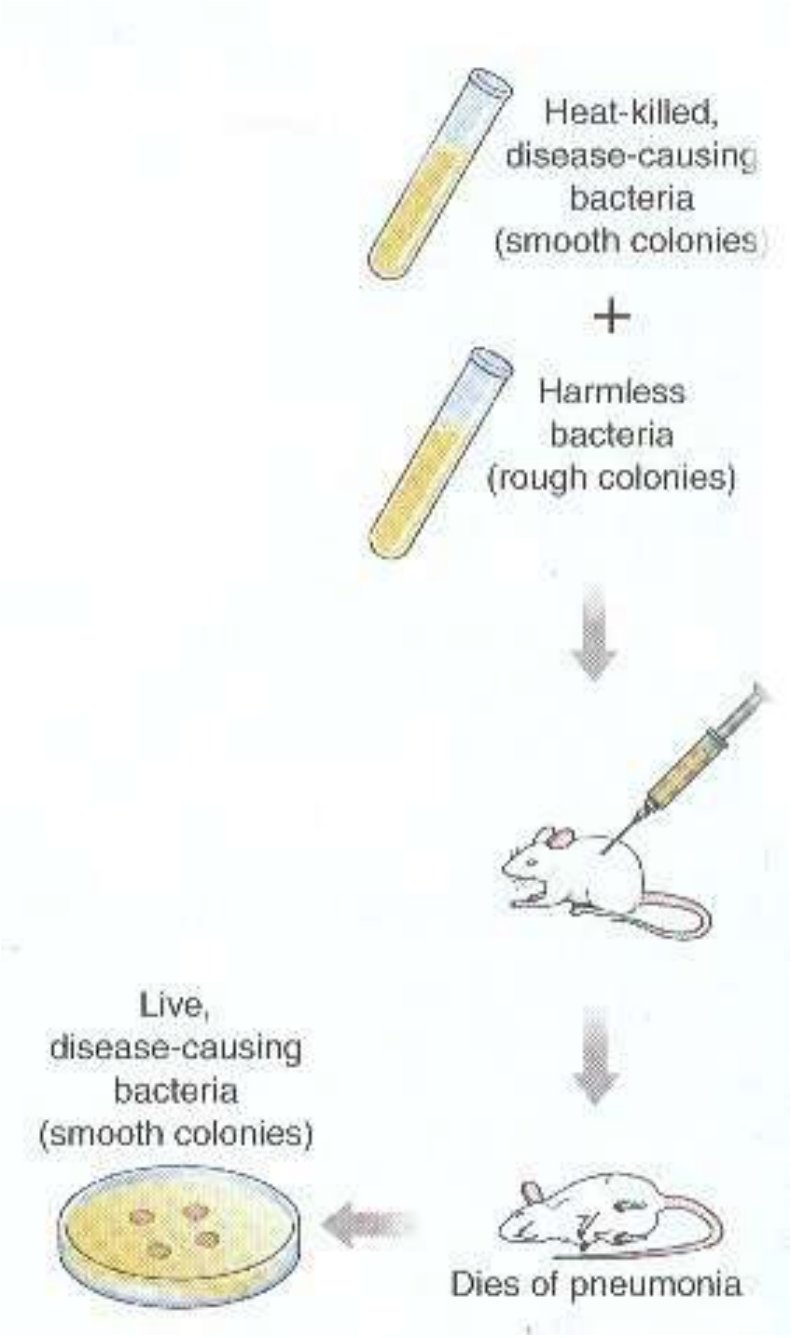
   a. Frederick Griffith made discovery while investigating bacteria known to produce pneumonia

   b. Griffith isolated two different strains of bacteria

1). Disease causing strain- had <u>smooth</u> edges. When injected into mice caused pneumonia.

2). Harmless strain- grew with <u>rough</u> edges.





c. When disease causing bacteria heated- mice survived when injected

d. Mixed the heated-killed bacteria and harmless ones. When injected caused pneumonia. Concluded that one strain had been changed into another. Called transformation.

2. Avery and DNA- group of scientists repeated Griffith's experiment to discover "transforming" factor.

a. Made extract from heat-killed bacteria

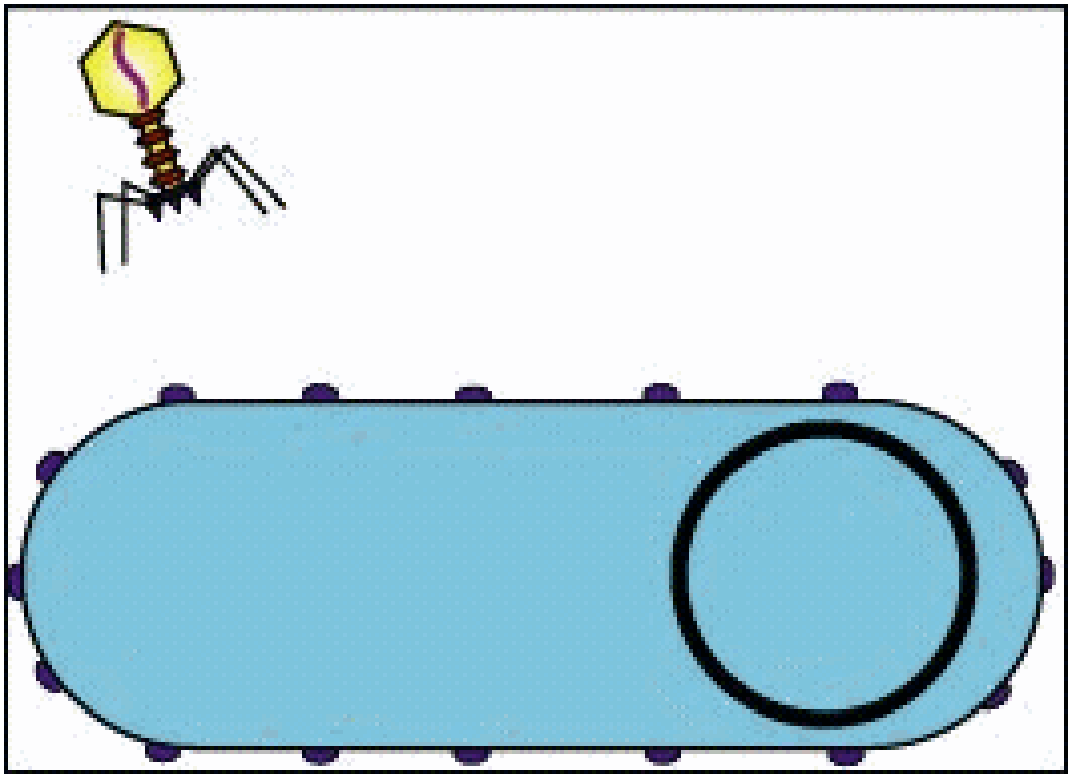
b. Treated extract with enzymes that destroyed proteins, lipids, carbohydrates, and other molecules- **transformation still occurred.**

c. Repeated using enzymes that would break down DNA. **Transformation did not occur!**

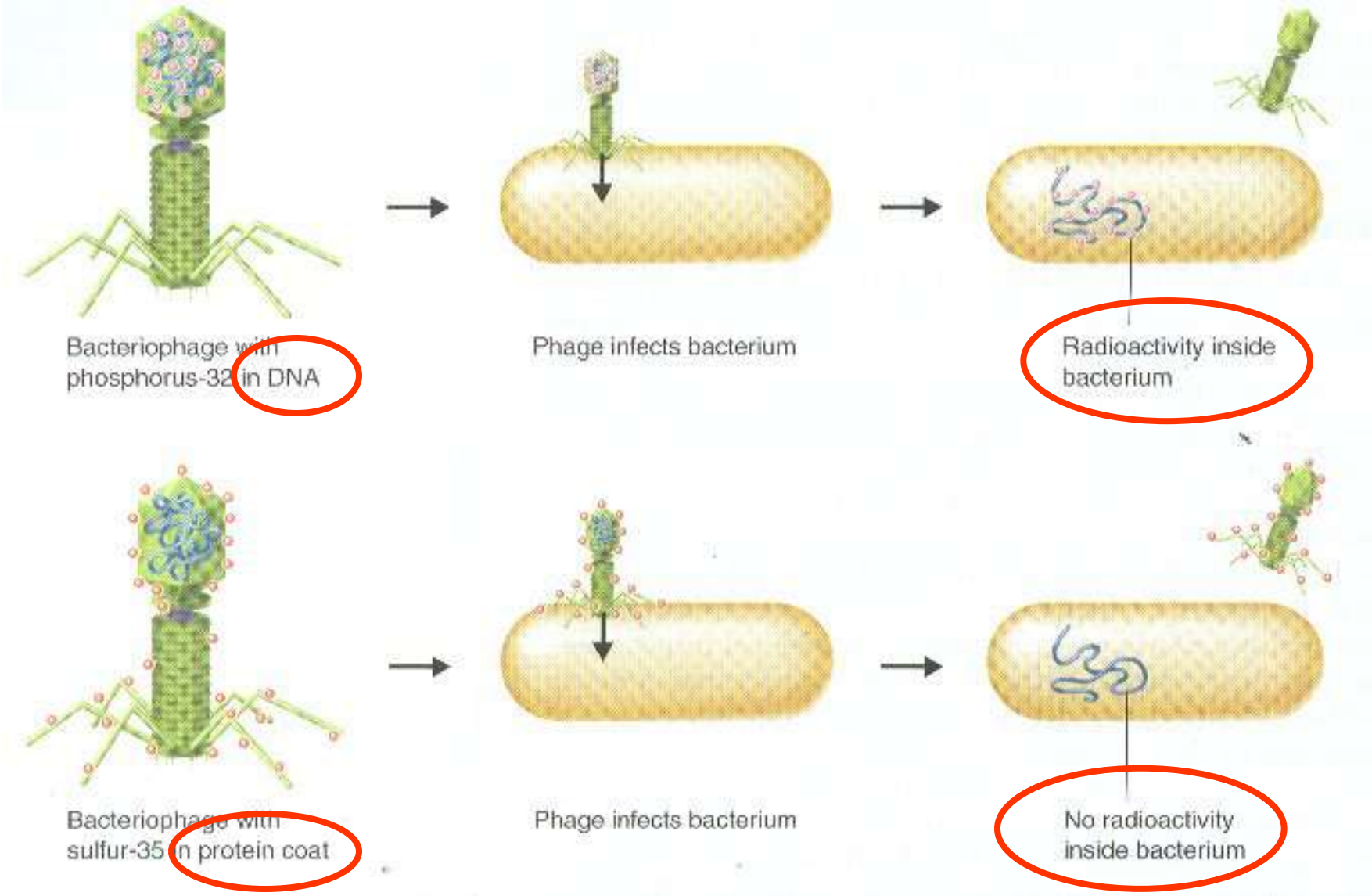
d. Concluded- DNA carries genetic code

3. Hershey-Chase Experiment- (1952) showed conclusively that DNA was molecule that carried genetic code

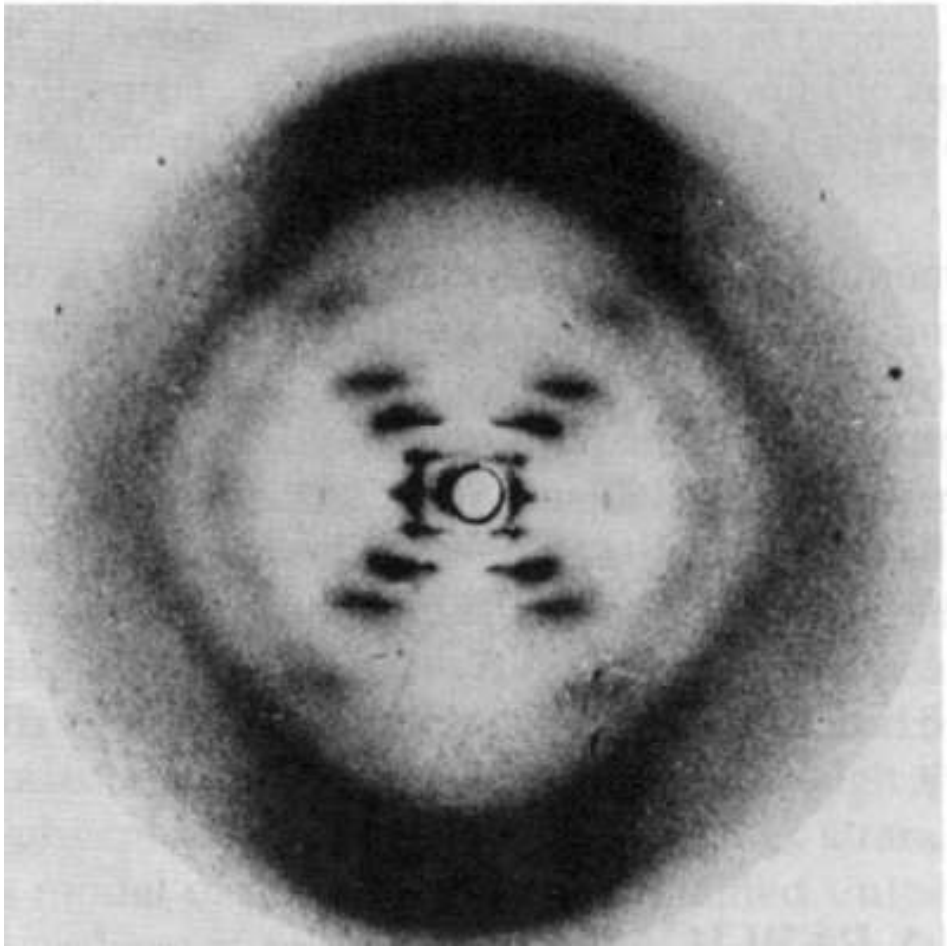
a. Studied viruses known as **bacteriophages**



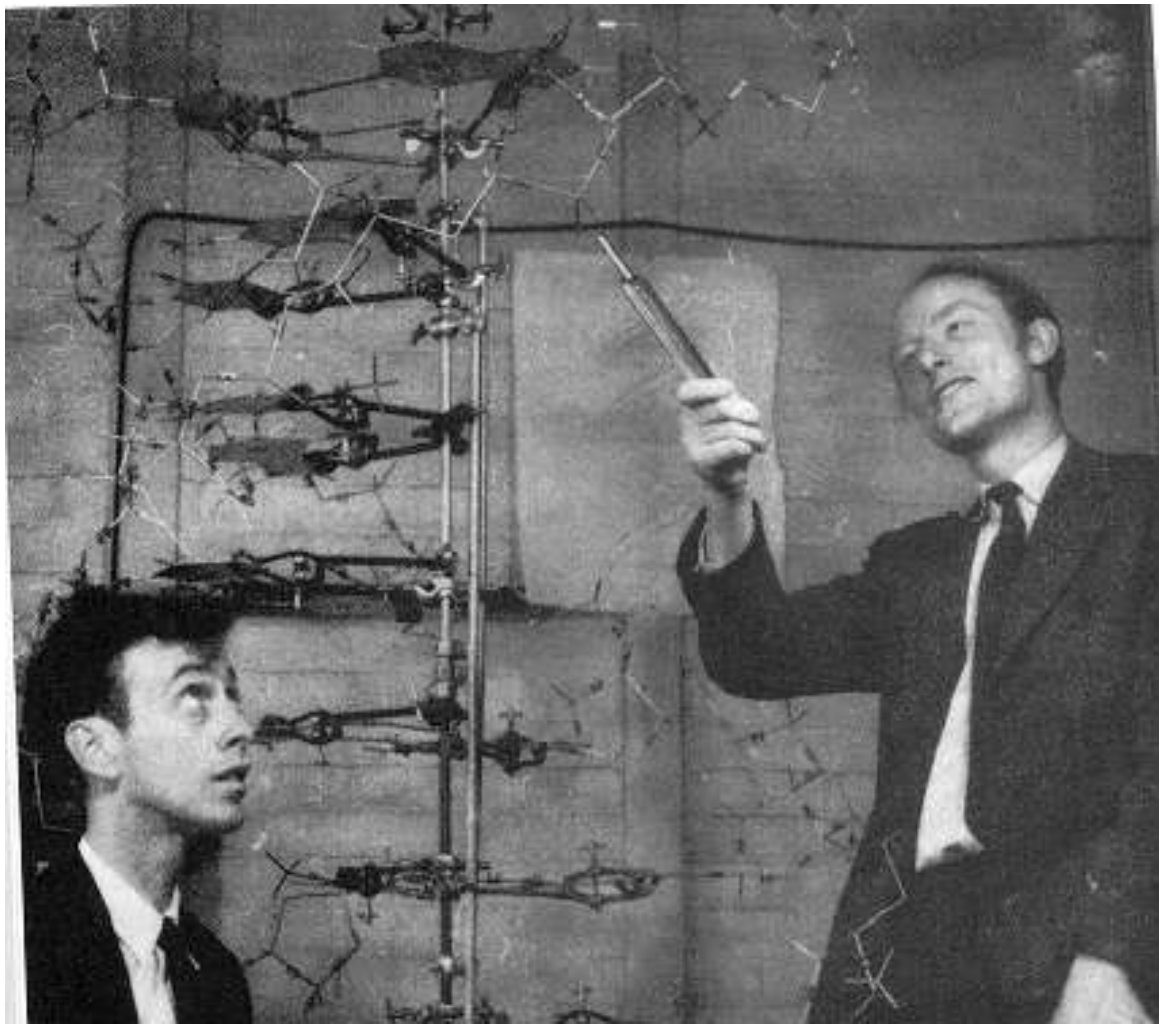
b. Used different radioactive markers to label DNA and proteins of bacteriophages



b. X-Ray evidence- 1950's Rosalind Franklin used X-ray diffraction to study structure of DNA molecule. Concluded structure was coiled like a spring (**helix**)



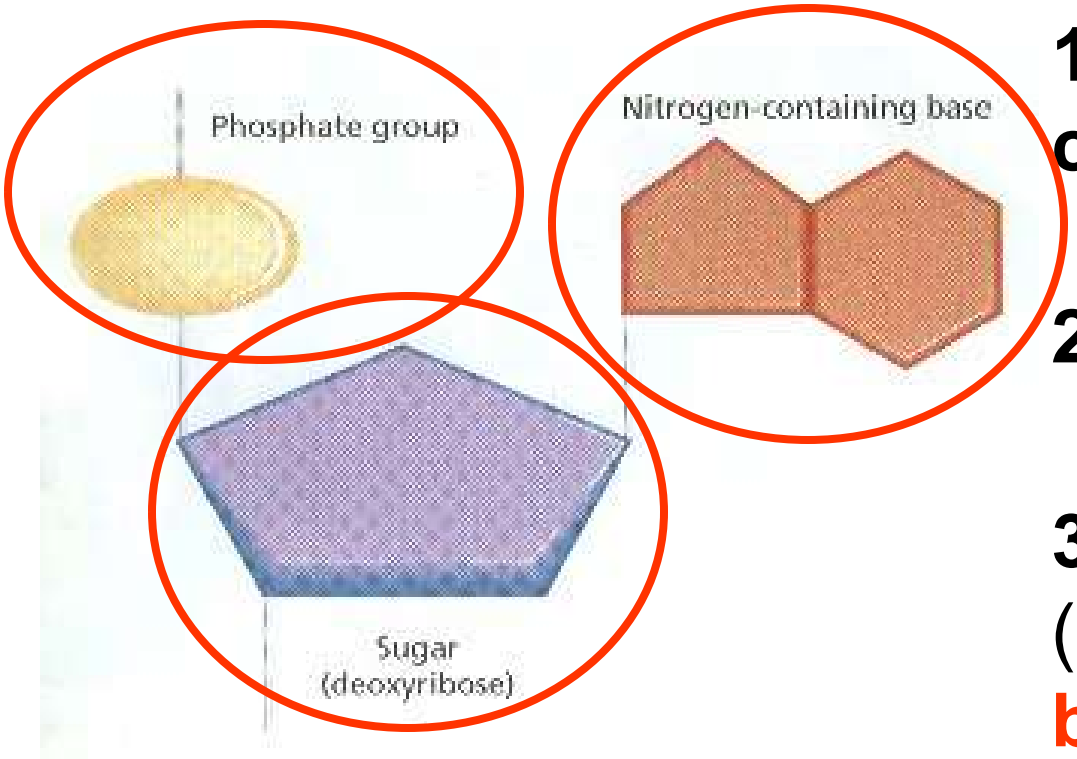
c. The Double Helix- after looking at Franklin and Wilkin's work, Watson and Crick constructed a model of DNA molecule (1953)



B. The Structure of DNA

1. DNA made of units called **nucleotides**

   a. Nucleotides made up of **3** parts



1). 5-carbon sugar called deoxyribose

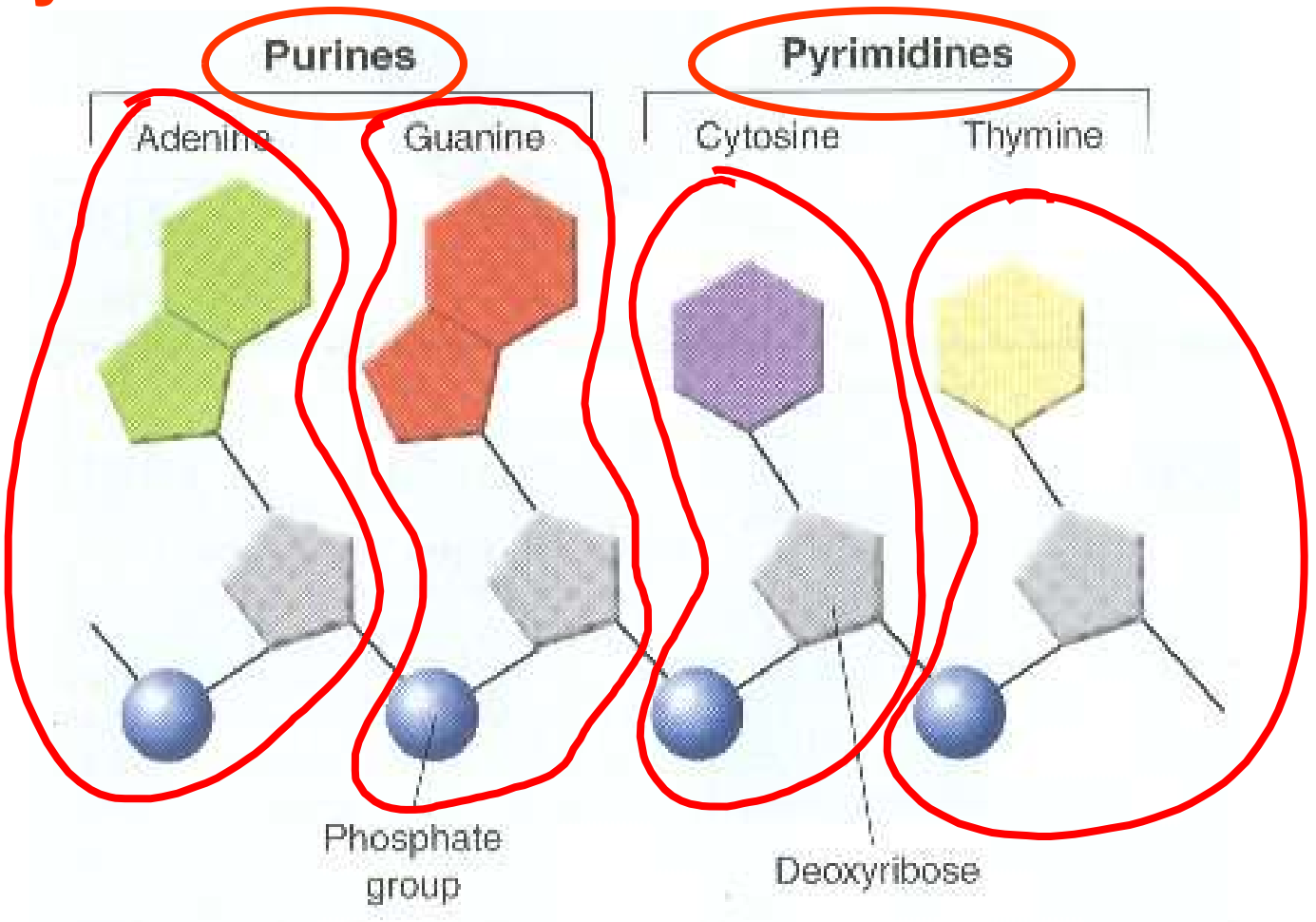
2). Phosphate group

3). Nitrogenous (nitrogen containing) **base**

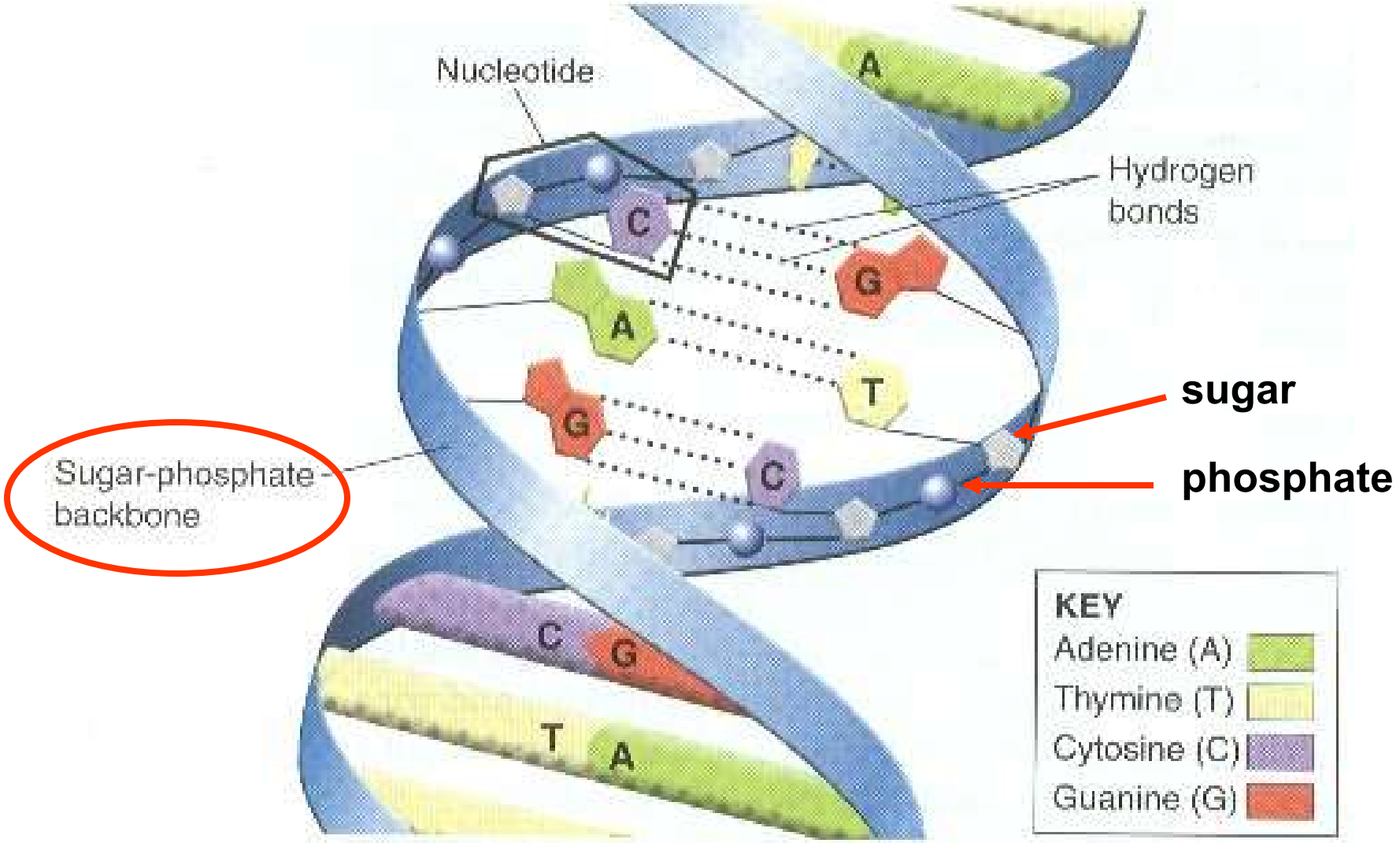
a). **Four kinds of nitrogenous bases**

b). **Purines-** include **adenine** and **guanine**

b). **pyrimidines-** include **cytosine** and **thymine**



b. Backbone of DNA chain formed by sugar and phosphate groups of nucleotides



2. **Discoveries-** understanding DNA's structure

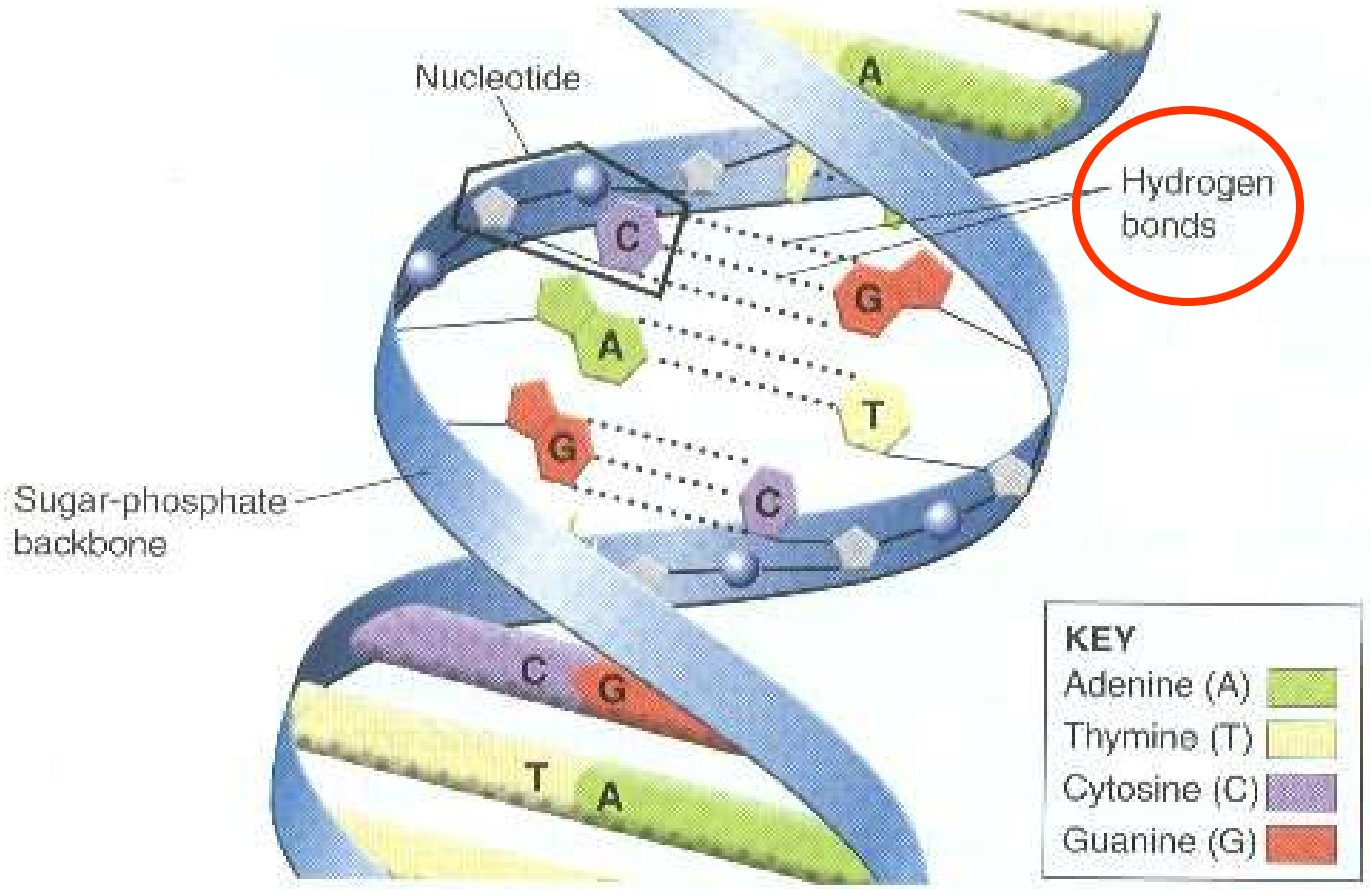
   a. **Chargaff's Rule-** ratio of guanine:cytosine and adenine:thymine are equal

Percentages of Bases in Four Organisms				
Source of DNA	A	T	G	C
Streptococcus	29.8	31.6	20.5	18.0
Yeast	31.3	32.9	18.7	17.1
Herring	27.8	27.5	22.2	22.6
Human	30.9	29.4	19.9	19.8

The amounts of A = T and G = C

1). Hydrogen bonds between base pairs holds two strands together

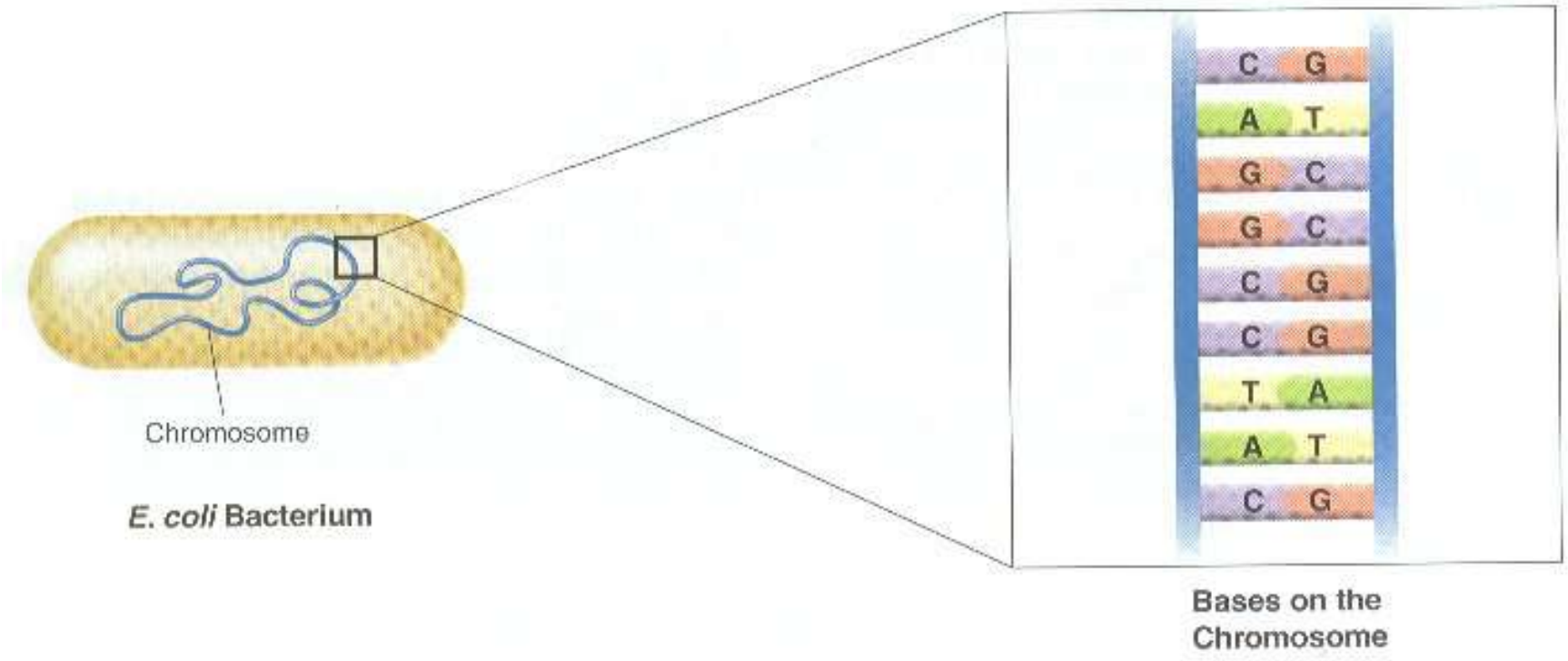
2). Base Pairing –explained Chargaff's Rule A=T and C=G



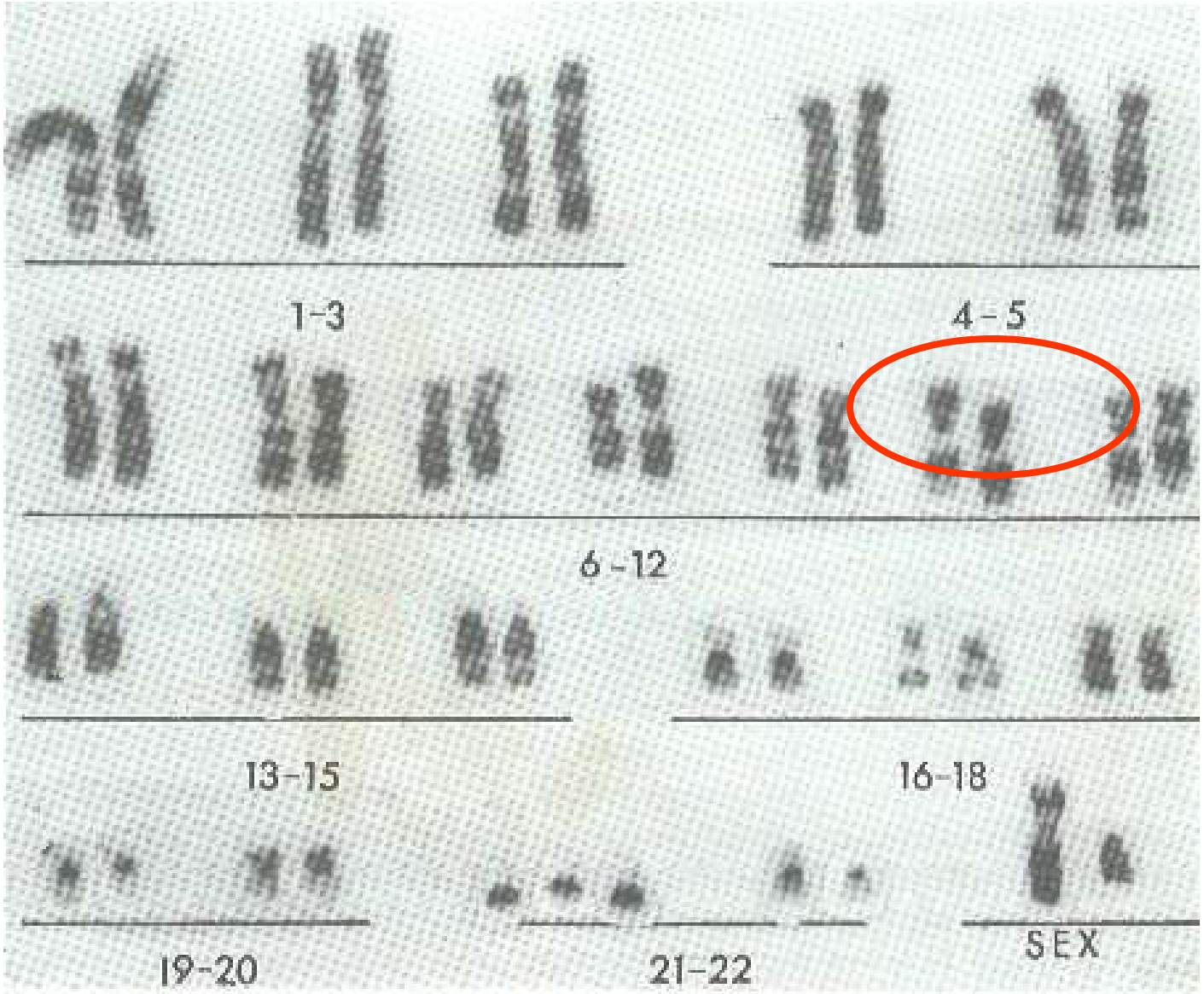
II. Chromosomes and DNA Replication

A. DNA and Chromosomes- found in both eukaryotic and prokaryotic cells

1. Prokaryotic cells- DNA located in cytoplasm in single circular DNA molecule (referred to as cell's chromosome)

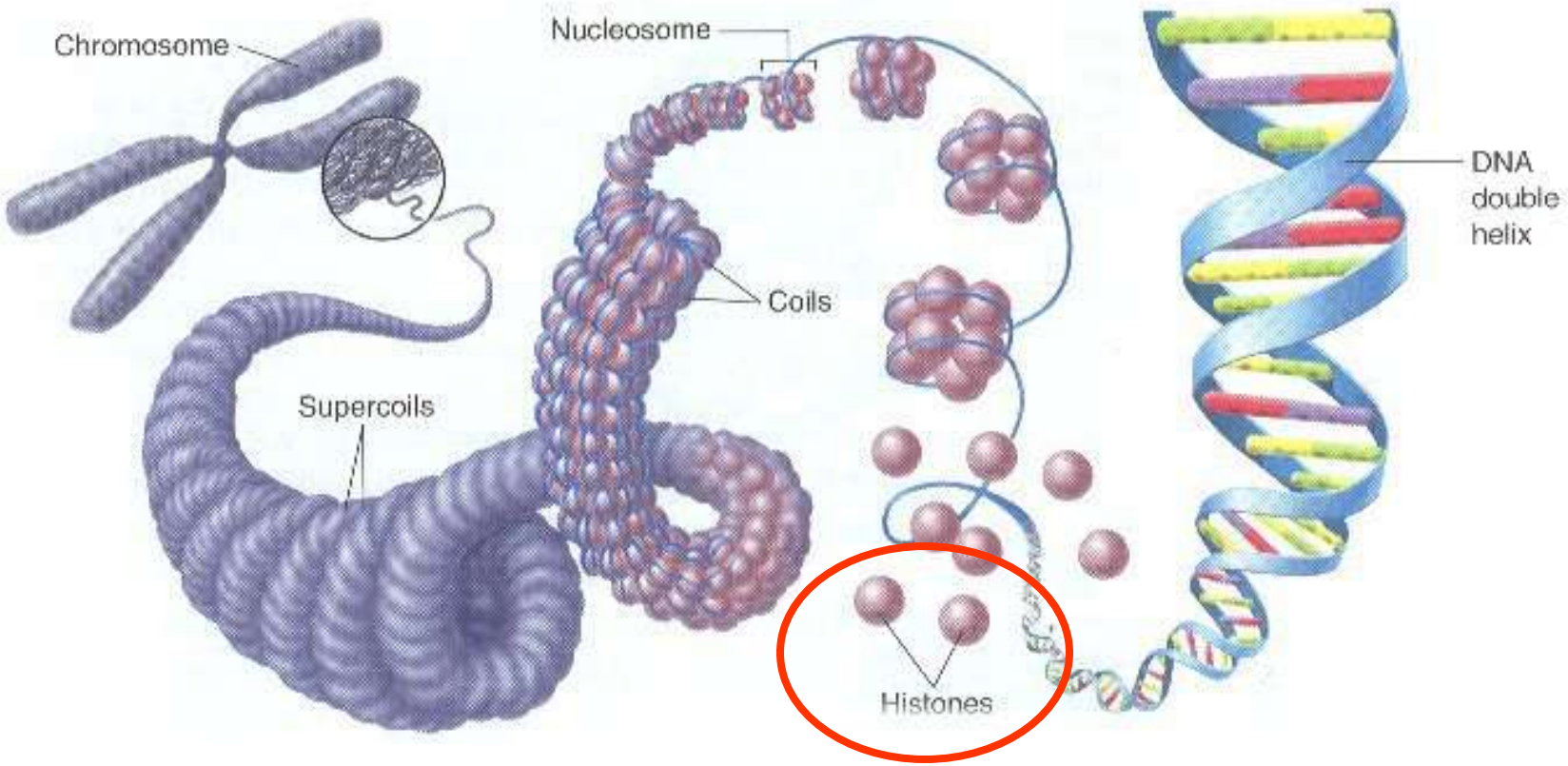


2. Eukaryotic Cells- DNA located in cells nucleus in form of a number of chromosomes

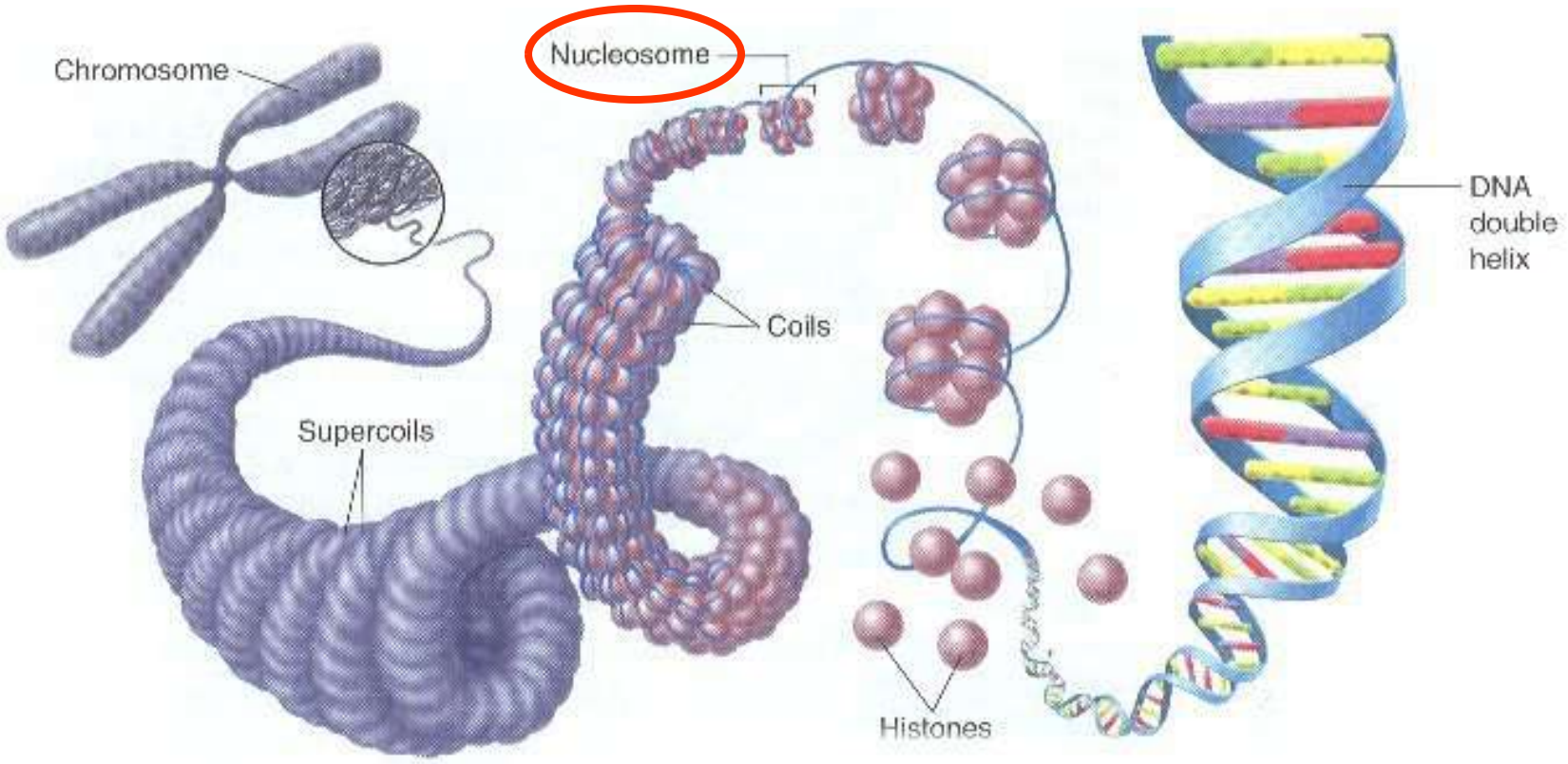


B. Chromosome Structure- even the smallest of human chromosomes contains 30 million base pairs

1. Eukaryotic chromosomes tightly packed together to form substance called **chromatin**. DNA coiled around proteins called **histones**



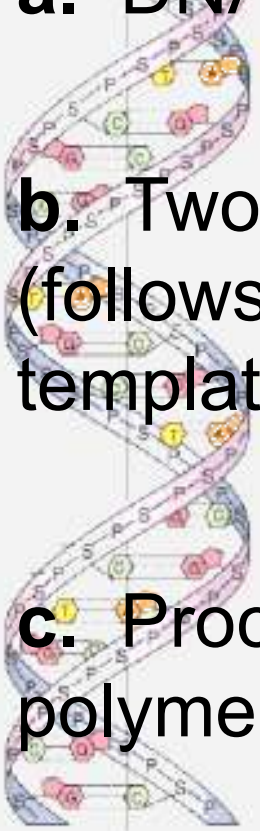
2. Nucleosome- DNA wrapped around histones



C. DNA Replication

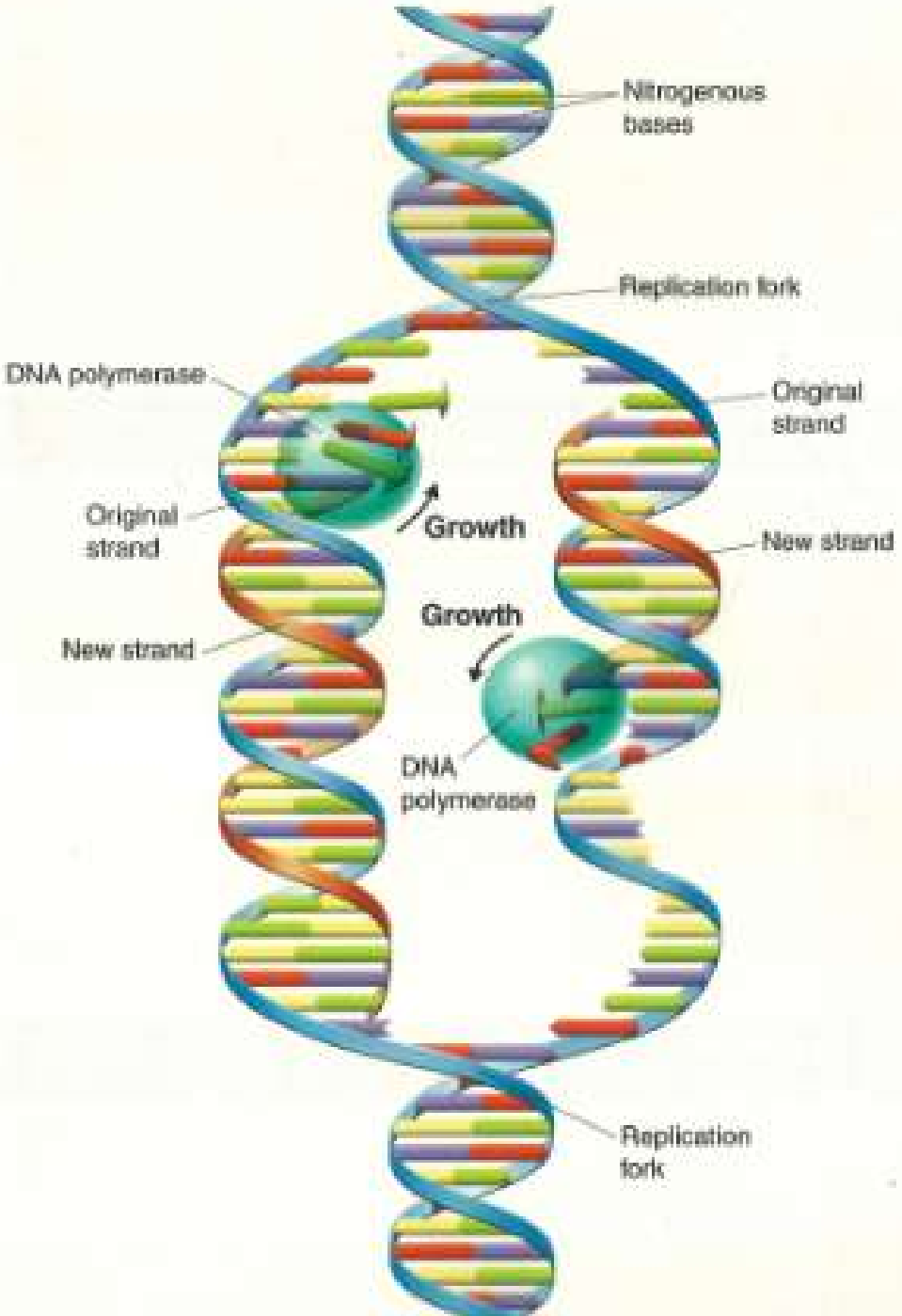
1. Duplicating DNA- before cell divides, it duplicates it's DNA in a process called **replication**

a. DNA molecule separates into two strands



b. Two new **complementary** strands produced (follows rules of base pairing) each strand serves as template for new strand

c. Process carried out by series of **enzymes** (DNA polymerase)


Nitrogenous bases
Replication fork
DNA polymerase
Original strand
Original strand
Growth
New strand
Growth
New strand
DNA polymerase
Replication fork

D. RNA and Protein Synthesis

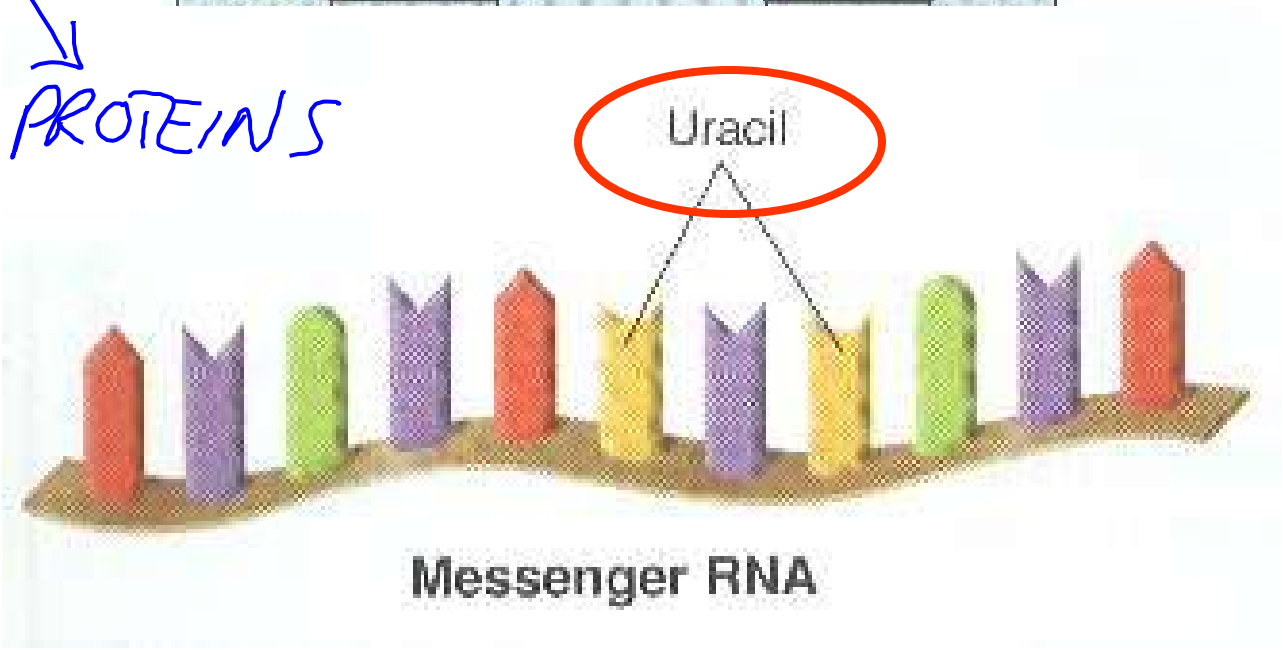
1. Structure of RNA- 3 main differences between RNA and DNA

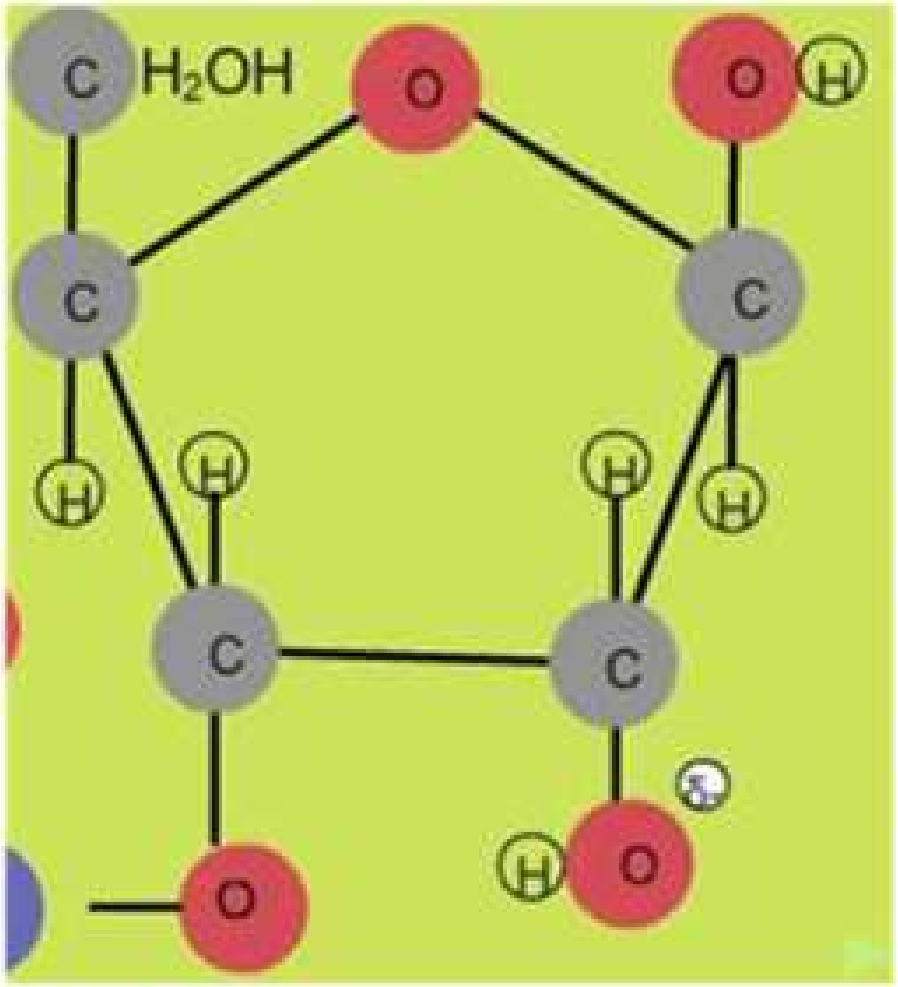
a. Sugar in RNA is **ribose**

b. RNA is **single stranded**

c. RNA contains **uracil** in place of **thymine**

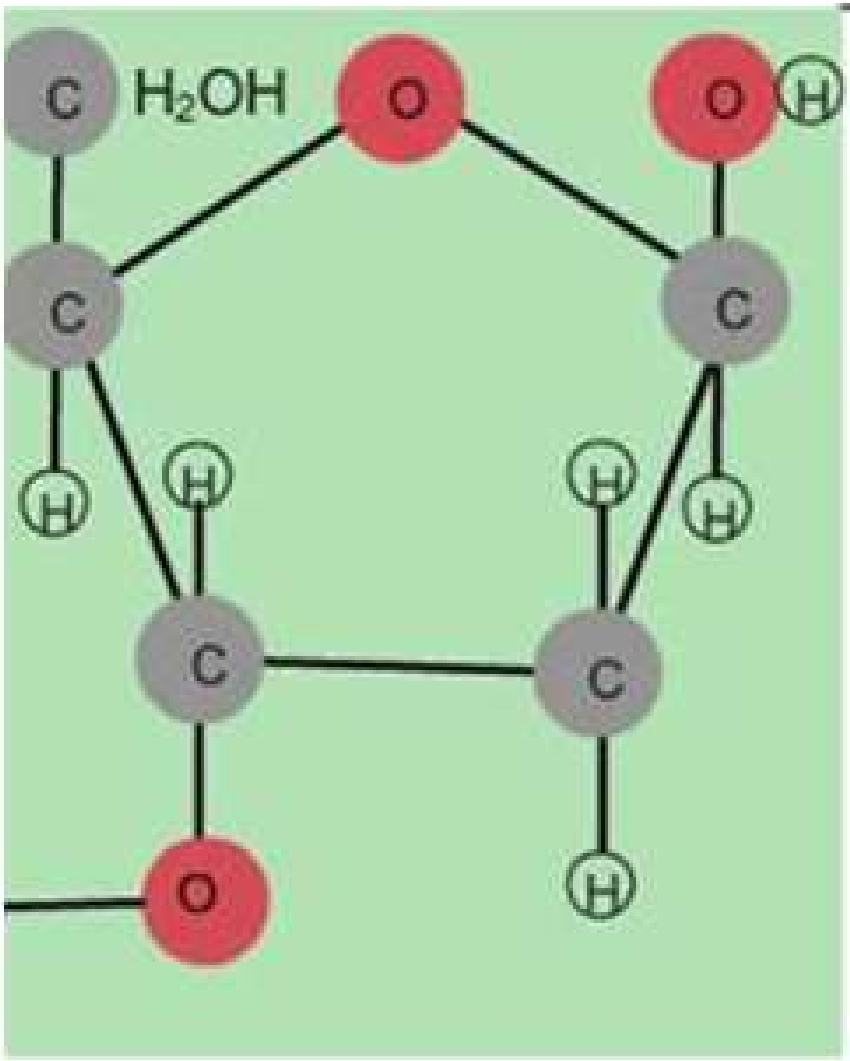
DNA → RNA → PROTEINS





Ribose

vs.

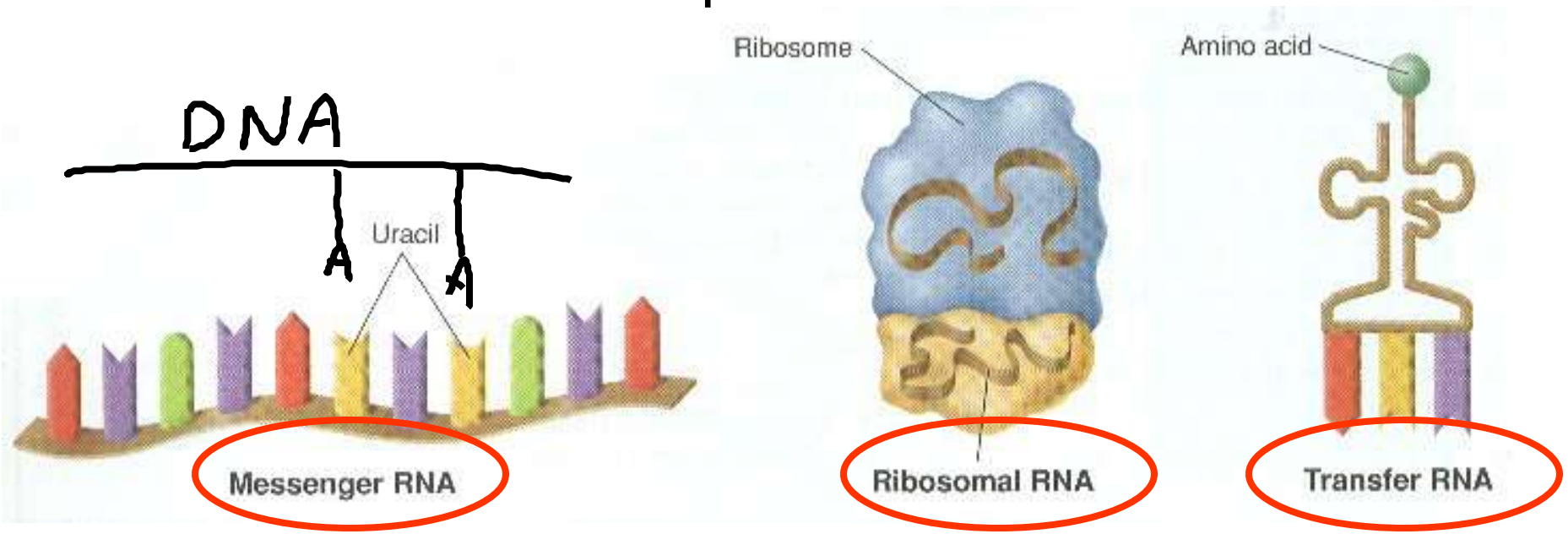


Deoxyribose

2. Most RNA involved in **Protein Synthesis**
3. **3 Types of RNA**
   a. **Messenger RNA (mRNA)-** disposable copy of DNA to carry instructions to rest of cell

DNA → RNA → PROTEIN

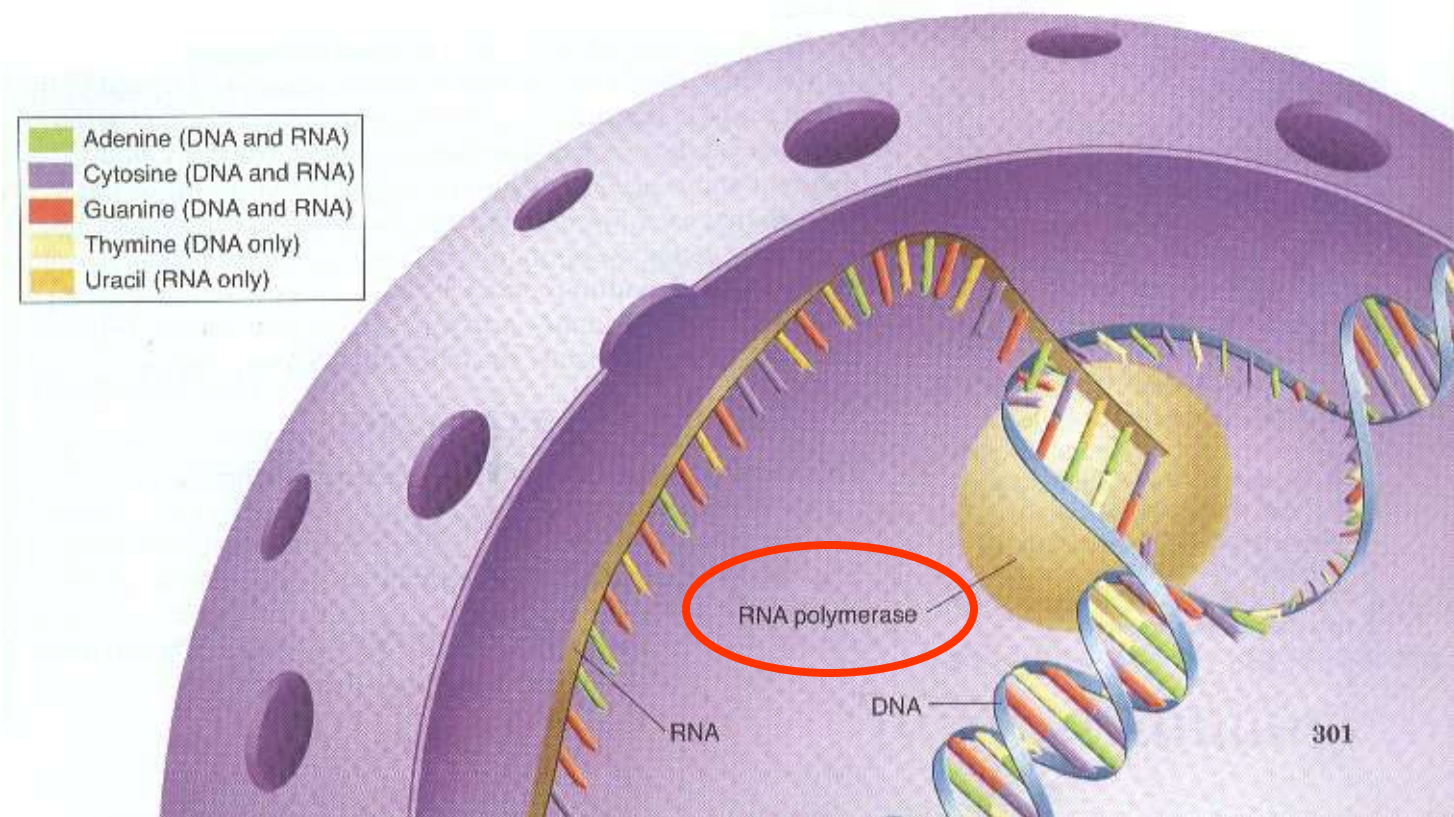
   b. **Ribosomal RNA (rRNA)-** helps to assemble proteins on ribosomes
   c. **Transfer RNA (tRNA)-** transfers amino acids to ribosomes to construct protein molecules



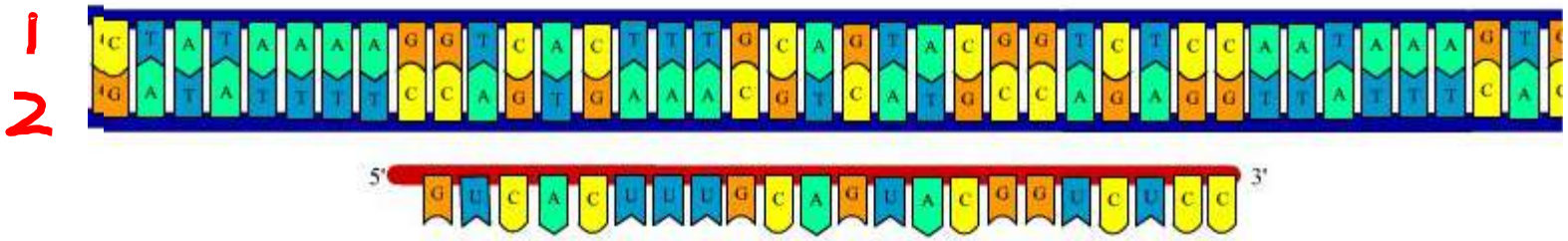
E. Transcription- process by which DNA makes complementary sequence of RNA

1. Enzyme (RNA Polymerase) separates DNA strand

2. One strand of DNA used as template to assemble strand of RNA. Takes place in nucleus



3. Transcription begins at specific locations on DNA (promoters)



F. Translations- "making Proteins" *Translating language of nucleic acids (**base sequences**) into language of proteins (**amino acids**)*

1. Gene carries code to make one protein (300 to 3000 base pairs)

a. Code written in language with only 4 "letters"

b. Code read 3 letters at a time (each 3 letter "word" known as a **codon**

UCGCACGGU

UCG – CAC – GGU

Represents the amino acids

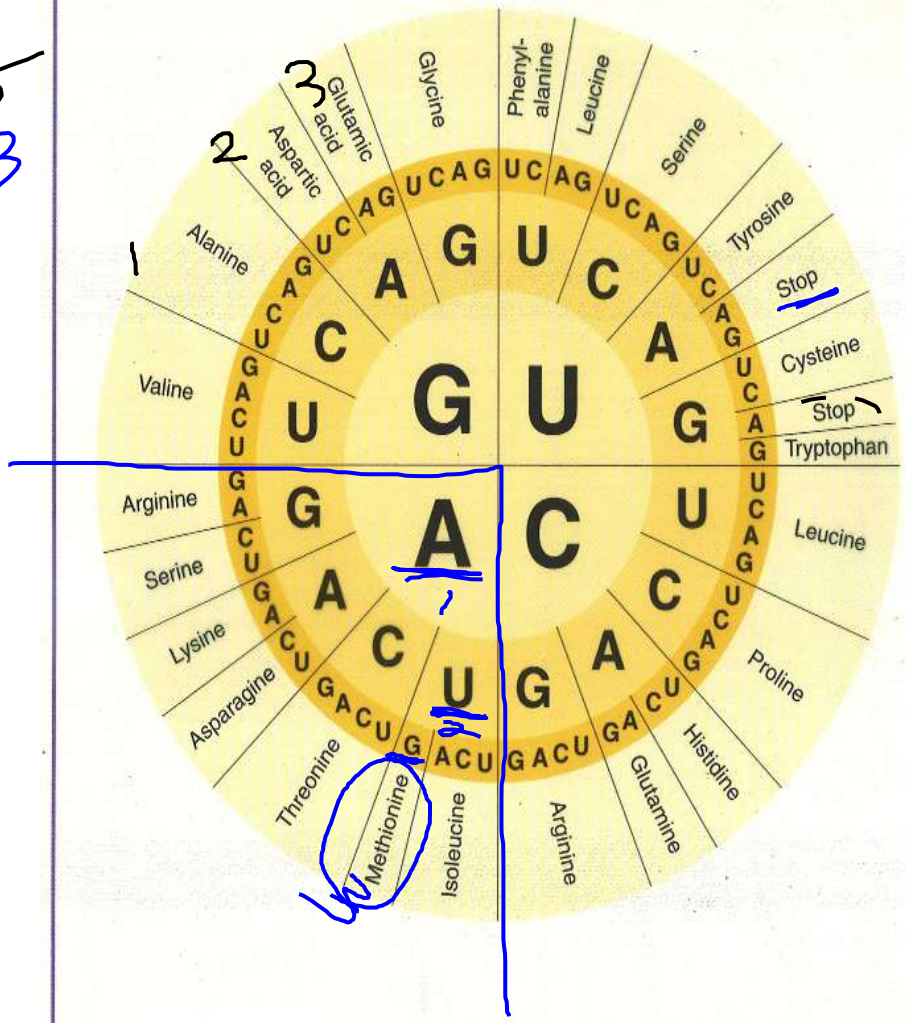
Serine – Histidine – Glycine

FIGURE 12–17 THE GENETIC CODE

start codon

AUG

1 2 3

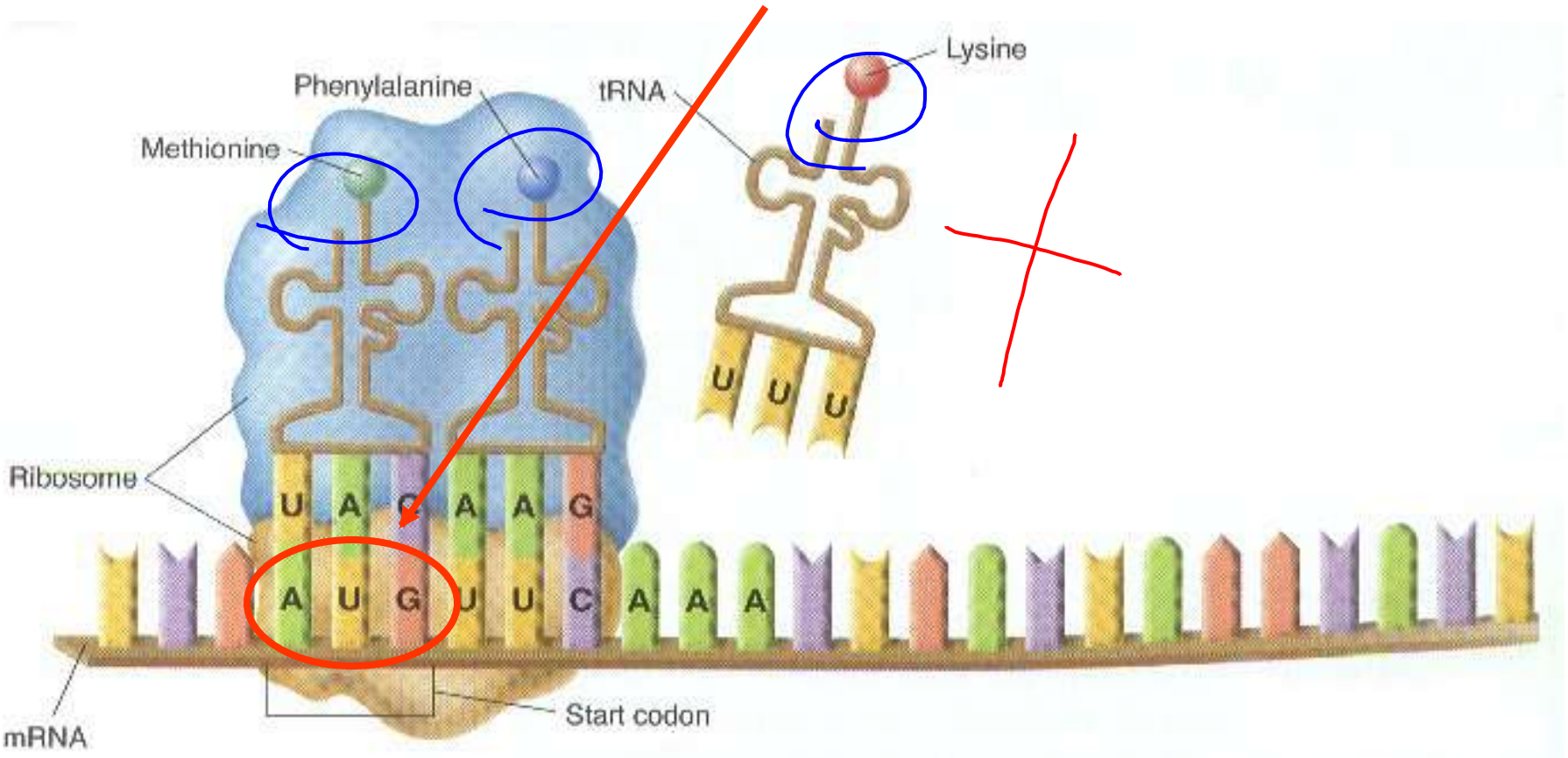


UAA
UAG
UGA

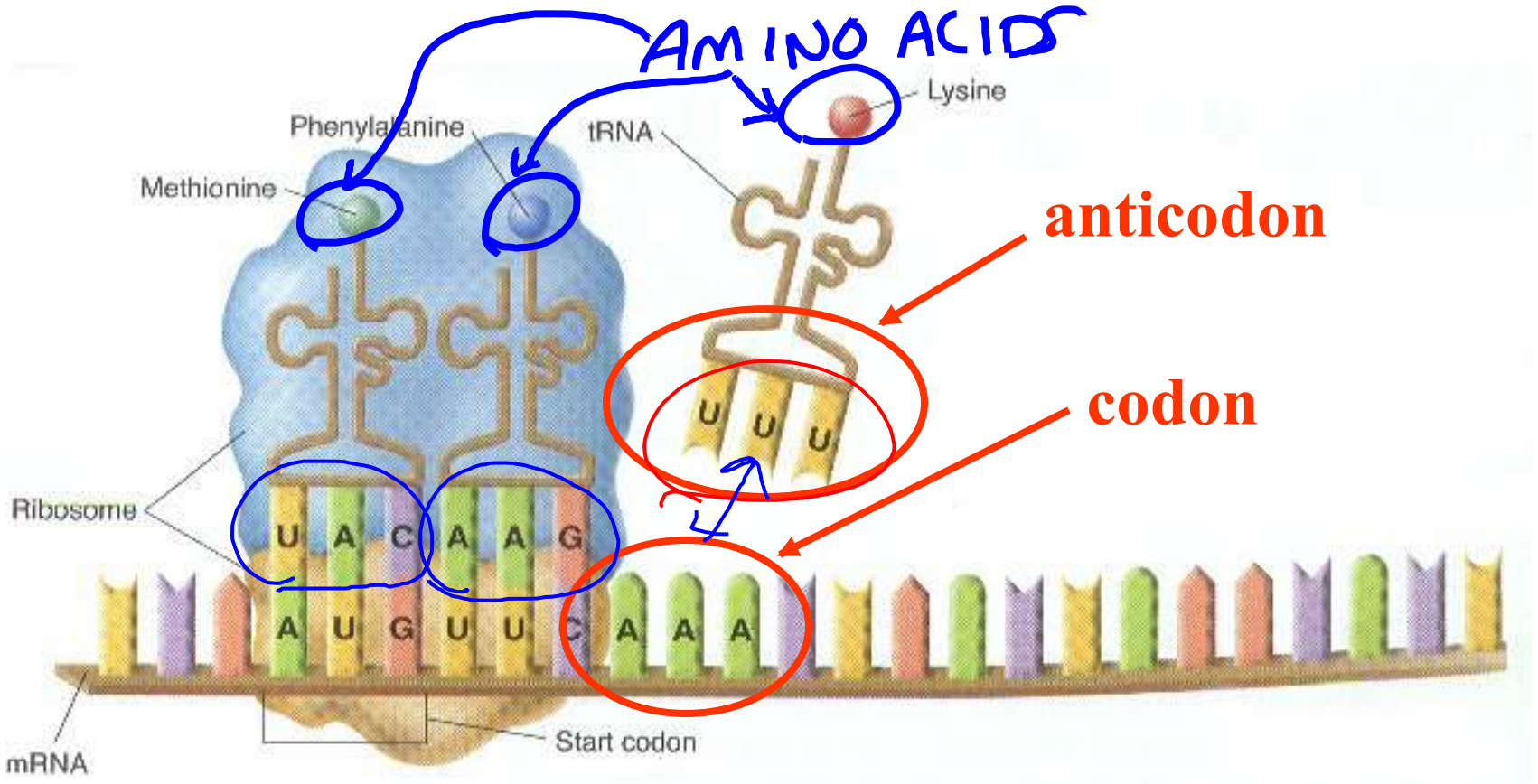
2. Process used all 3 types of RNA

a. mRNA transcribed in nucleus and released into the cytoplasm

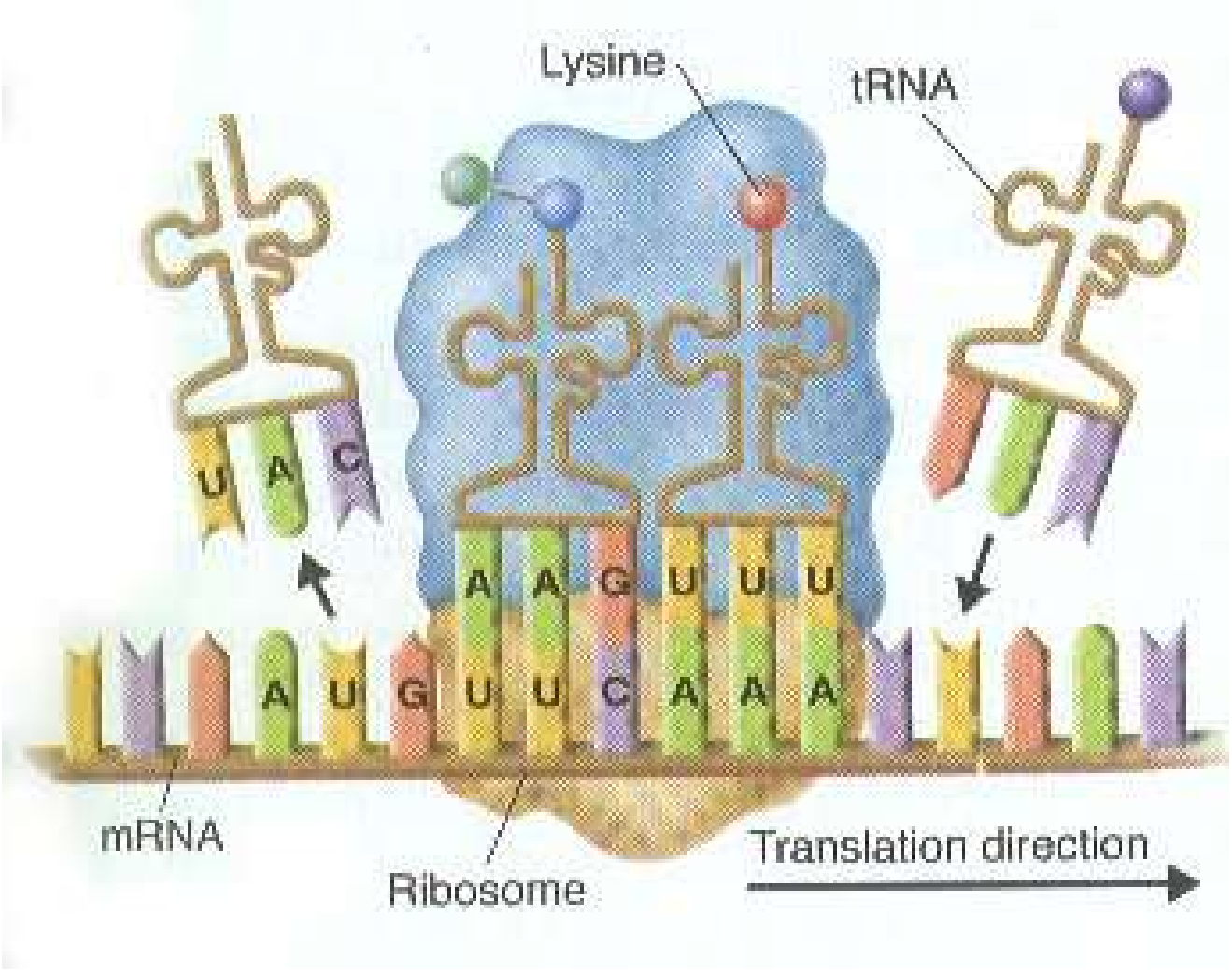
b. mRNA attaches to **ribosome.** Translation begins **AUG**, the **start codon**



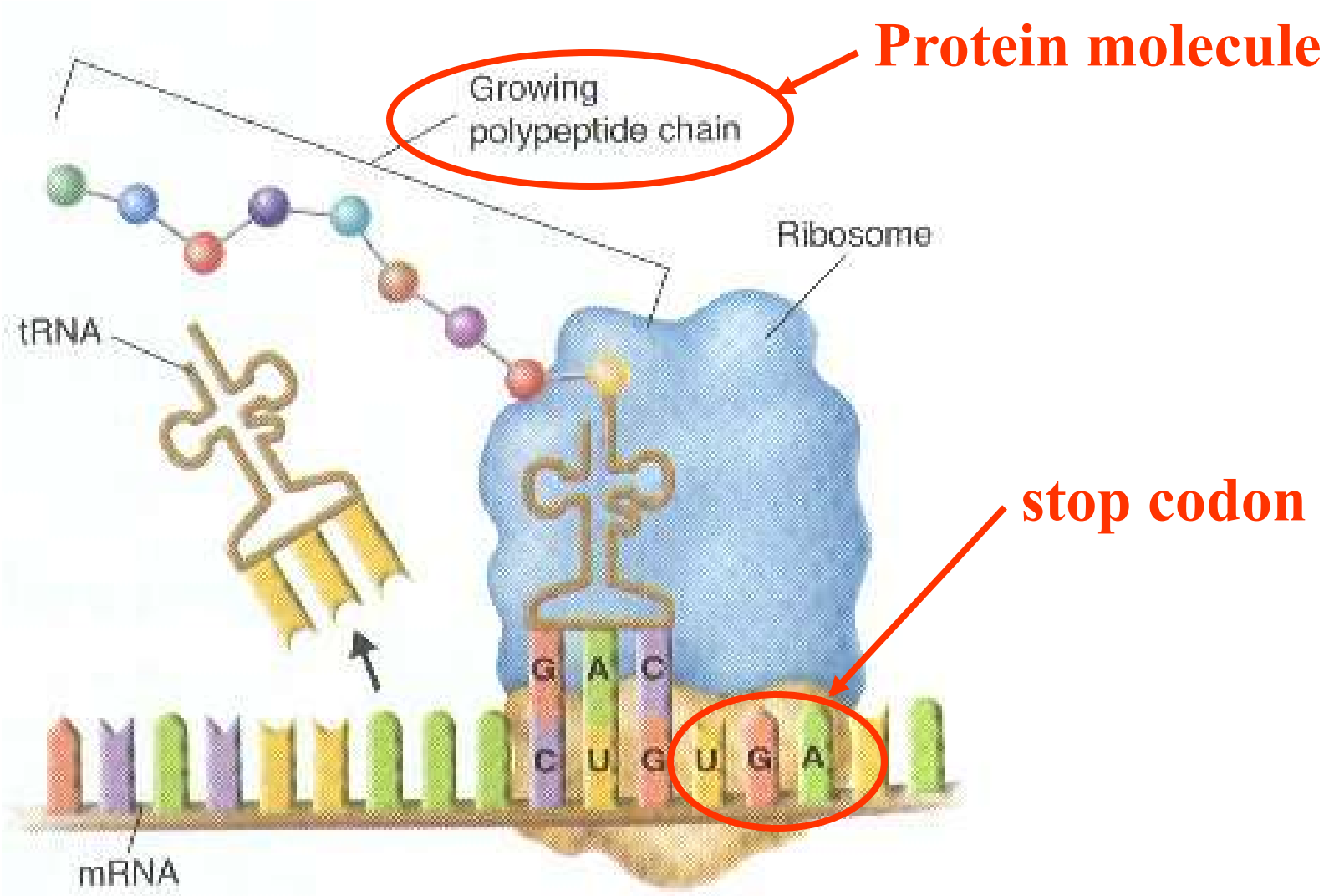
c. Each tRNA has an **anticodon** whose bases are <u>complementary</u> to **codon** on mRNA. tRNA brings amino acids to ribosomes



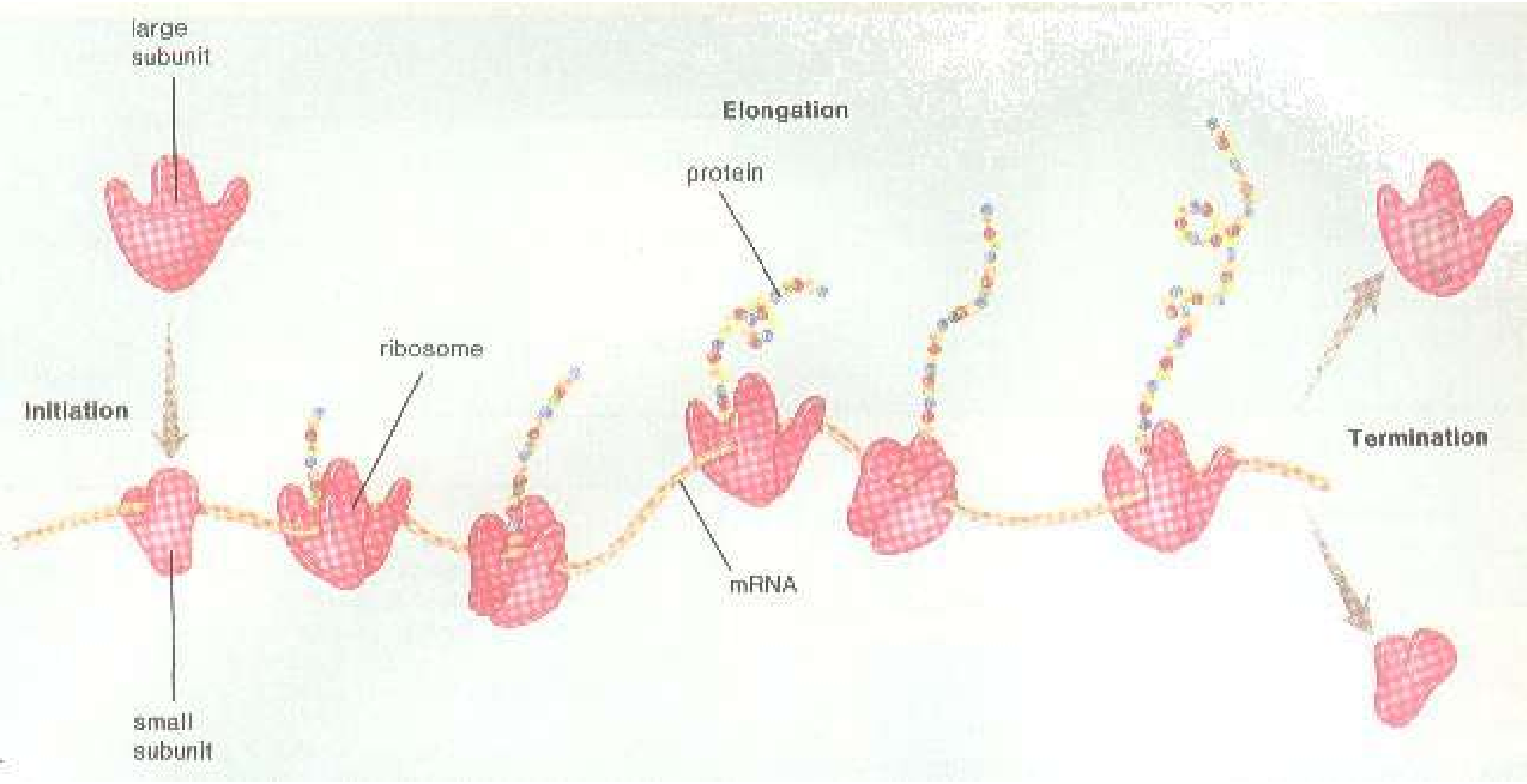
d. Ribosome moves along mRNA, binding new **tRNA molecules** and **amino acids**



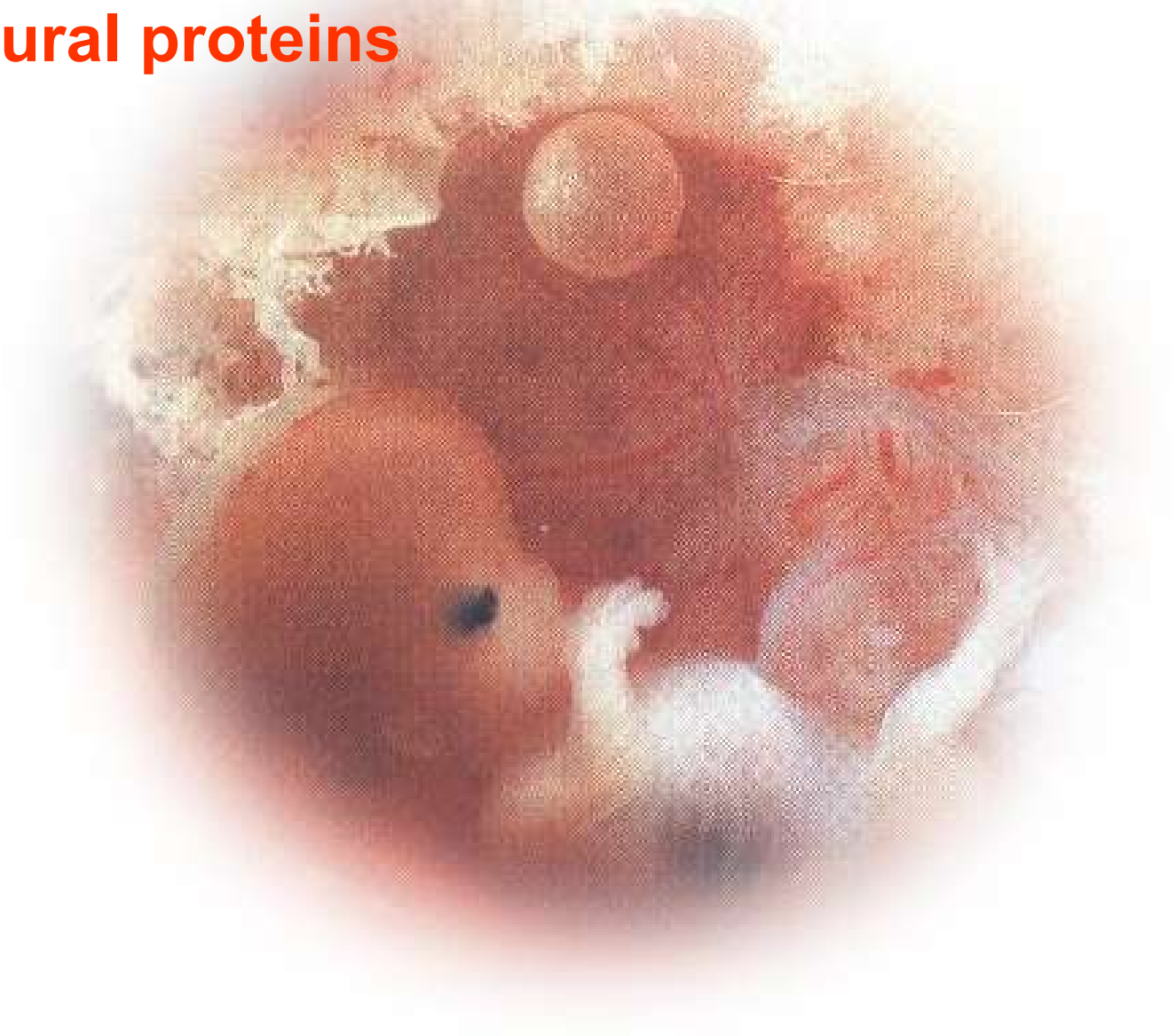
e. Polypeptide chain (protein) grows until ribosome reaches **stop codon**



f. Protein and mRNA released completing process of translation



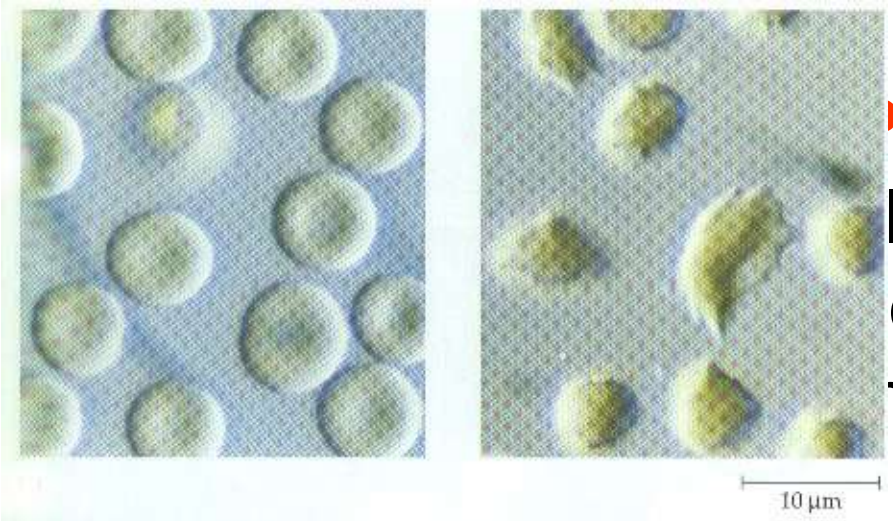
G. Genes and Proteins- proteins are key to everything cells do. **Functional** (enzymes) and **structural proteins**



III. Mutations- *changes in the DNA sequence that affect genetic information*

A. Gene Mutations- results from changes in a single gene

1. Several types- some involve several nucleotides, but most affect only one

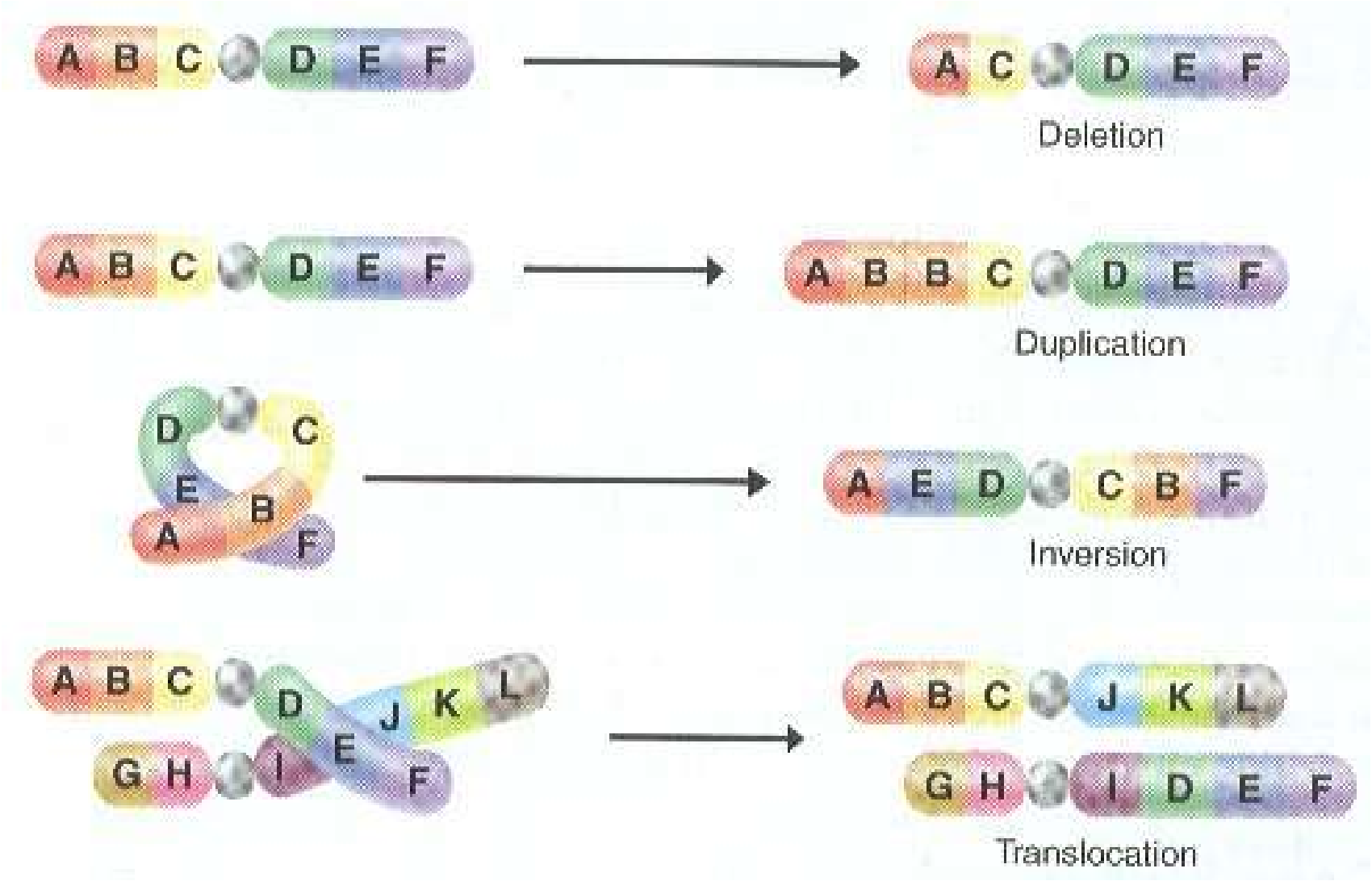


Point mutations- occurs at a le point in DNA sequence. erally change in one of no acids

a. Frameshift mutation- insertion or deletion of nucleotide. **Causes bigger changes!**

b. Can alter protein- making it unable to perform normal functions

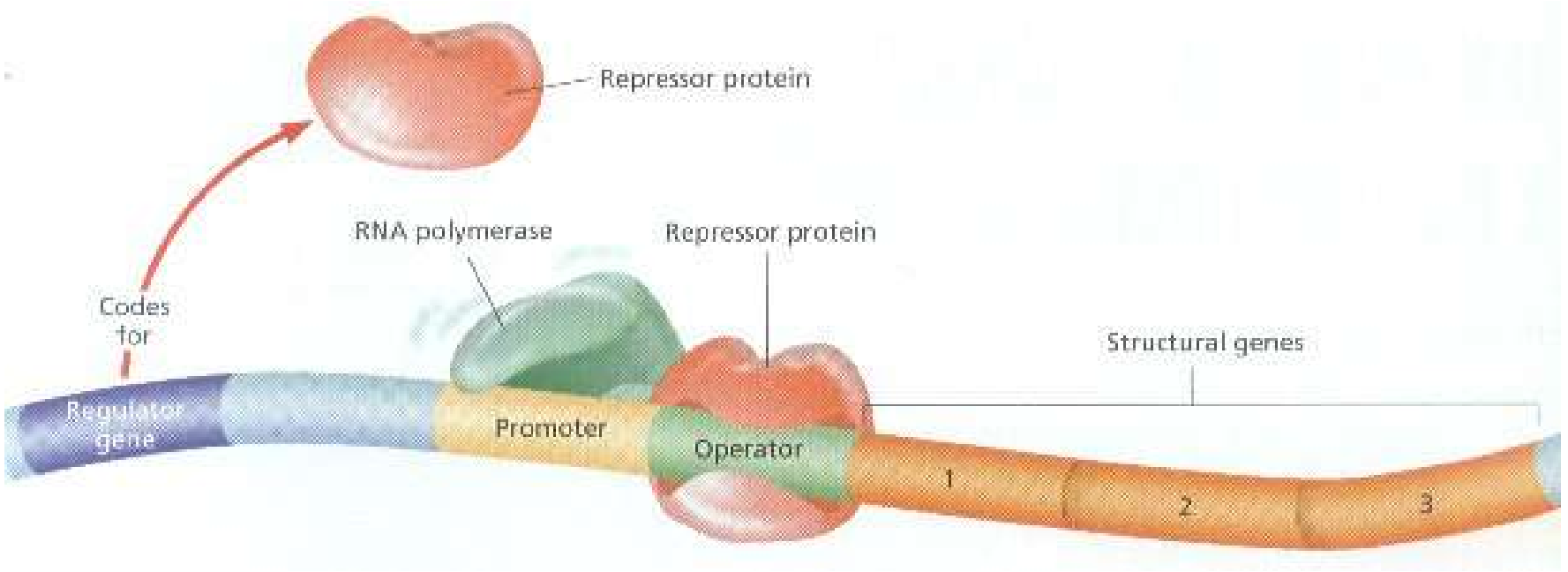
B. Chromosomal Mutations- involves changes in the number and structure of chromosomes



C. Gene Regulation- how does organism "know" when to turn a gene on or off?

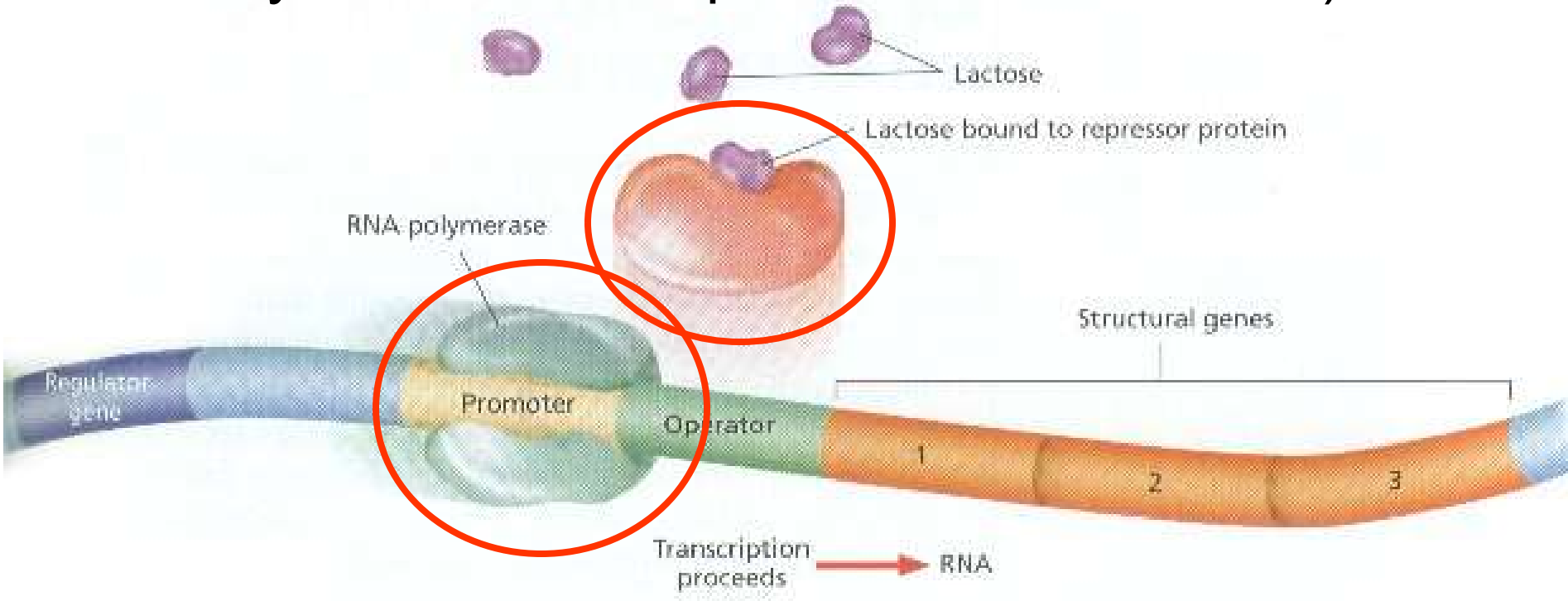
1. Genes are "turned off" by presence of **repressor protein** (produced by regulator gene)

2. Genes are "turned off" by presence of **repressor protein** (produced by regulator gene)



3. Presence of certain chemicals (e.g.- lactose in *E. ecoli*) bind to site on repressor protein causing it to change shape and "fall off" the DNA molecule.

4. RNA plymerase is allowed to transcribe mRNA molecule to code for protein (e.g. enzymes to break apart lactose molecules)



D. Regulation and Development- especially important in shaping the way a complex organism develops from single fertilized cell.

1. Hox genes- controls organs and tissues that develop in various parts of the embryo

a. Mutation in one of these "master control genes" can completely change organs that develop in specific parts of the body

b. Genes tell cells in the body which organs and structures they should develop into as the body grows.

2. Mutations may have led to drastic and quick evolutionary changes