



# **BASIC CONCEPTS** **in GENETIC**

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**FAKULTAS TEKNOLOGI**  
**PERTANIAN**  
**2012**

# WHAT IS GENETICS?

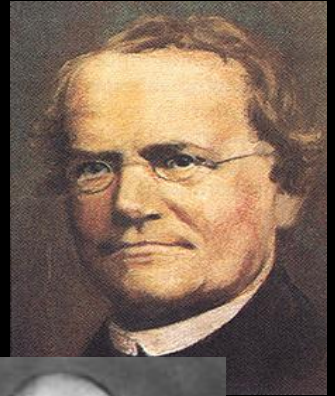
**THE  
SCIENTIFIC  
STUDY OF  
HEREDITY**



# SEJARAH PENEMUAN BAHAN GENETIKA

**1865, Gregor Mendel**

suatu bagian dari sel  
bertanggungjawab atas sifat yang  
diturunkan dari satu generasi ke  
generasi berikutnya



**1868, Friedrich Miescher**

senyawa kimia yang berasal dari  
inti sel

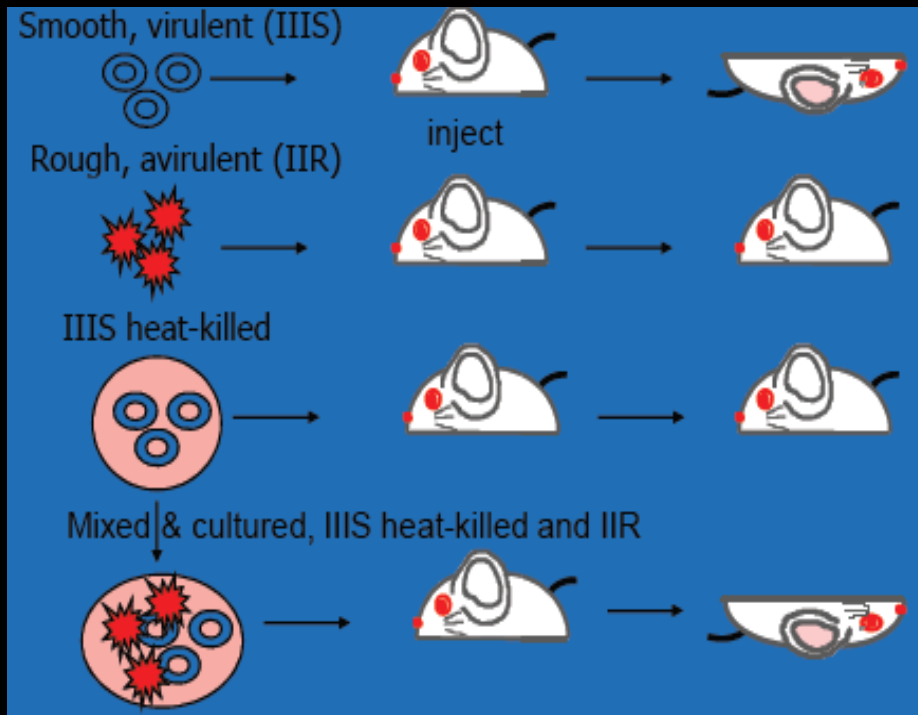


**1879, Albrecht Kossel**

asam nukleat



# PERUBAHAN BENTUK DINDING SEL *STREPTOCOCCUS PNEUMONIA*



## Penelitian Fred Griffith

Dua galur:

Smooth (**S**) – Virulent (gel coat)

Rough (**R**) – Kurang Virulen

Tikus disuntik dengan **galur R** and **galur S** yang dimatikan melalui pemanasan

Tikus mati dan ditemukan hanya mengandung bakteri **galur S**



# **PENELITIAN WATSON DAN CRICK**



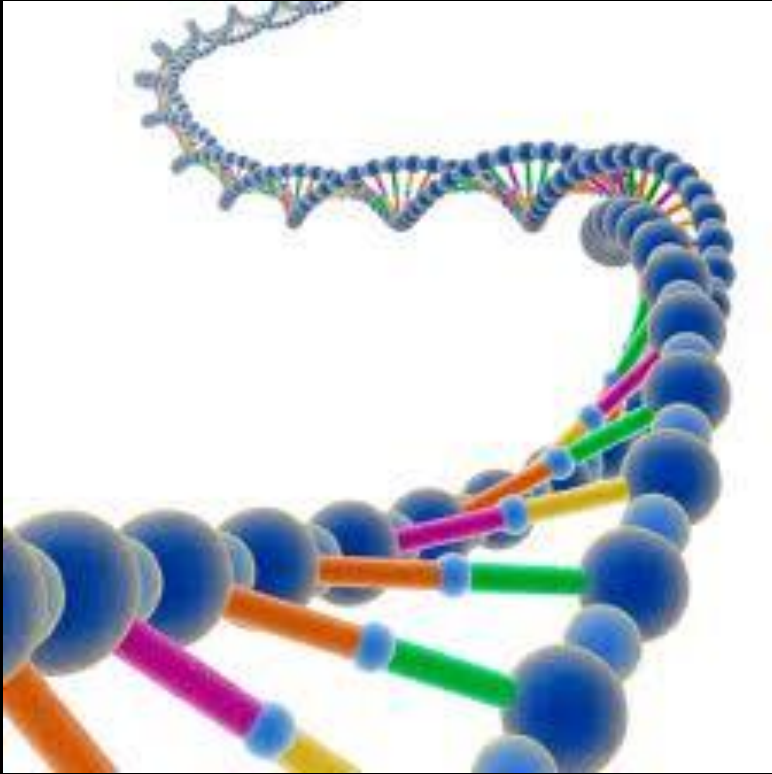
**Dengan dukungan data difraksi sinar-X dari Rosalind Franklin dan Maurice Wilkins**

**Dengan dukungan data analisis kimia basa nitrogen dari Erwin Chargaff**

**Memformulasikan struktur DNA**

**Mengelompokkan basa DNA menjadi purin (A,G) dan pirimidin (C,T)**

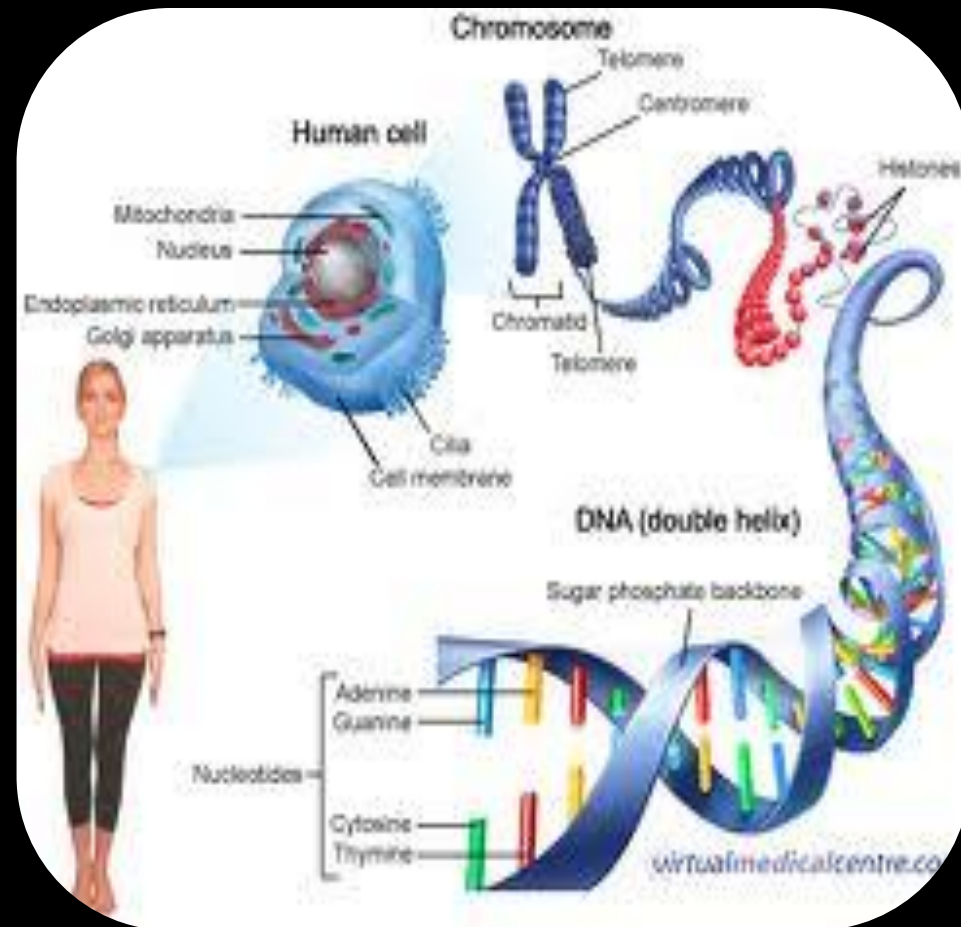
**Memformulasikan model replikasi DNA**



# GENETIC INFORMATION

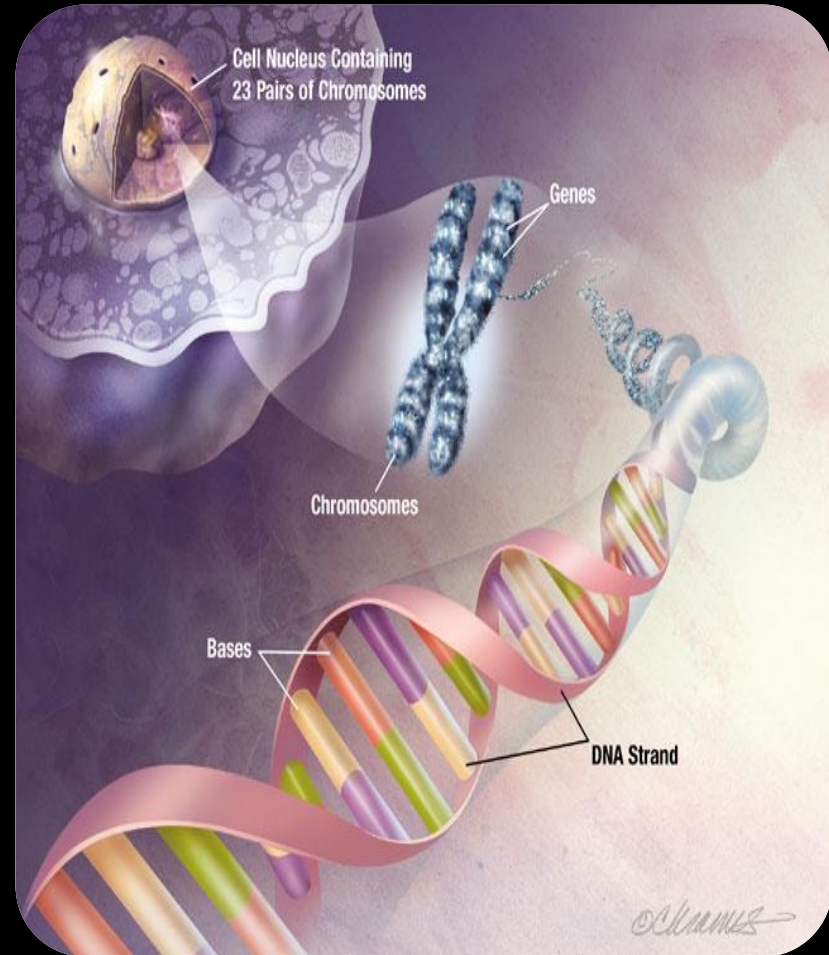
# GENETIC INFORMATION

- **Gene** – basic unit of genetic information. Genes determine the inherited characters
- **Chromosomes** – length of DNA containing genes
- **Genome** – sum total of genetic material of an organism (chromosomes + mitochondria /chloroplasts and/or plasmids)
  - genome of cells – **DNA**
  - genome of viruses – **DNA** or **RNA**



# GENOMES VARY IN SIZE

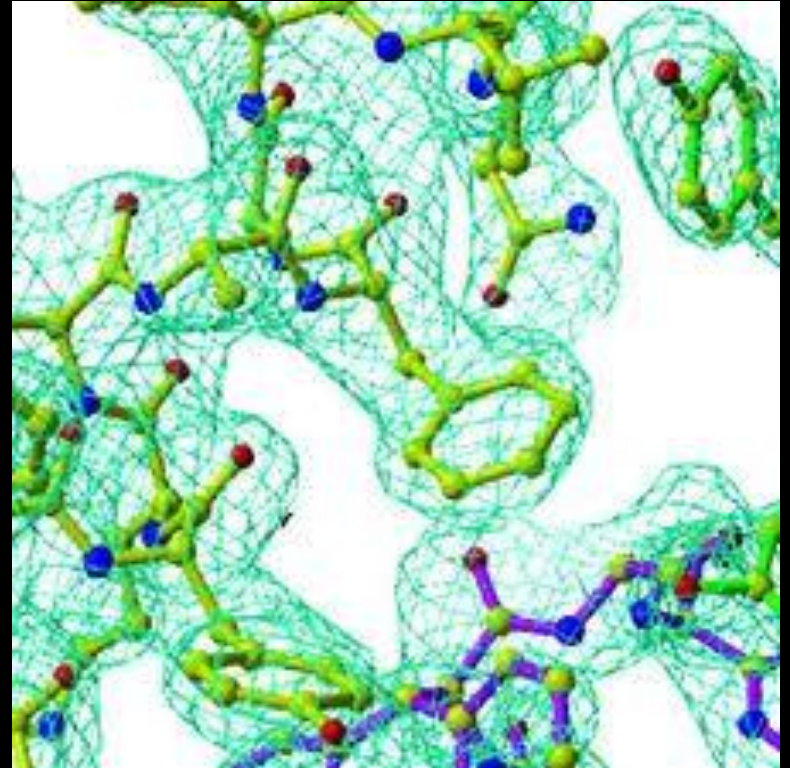
- **smallest virus – 4-5 genes**
- ***E. coli* – single chromosome containing 4,288 genes; 1 mm; 1,000X longer than cell**
- **Human cell – 46 chromosomes containing 31,000 genes; 6 feet; 180,000X longer than cell**

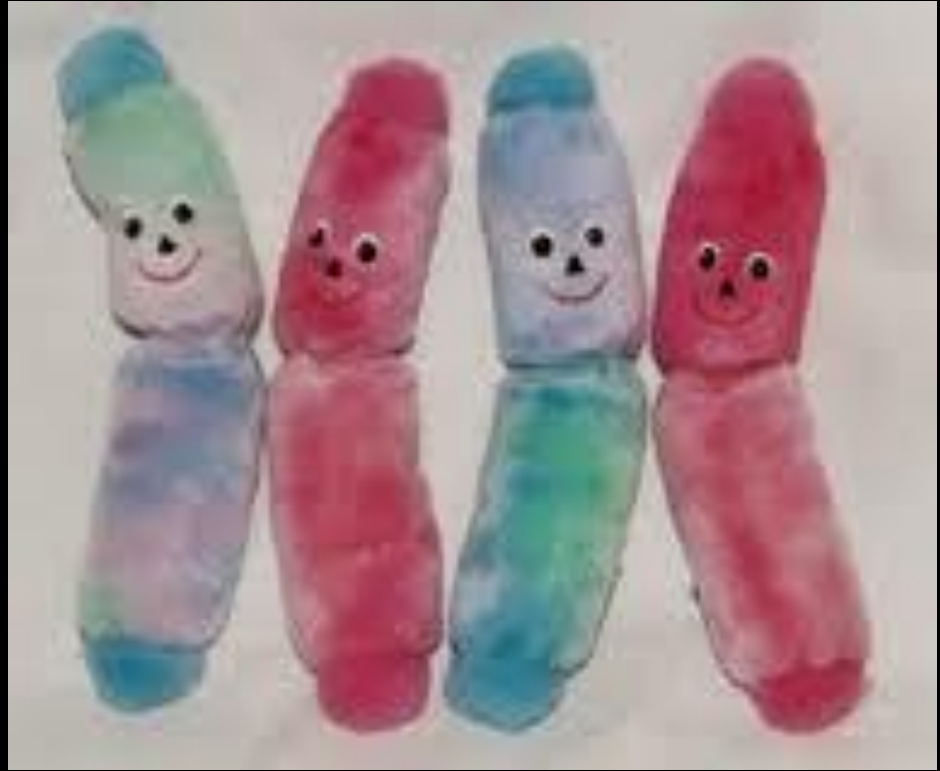




**Nucleic acids are made of nucleotides similar to how proteins are made of amino acids each nucleotide consists of 3 parts**

- ✓ **a 5 carbon sugar (deoxyribose or ribose)**
- ✓ **a phosphate group**
- ✓ **a nitrogenous base (adenine, thymine, cytosine, guanine, and uracil)**



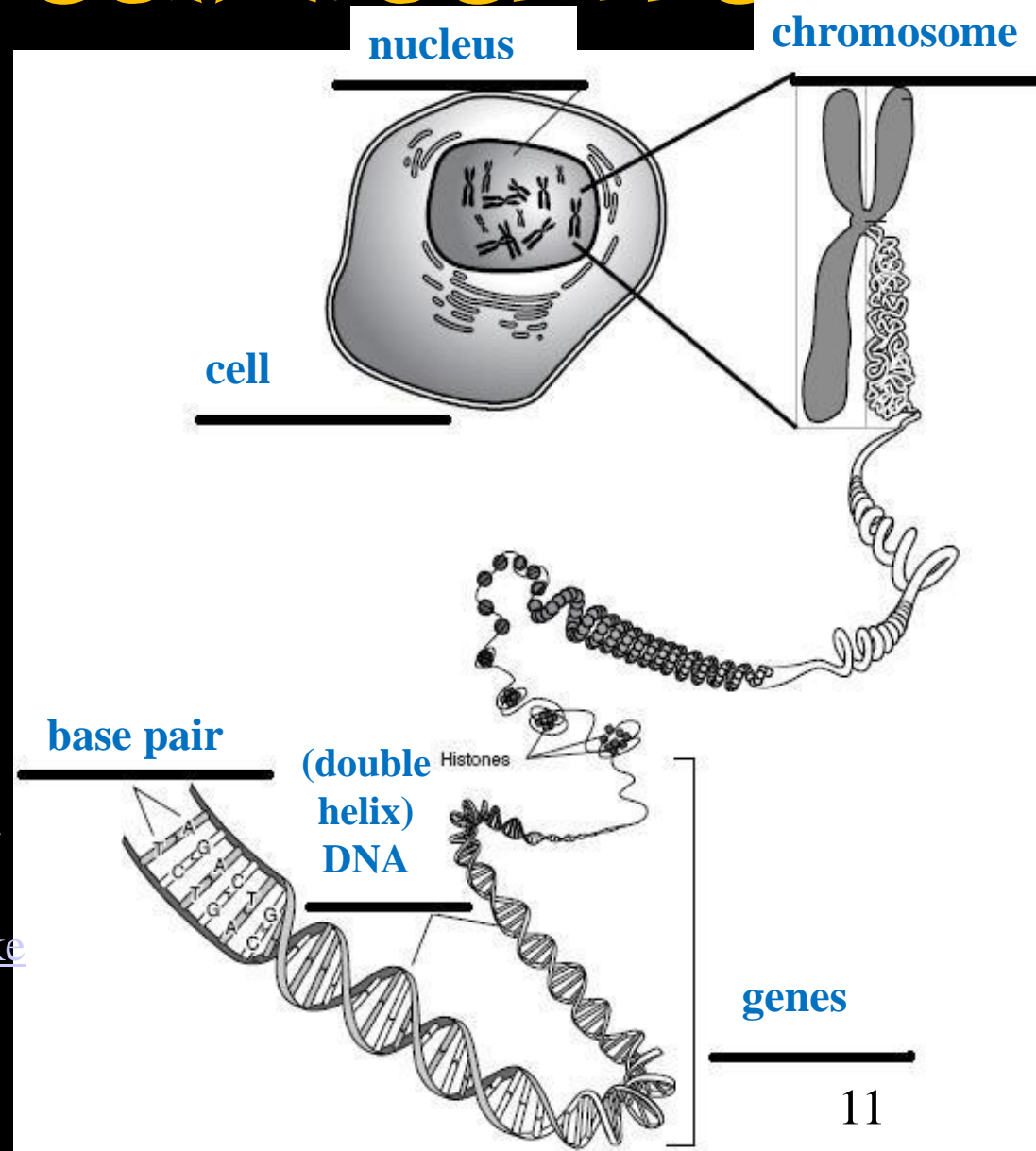


# BASIC GENETIC CONCEPTS & TERMS

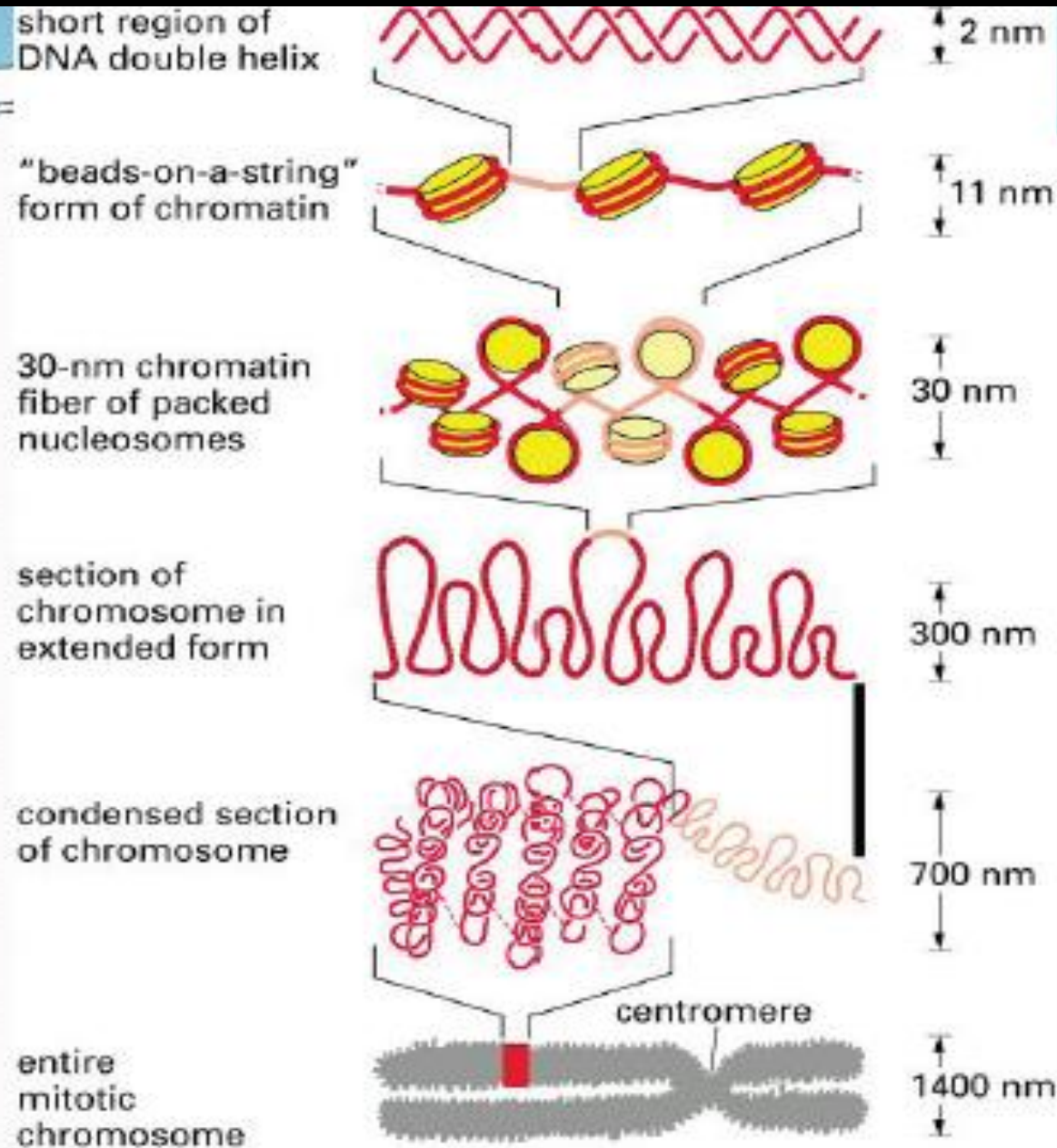
# WORD MATCH ACTIVITY

- base pair
- cell
- chromosome
- DNA  
(Deoxyribonucleic Acid)
- double helix\*
- genes
- nucleus

Illustration Source: Talking Glossary of  
Genetic Terms  
<http://www.genome.gov/glossary.cfm?key=chromosome>



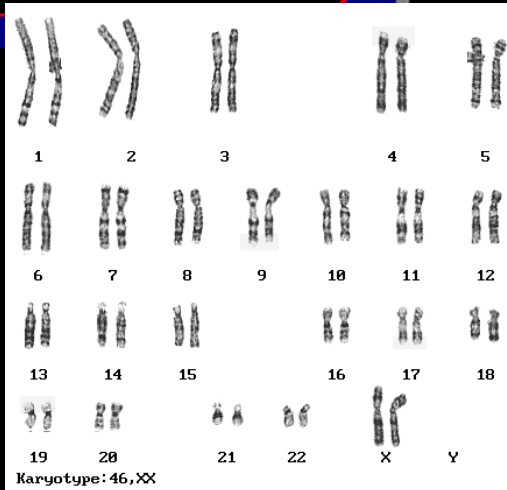
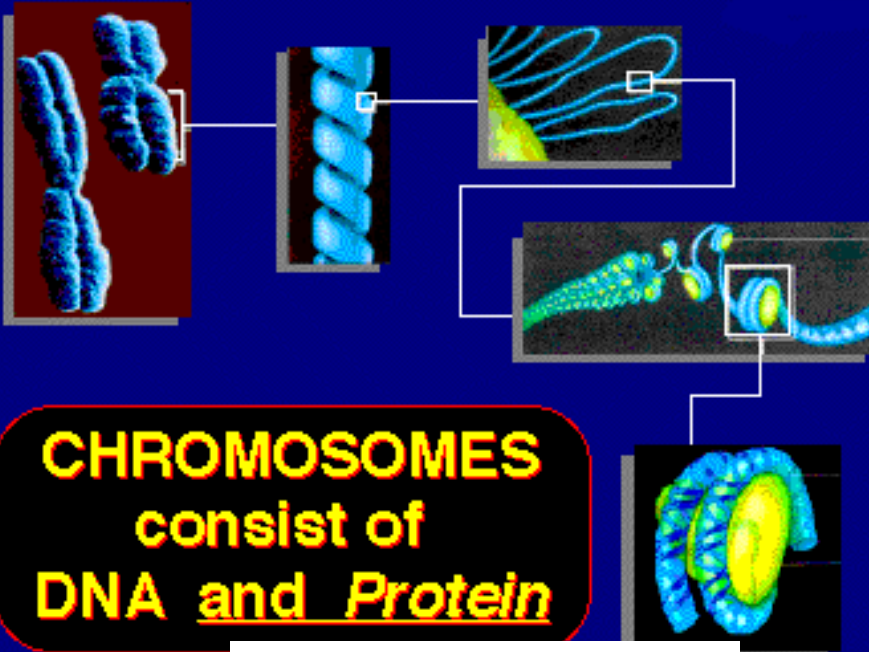
# Chromatin Packing



NET RESULT: EACH DNA MOLECULE HAS BEEN PACKAGED INTO A MITOTIC CHROMOSOME THAT IS 10,000-FOLD SHORTER THAN ITS EXTENDED LENGTH

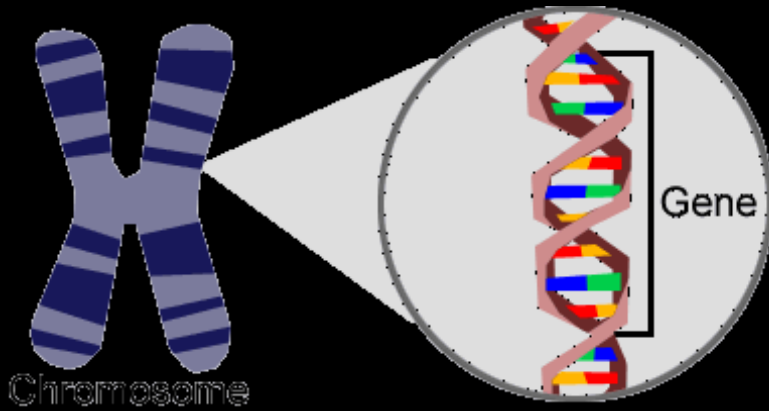


# Chromosomes vs Genes



- A **chromosome** constitutes an entire DNA molecule + protein
  - Protein = histones
  - Supercoiled DNA in nucleosomes
  - Humans contain 46 such molecules (23 pairs)
    - 44 somatic chromosomes
    - 2 sex chromosomes (X + Y)

# Chromosomes vs Genes



- **Genes** constitute distinct regions on the chromosome
- Each gene codes for a protein product
- DNA -> RNA-> protein
- Differences in proteins brings about differences between individuals and species

# Gene & Protein

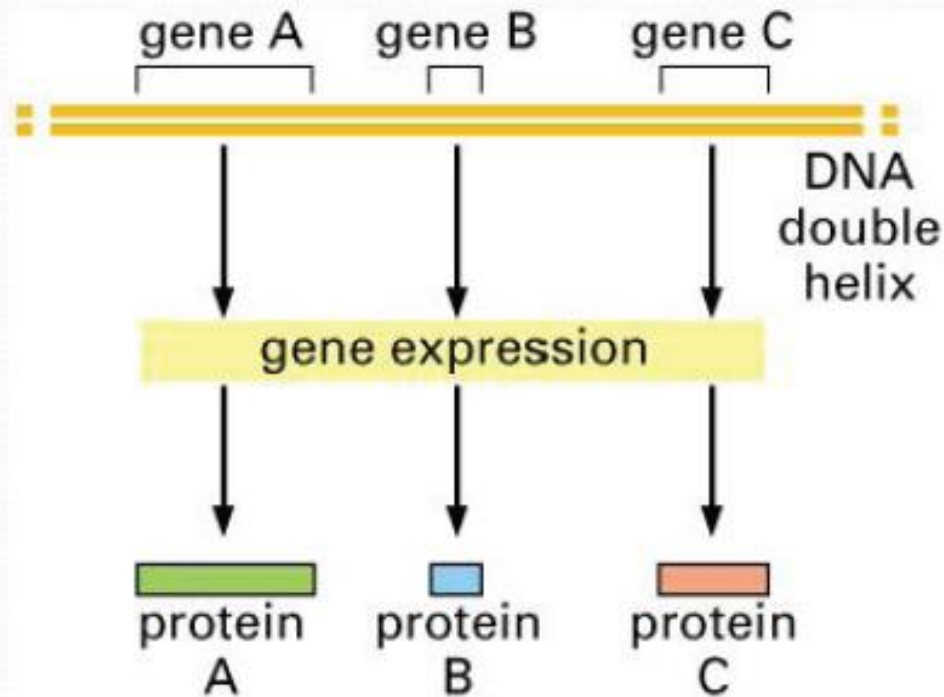


Figure 4–6. Molecular Biology of the Cell, 4th Edition.

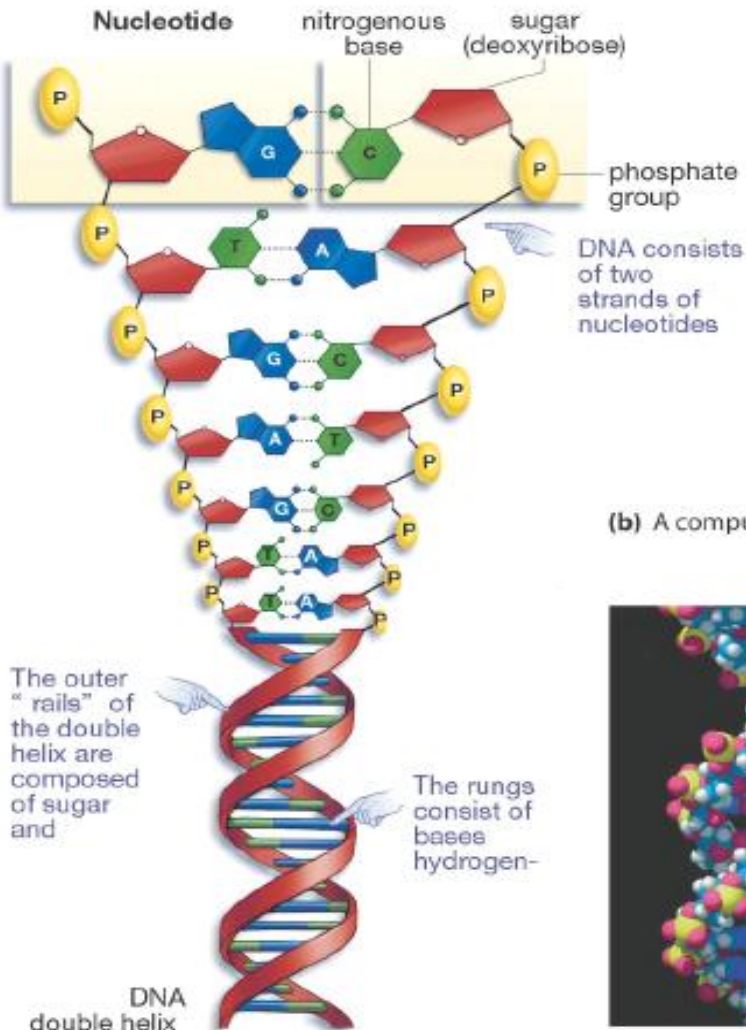


# DNA

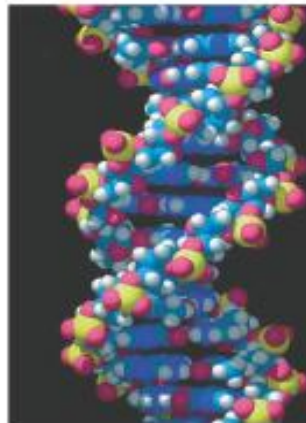


# DNA MOLECULE

(a) Nucleotides are the building blocks of DNA

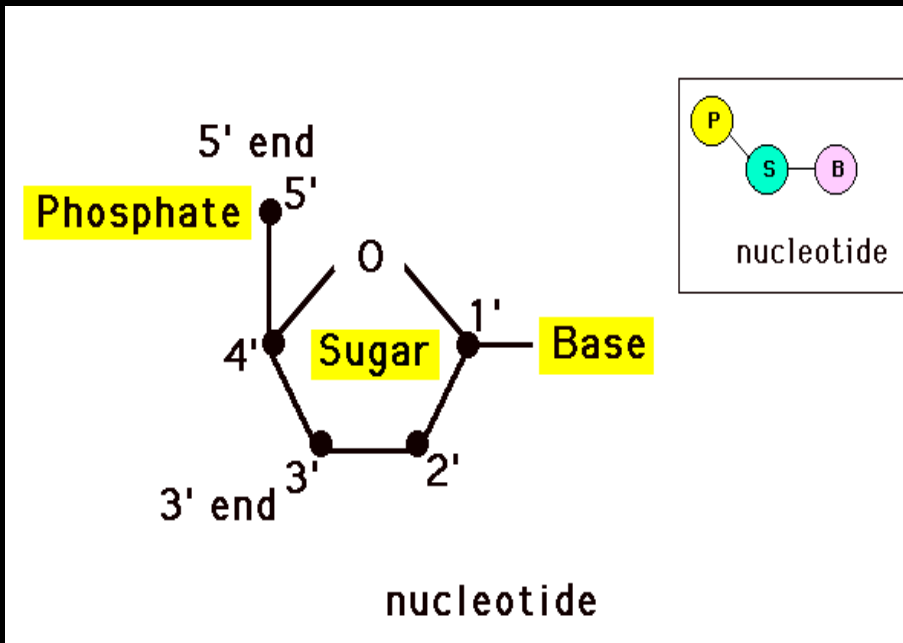


(b) A computer-generated model of DNA



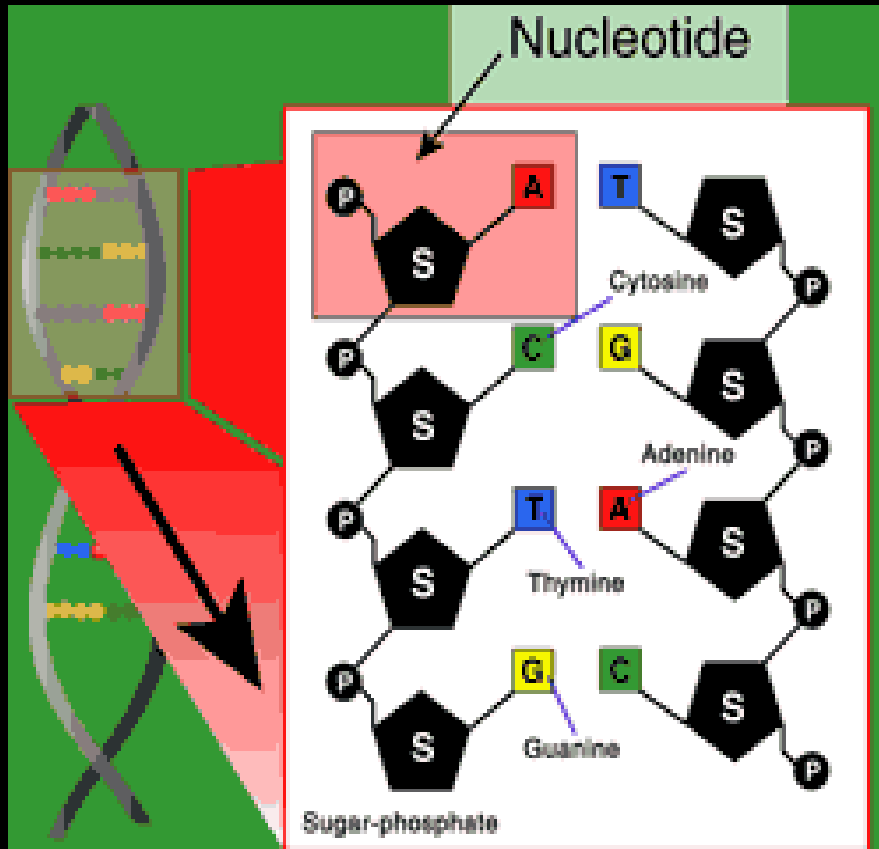
- Composed of 2 polymers of nucleotides
- antiparallel strands 3'to 5' and 5'to 3'
- each strand provides a template for the exact copying of a new strand

# Nucleotide structure of DNA



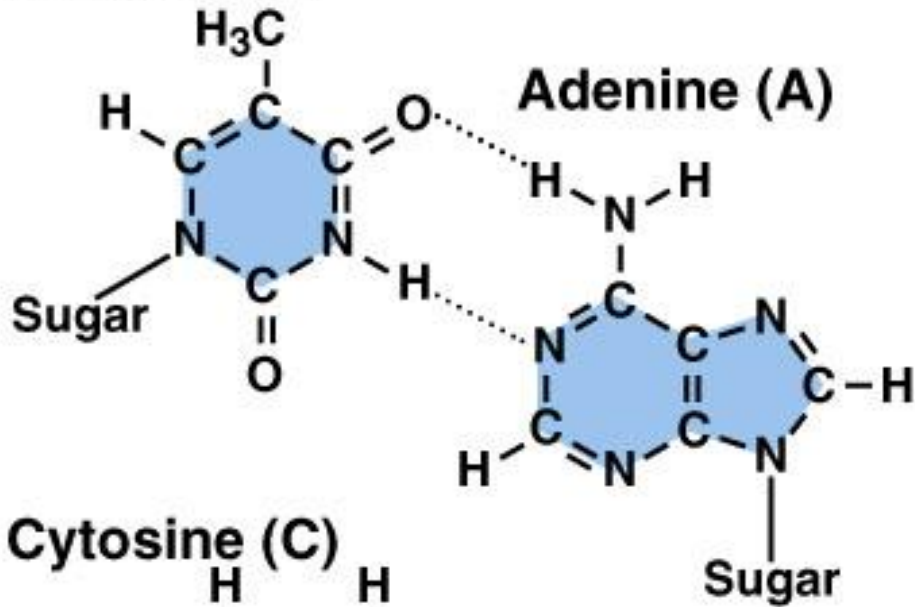
- Each nucleotide of DNA contains:
  - Deoxyribose
  - Phosphate
  - Nitrogen base (either A, G, C, T)

# DNA structure

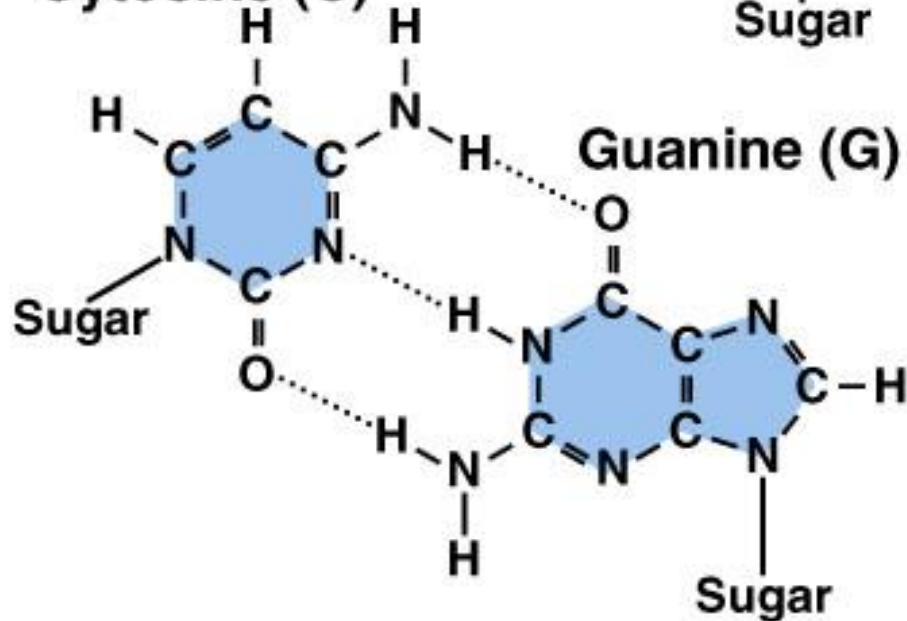


- “Double helix”  
proposed by Watson  
and Crick (1953)
- Antiparallel backbones
- Complementary base  
pairing:
  - Adenine to Thymine
  - Cytosine to Guanine

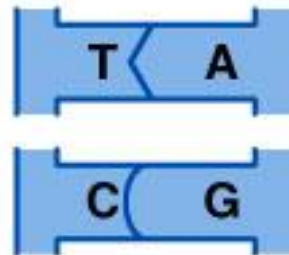
## Thymine (T)



## Cytosine (C)

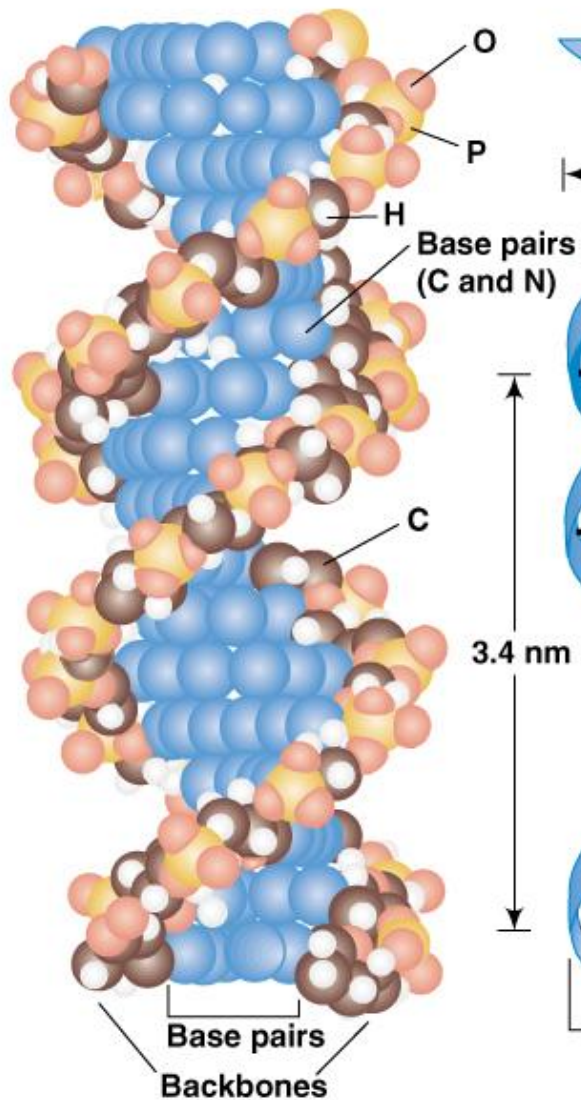


# DNA base pairs

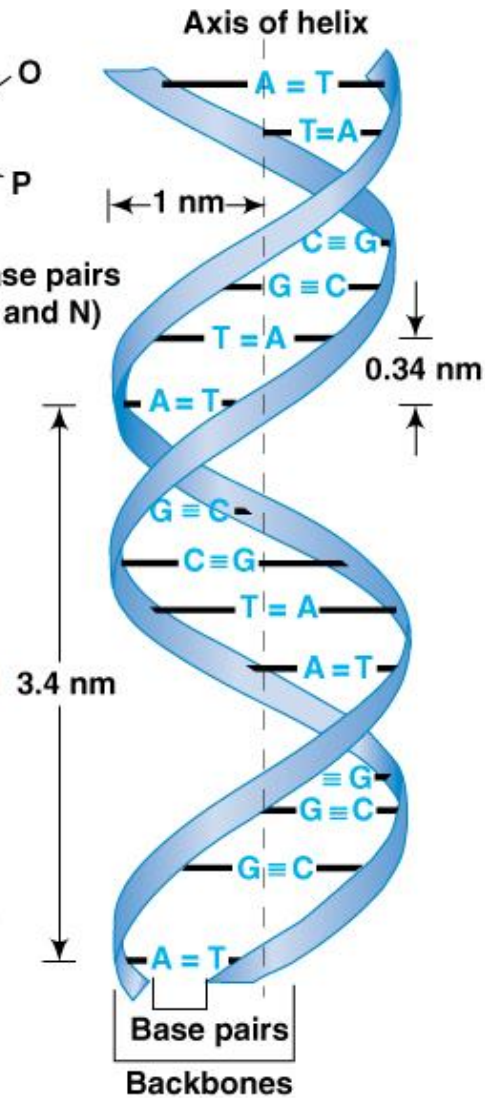




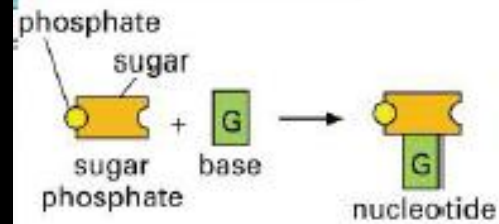
a) Molecular model



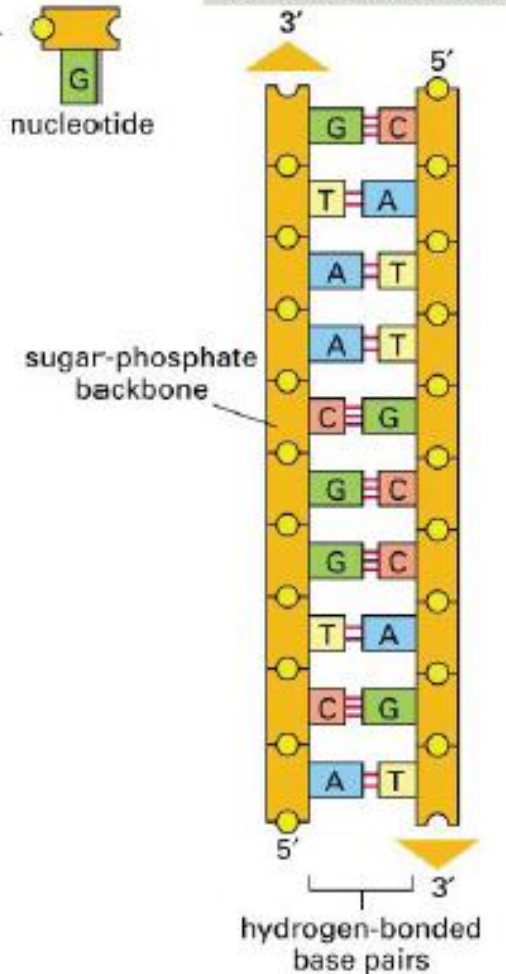
b) Stylized diagram



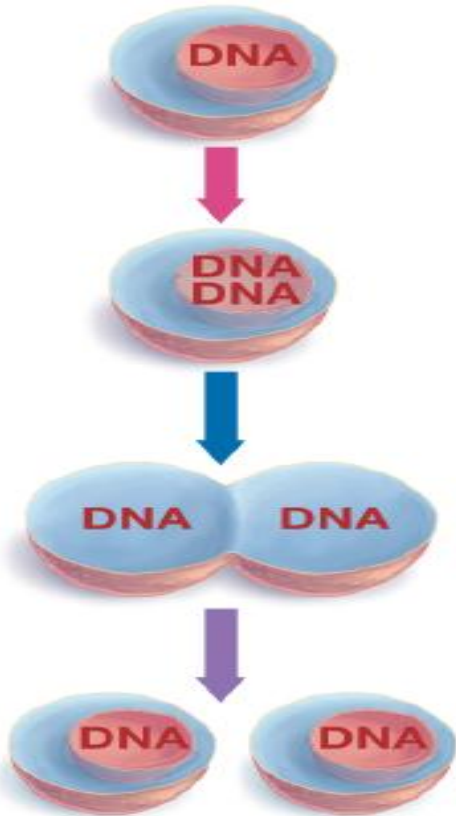
building blocks of DNA



double-stranded DNA



# Therefore, prior to dividing, any cell must first replicate DNA



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- Each single-stranded (SS) chromosome duplicates to become a double-stranded (DS) chromosome
- Example:
  - A human cell is formed with 46 SS chromosomes
  - Each chromosome replicates to produce 46 DS chromosomes

# DNA is a template for its own duplication

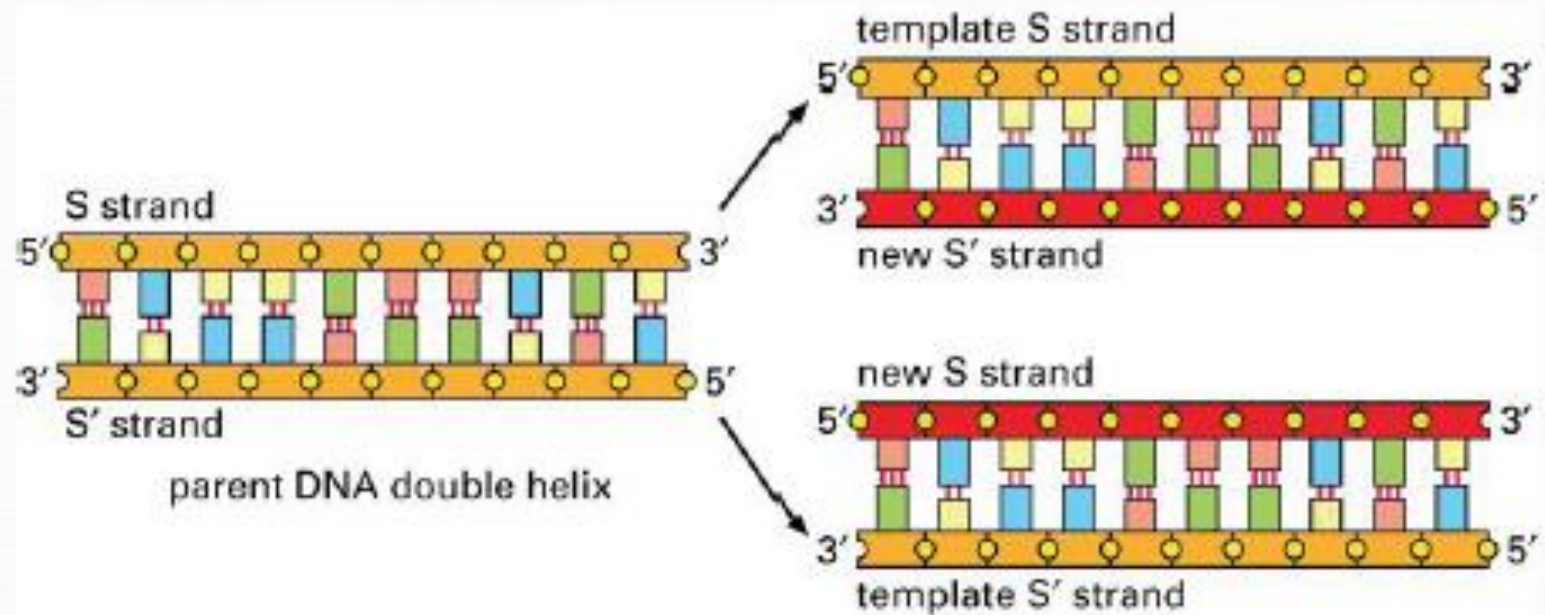
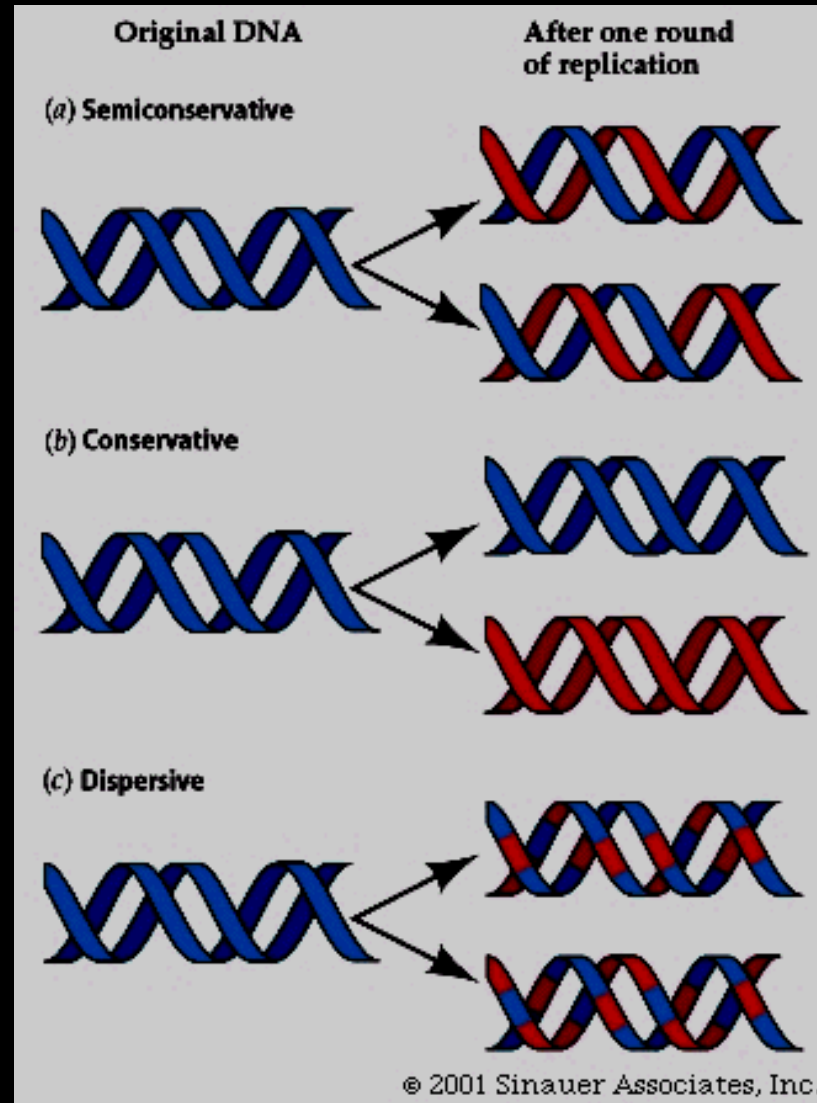
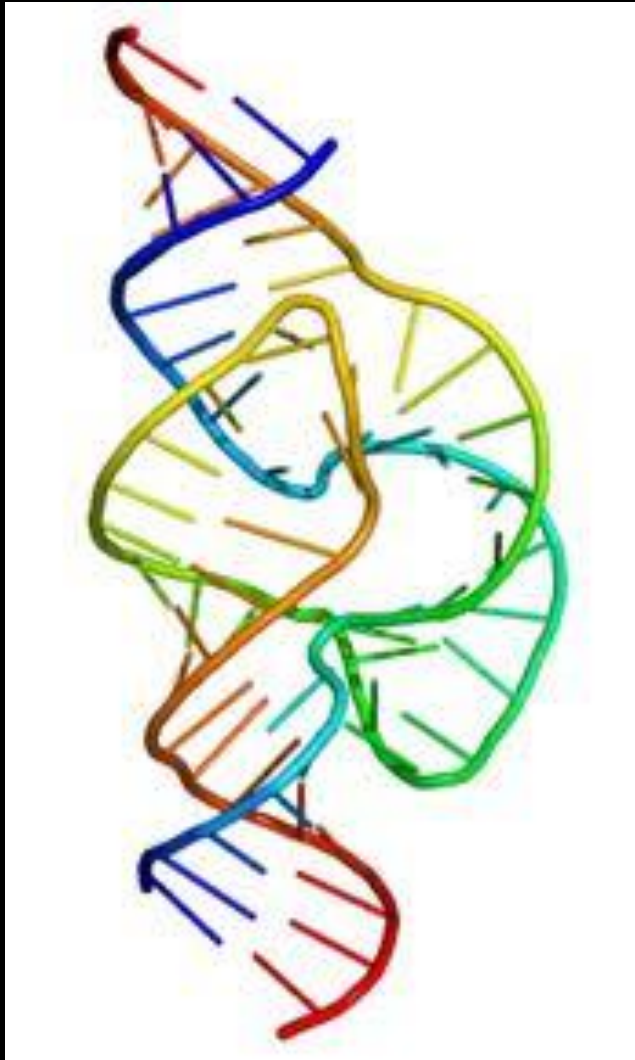


Figure 4-8. Molecular Biology of the Cell, 4th Edition.

# REPLIKASI DNA

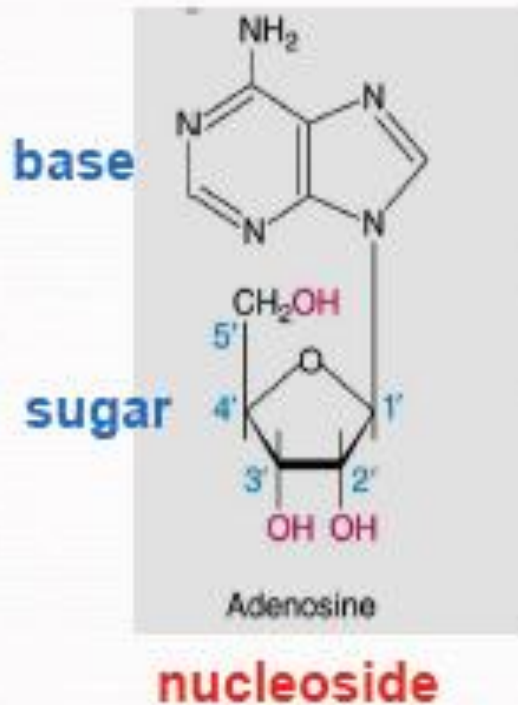






**RNA**

# RNA: terminology

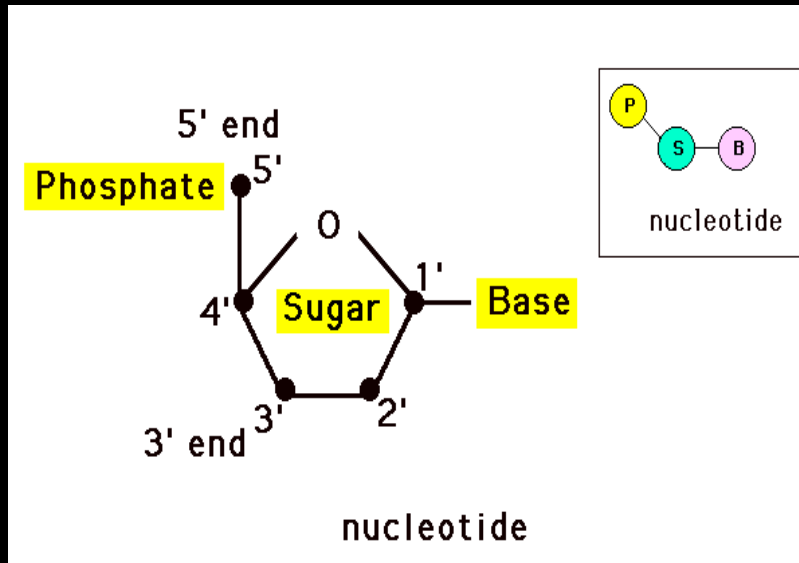


<u>Base</u>	<u>Nucleoside (RNA)</u>	<u>Deoxynucleoside (DNA)</u>
Adenine	Adenosine	Deoxyadenosine
Guanine	Guanosine	Deoxyguanosine
Cytosine	Cytidine	Deoxycytidine
Uracil	Uridine	(not usually found)
Thymine	(not usually found)	(Deoxy)thymidine

# RNA (ribonucleic acid)

- RNA plays a central role in the life of the cell. We are mostly look at its role in protein synthesis, but RNA also does many other things.
- RNA can both store information (like DNA) and catalyze chemical reactions (like proteins).
- One theory for the origin of life has it starting out as RNA only, then adding DNA and proteins later. This theory is called the “RNA World”.

# Nucleotide structure of RNA



- Each nucleotide of RNA contains:
  - Ribose
  - Phosphate
  - Nitrogen base (either A, G, C, U\*)

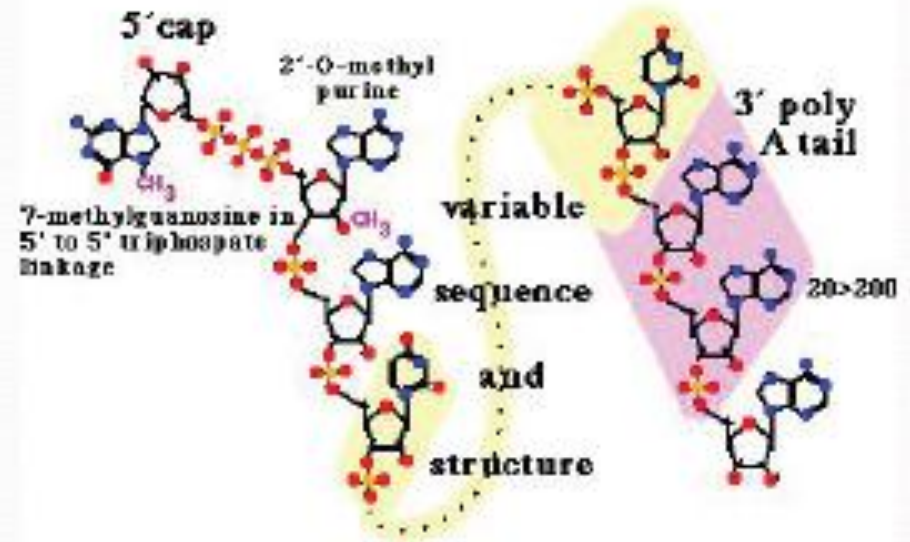
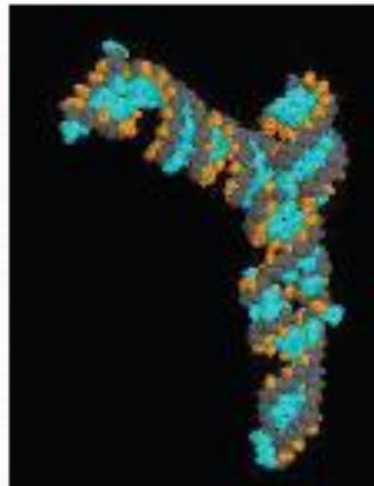
\*contains Uracil instead of Thymine

# Types of RNA Molecule



tRNA

rRNA



mRNA

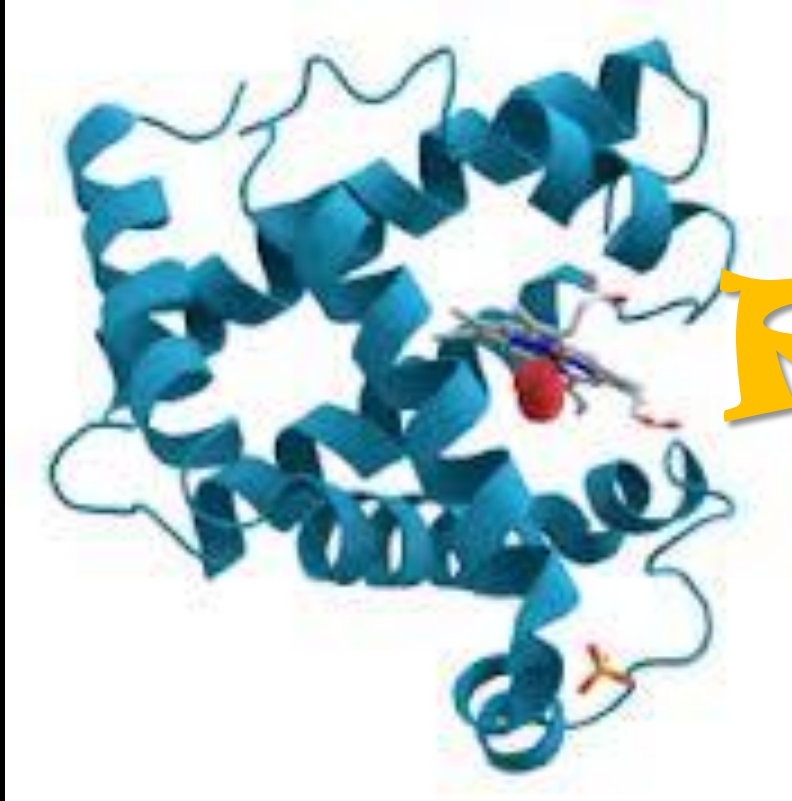


# RNA Used in Protein Synthesis

- messenger RNA (mRNA). A copy of the gene that is being expressed. mRNA consist of “codons” that code for each individual amino acid in the protein made by that gene.
  - in eukaryotes, the initial RNA copy of the gene is called the “primary transcript”, which is modified to form mRNA.
- ribosomal RNA (rRNA). Four different RNA molecules that make up part of the structure of the ribosome. They catalysis the adding of an amino acid to a growing peptide chain.
- transfer RNA (tRNA). Small RNA molecules that act as adapters between the codons of messenger RNA and the amino acids they code for.

# RNA vs. DNA

- RNA contains the sugar ribose; DNA contains deoxyribose.
- RNA contains the base uracil; DNA contains thymine instead.
- RNA is usually single stranded; DNA is usually double stranded.
- RNA is short: one gene long at most; DNA is long, containing many genes.



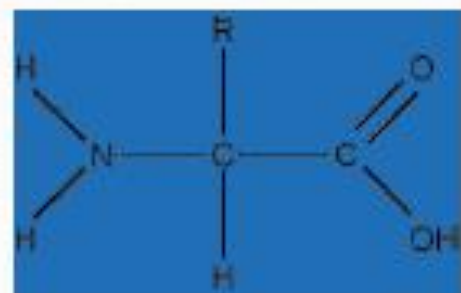
# PROTEIN

# Proteins

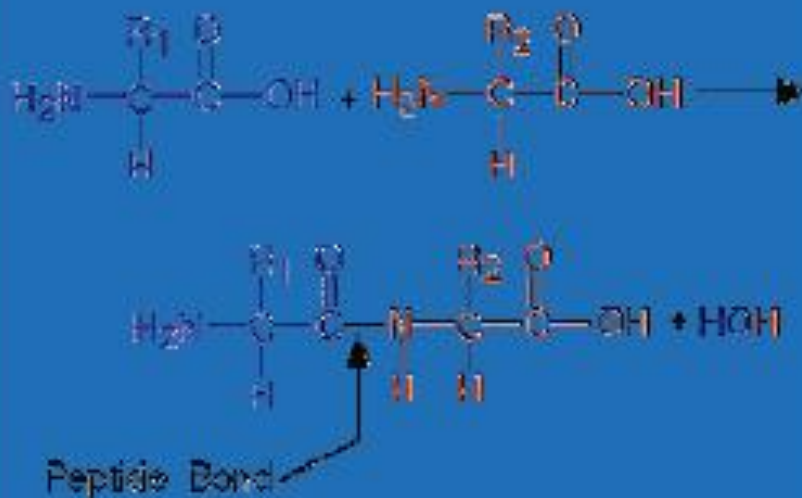
- Proteins are composed of one or more polypeptides, plus (in some cases) additional small molecules (co-factors).
- Polypeptides are linear chains of amino acids. After synthesis, the new polypeptide folds spontaneously into its active configuration and combines with the other necessary subunits to form an active protein. Thus, all the information necessary to produce the protein is contained in the DNA base sequence that codes for the polypeptides.
- The sequence of amino acids in a polypeptide is known as its “primary structure”.

# Amino Acids and Peptide Bonds

- There are 20 different amino acids coded in DNA.
- They all have an amino group ( $-\text{NH}_2$ ) group on one end, and an acid group ( $-\text{COOH}$ ) on the other end. Attached to the central carbon is an R group, which differs for each of the different amino acids.
- When polypeptides are synthesized, the acid group of one amino acid is attached to the amino group of the next amino acid, forming a peptide bond.



## Peptide Bond Formation





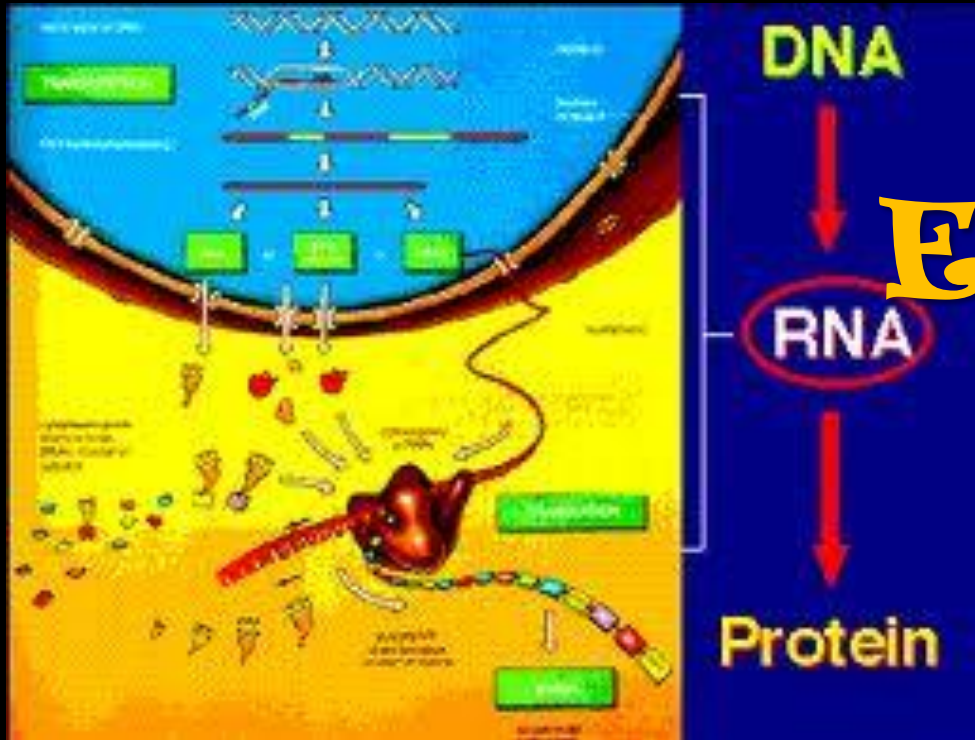
# The Genetic Code (3)

- **The degeneracy of the genetic code.** Each amino acid might have up to six codons that specify it.
- Different organisms have different frequencies of codon usage.
- A handful of species vary from the codon association described above, and use different codons for different amino acids.

# Second letter

		Second letter					
		U	C	A	G		
First letter	U	UUU Phenyl- alanine UUA Leucine UUG	UCU UCC Serine UCA UCG	UAU Tyrosine UAC UAA Stop codon UAG Stop codon	UGU Cysteine UGC UGA Stop codon UGG Tryptophan	U	C
	C	CUU CUC Leucine CUA CUG	CCU CCC Proline CCA CCG	CAU Histidine CAC CAA Glutamine CAG	CGU CGC Arginine CGA CGG	A	G
	A	AUU AUC Isoleucine AUA AUG Methionine; start codon	ACU ACC Threonine ACA ACG	AAU Asparagine AAC AAA Lysine AAG	AGU Serine AGC AGA Arginine AGG	U	C
	G	GUU GUC Valine GUA GUG	GCU GCC Alanine GCA GCG	GAU Aspartate GAC GAA Glutamate GAG	GGU GGC Glycine GGA GGG	A	G

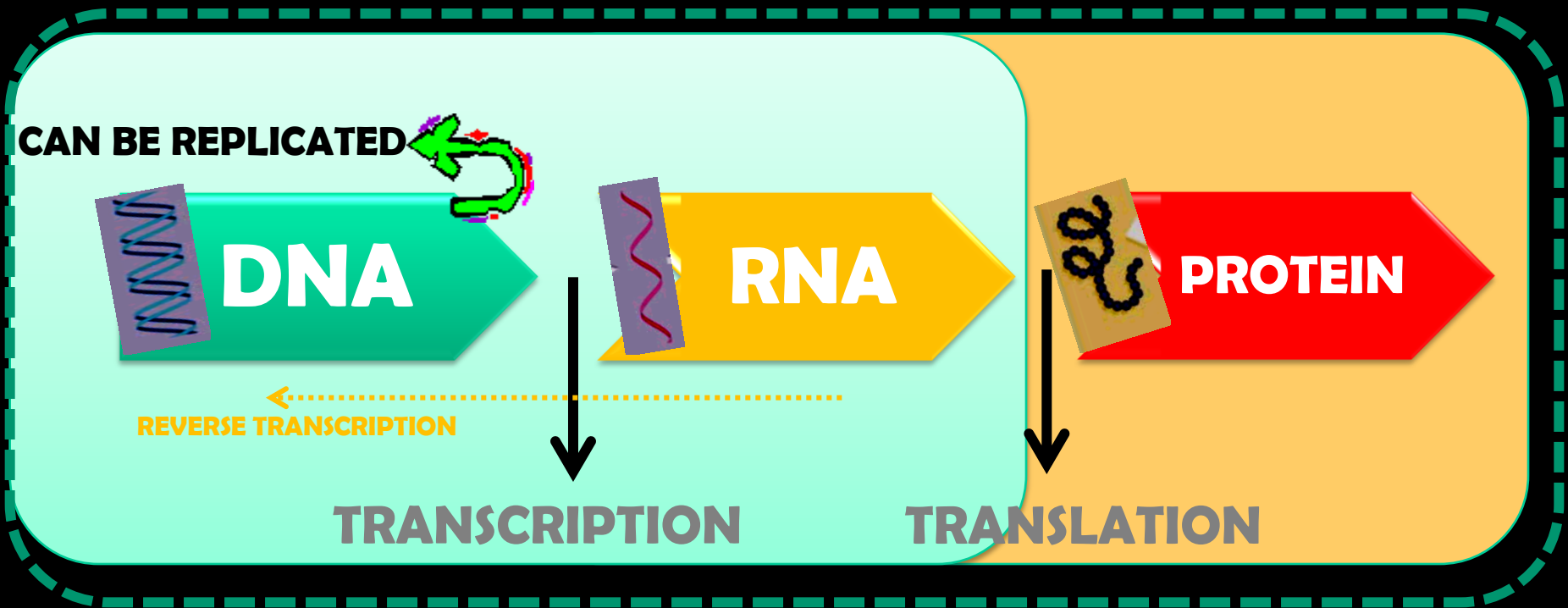
Third letter



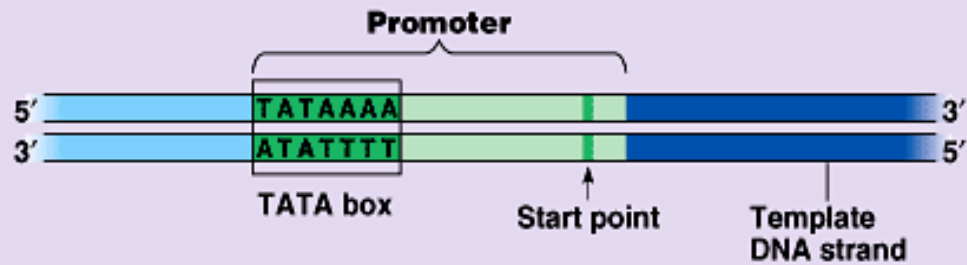
# EKSPRESI GEN

# CENTRAL DOGMA

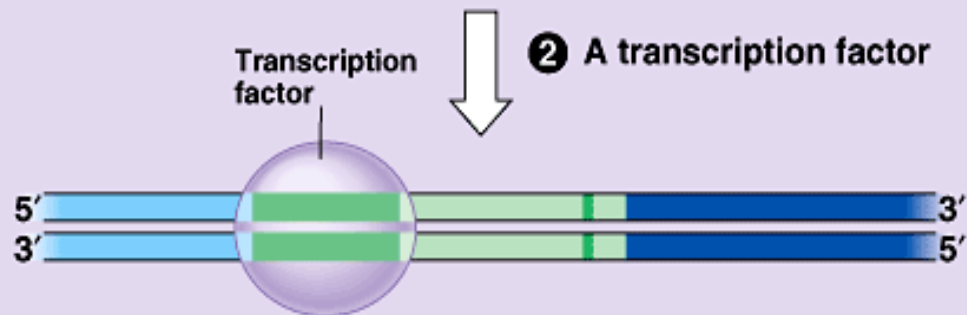
## ALIRAN INFORMASI GENETIK



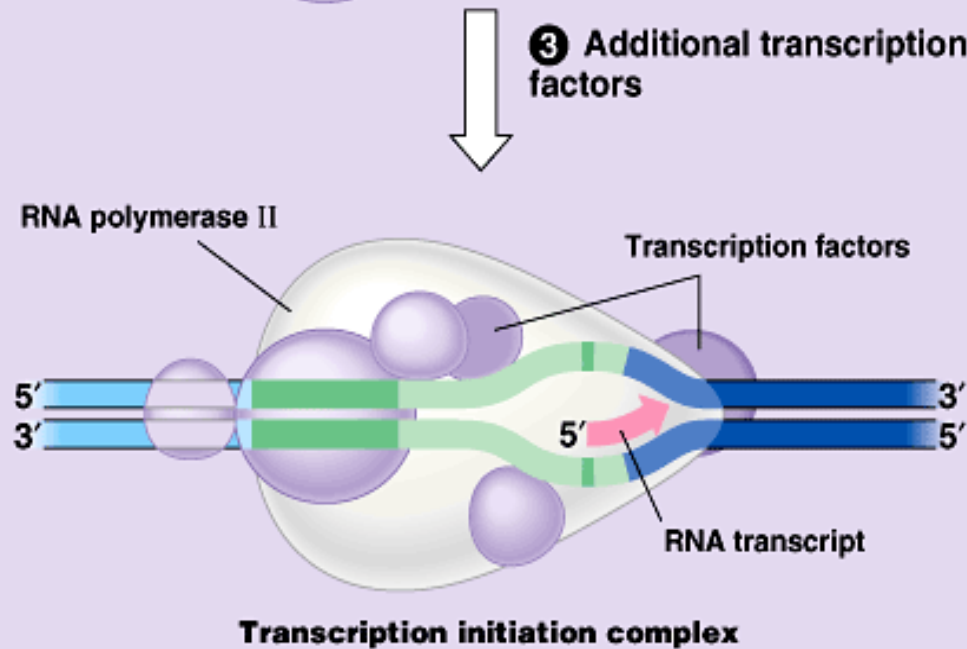
## 1 Eukaryotic promoters



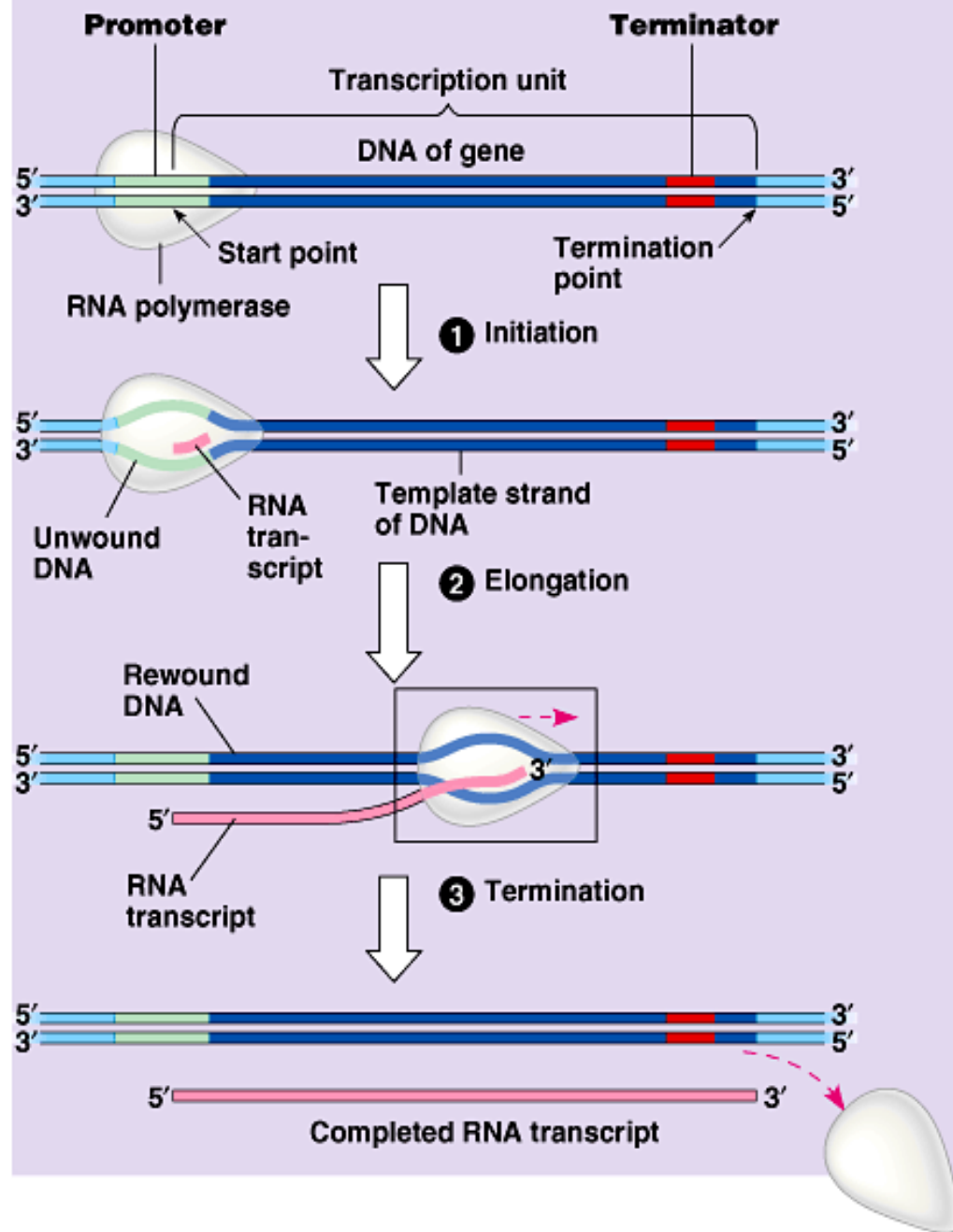
## 2 A transcription factor



## 3 Additional transcription factors







## ELONGATION

