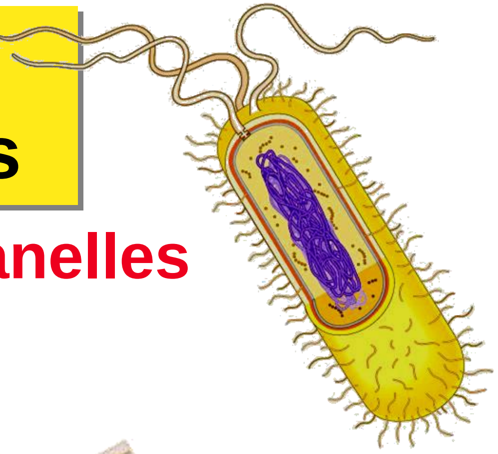
Cells, Communication and Molecular Biology Review

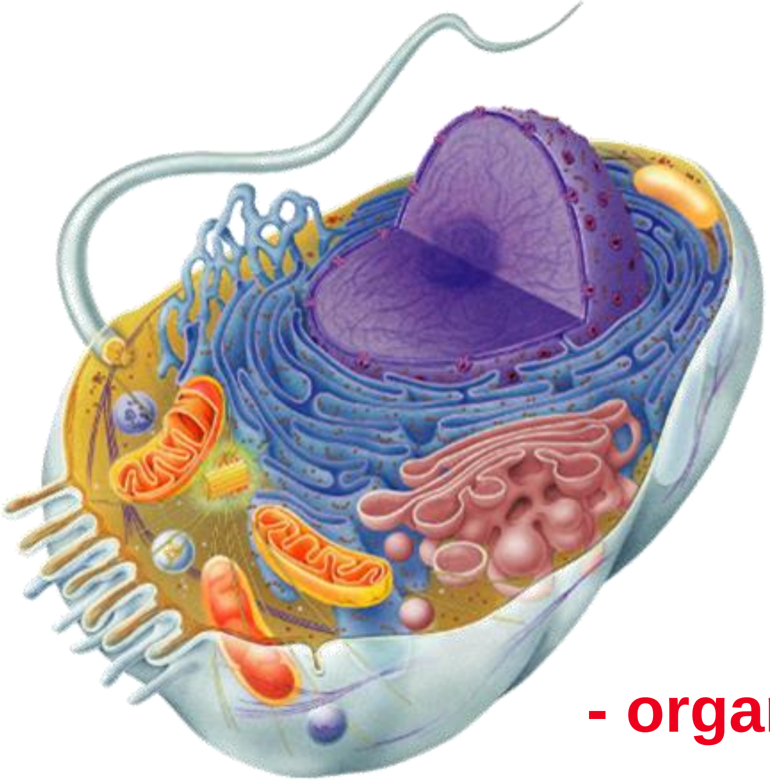
Make a Venn Diagram comparing prokaryote, plant and animal cells

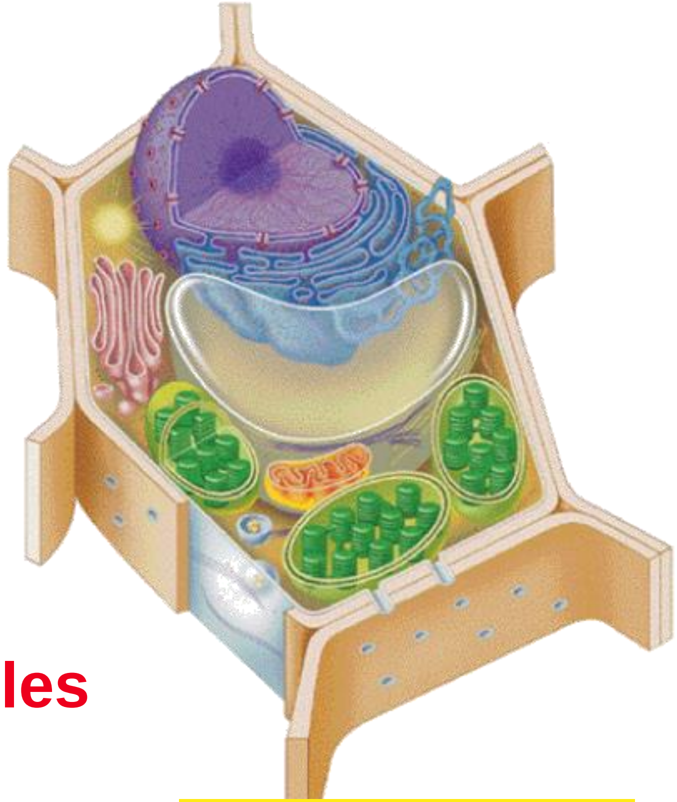
Types of cells

Prokaryote bacteria cells



- no organelles





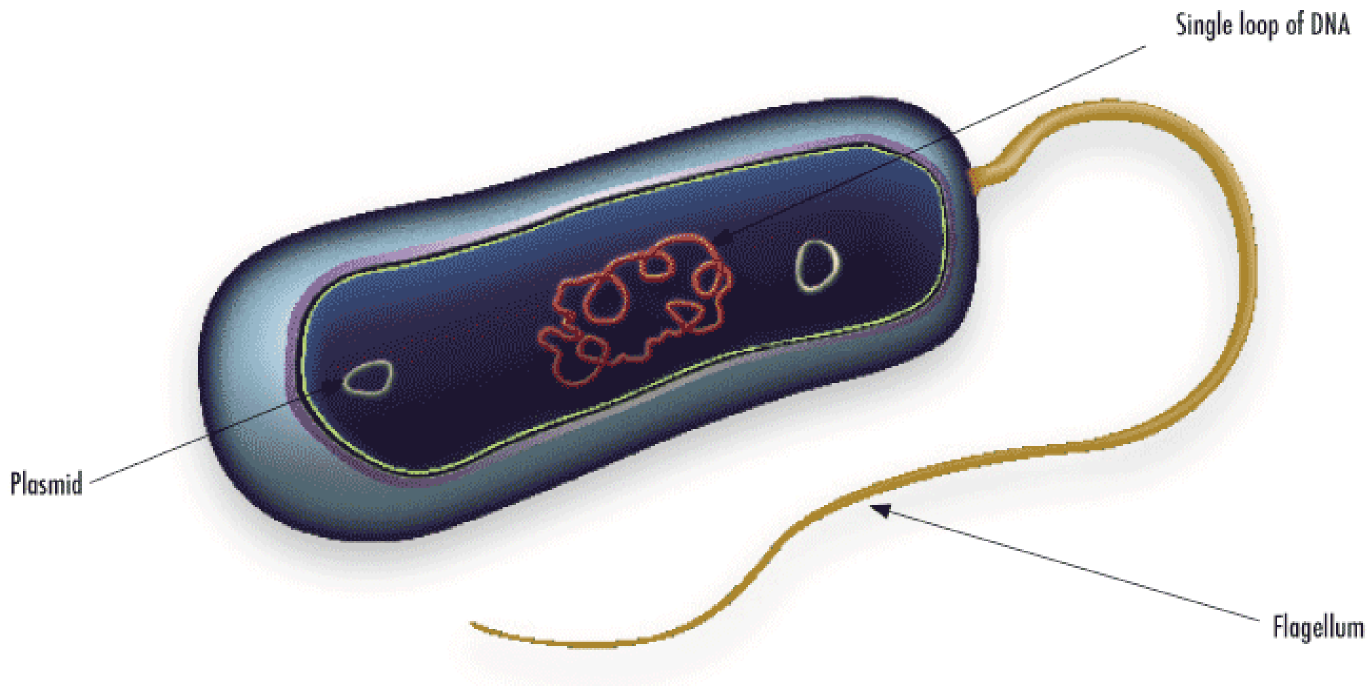
- organelles

Eukaryote animal cells

Eukaryote plant cells

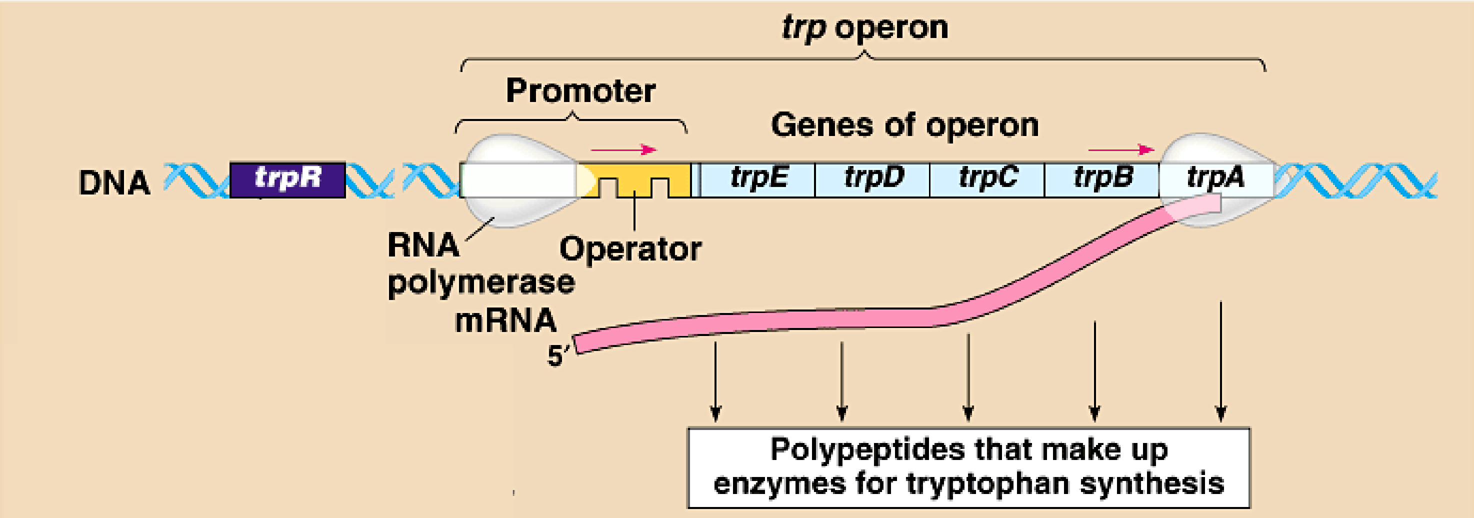
Bacterial Cell=Prokaryote

-have ribosomes, DNA loop + plasmid, cell wall, cell membrane, flagella or cilia



Bacteria group genes together

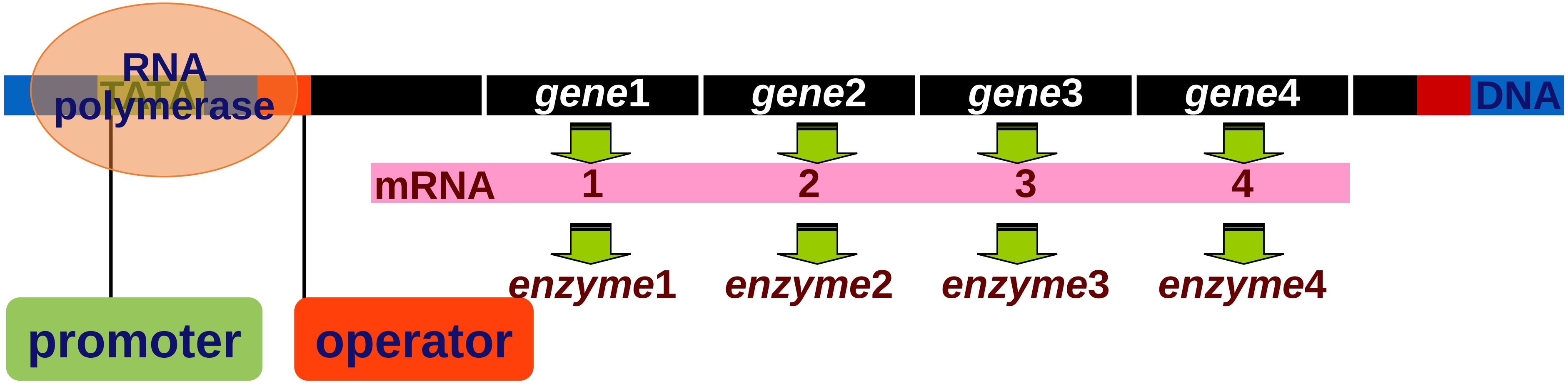
- Operon
  - genes grouped together with related functions
    - example: all enzymes in a metabolic pathway
  - promoter = RNA polymerase binding site
    - single promoter controls transcription of all genes in operon
    - transcribed as one unit & a single mRNA is made
  - operator = DNA binding site of repressor protein



Operon model

When gene is turned ON:

Polymerase binds promoter
Gene is transcribed



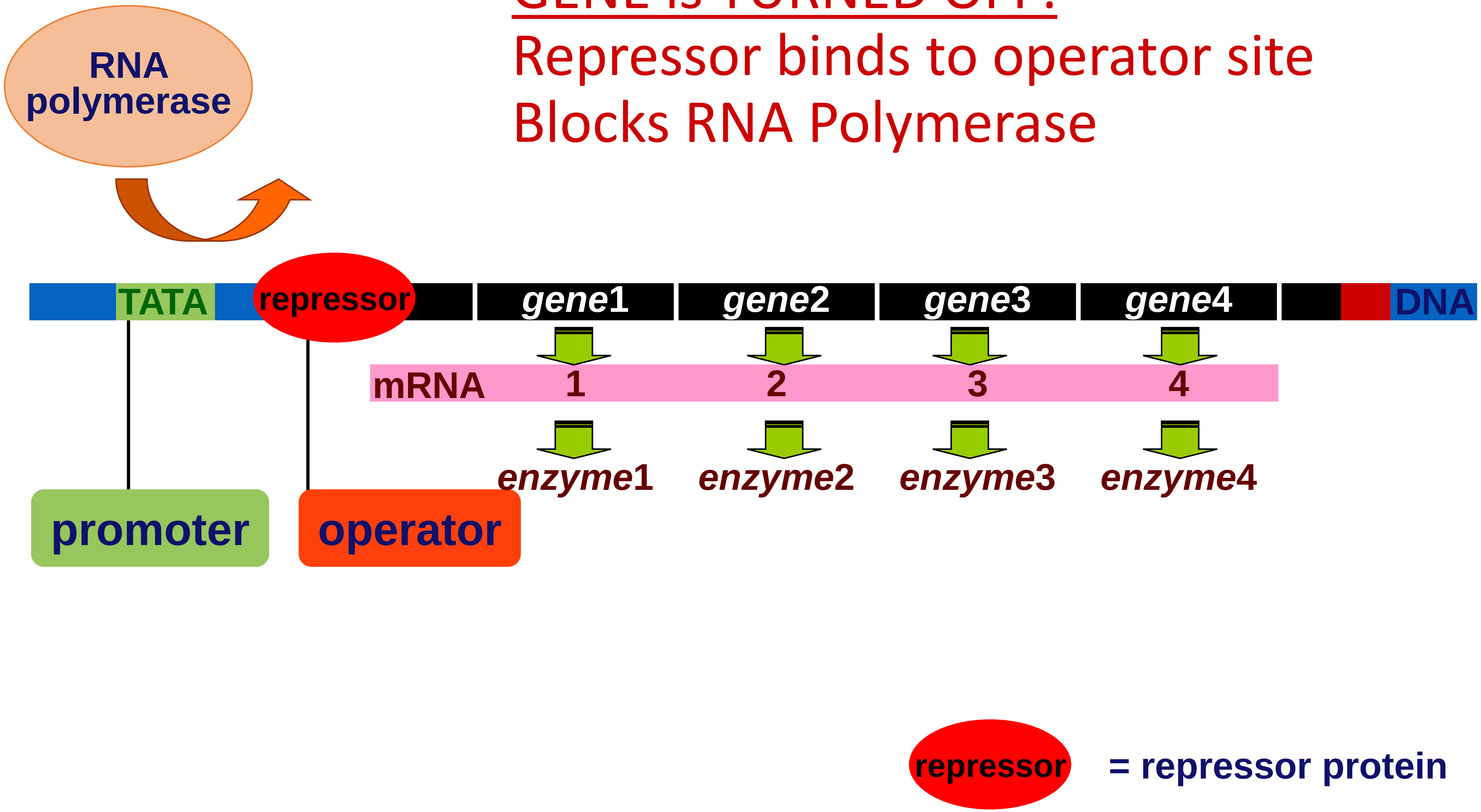
Slide by Kim Foglia modified

Operon model

GENE is TURNED OFF:

Repressor binds to operator site

Blocks RNA Polymerase



- REPRESSIBLE OPERONS are ON

Can be turned off

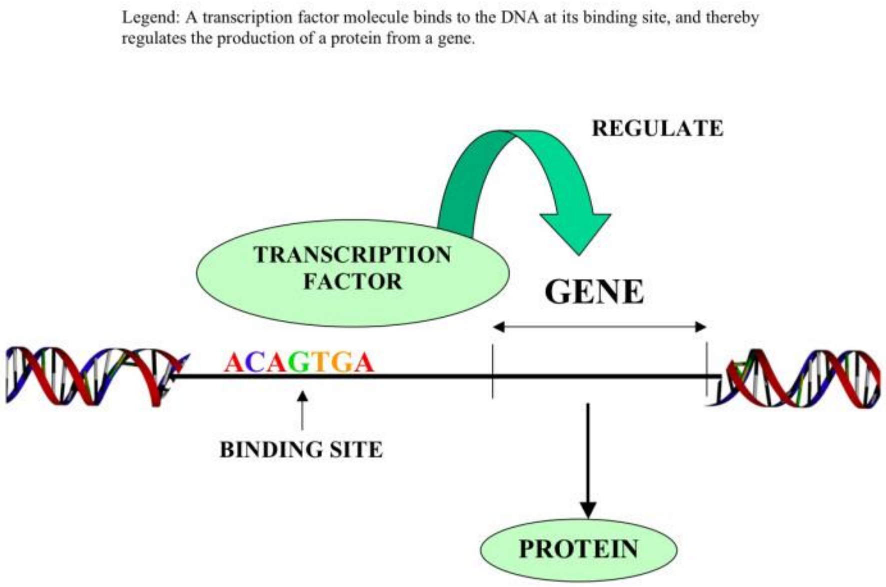
EX: *trp* operon--makes enzymes used in tryptophan synthesis

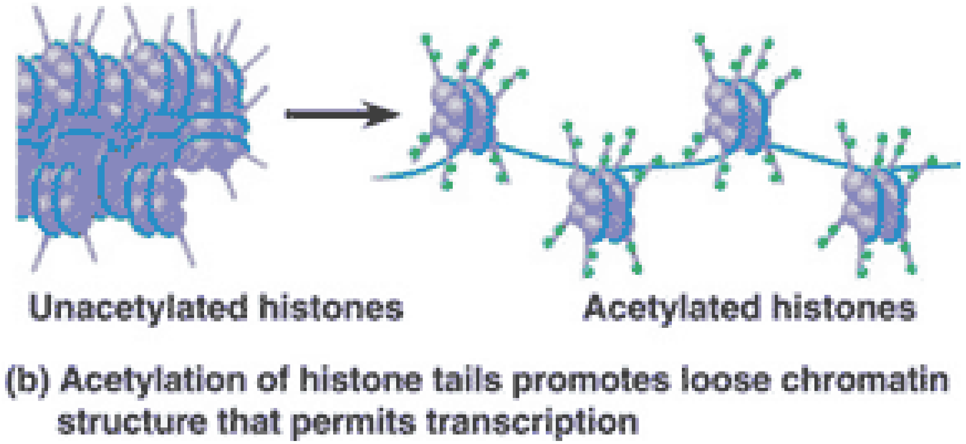
- INDUCIBLE OPERONS are OFF

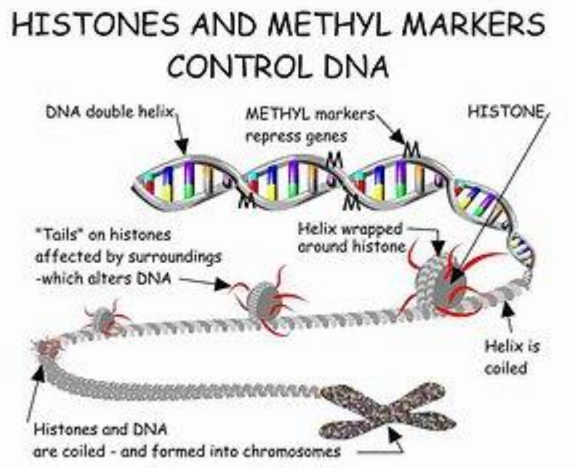
Can be turned on

EX: lac operon--makes enzymes used in lactose digestion

Eukaryotic Gene Regulation







Question 1: Which of the following is true regarding spherical cells?

A. As the diameter decreases, the surface area remains the same.

B. As the diameter decreases, the surface area increases.

C. As the diameter decreases, the surface-to-volume ratio increases.

D. As the diameter increases, the volume decreases.

E. The surface-to-volume ratio is independent of diamete

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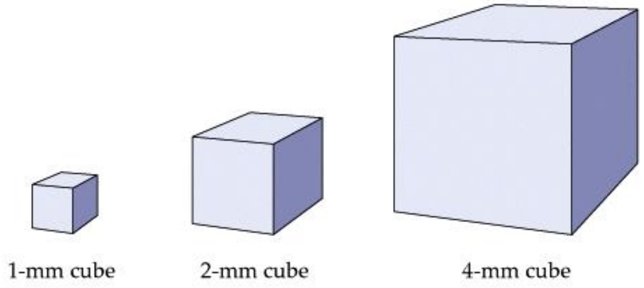
Limits to Cell Size

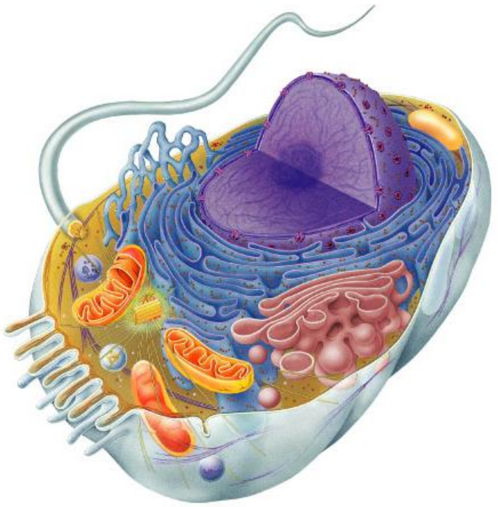
- <u>Diffusion</u> limits cell size
  - Movement from higher concentration to lower concentration
  - Larger the distance, slower the diffusion rate
  - A cell 20 cm would require <u>months</u> for nutrients to get to the center

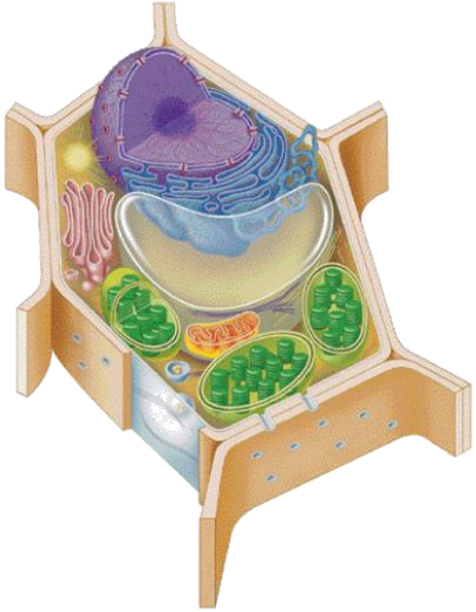


Surface area	6 sides × 1^2 = 6 mm^2	6 sides × 2^2 = 24 mm^2	6 sides × 4^2 = 96 mm^2
Volume	1^3 = 1 mm^3	2^3 = 8 mm^3	4^3 = 64 mm^3
Surface area-to-volume ratio	6/1	3/1	1.5/1

Cells gotta work to live!

- What jobs do cells have to do?
  - make proteins
    - proteins control every cell function
  - make energy
    - for daily life
    - for growth
  - make more cells
    - growth
    - repair
    - renewal





Question 2: Which of the following components of the cell membrane is responsible for active transport?

(A) Phospholipid
(B) Protein
(C) Lipid
(D) Phosphate
(E) Cholesterol

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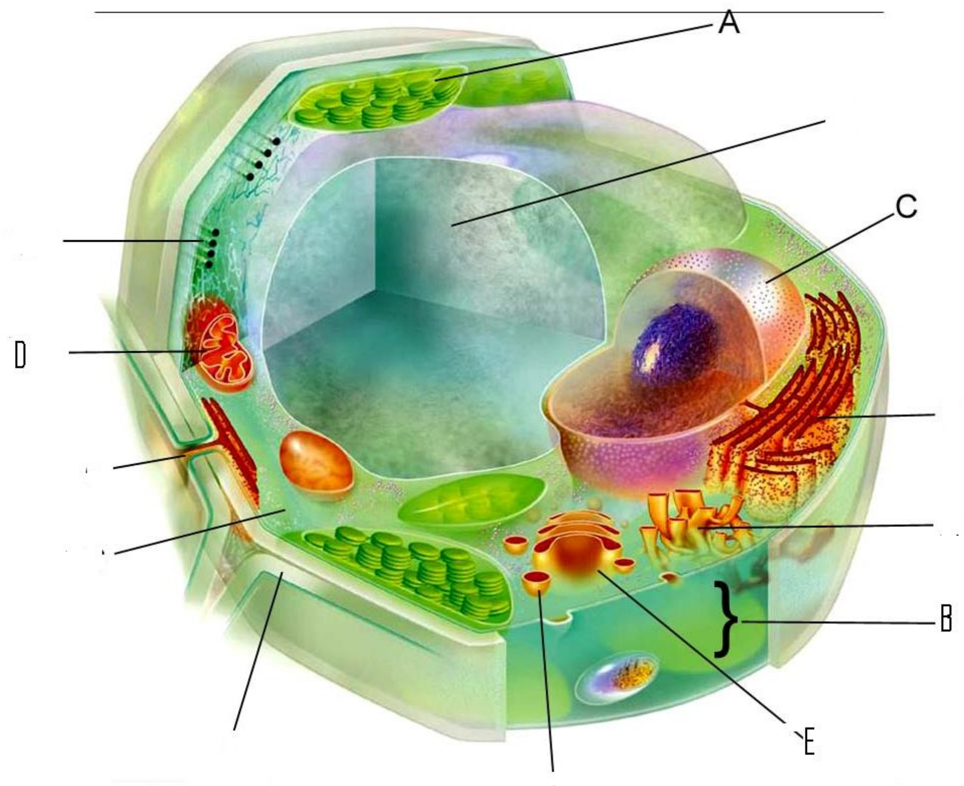
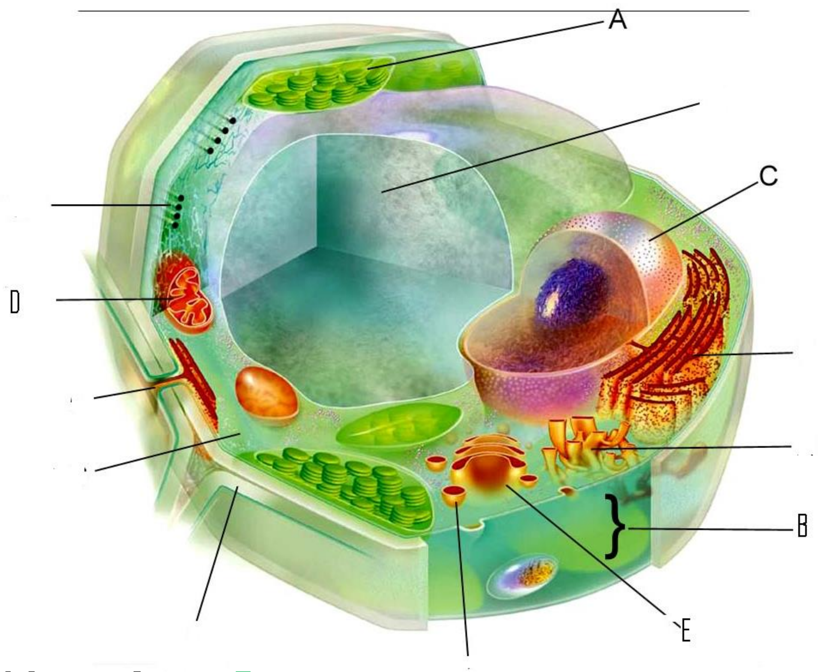
Questions 3-5



3. Site of glucose synthesis
4. Site of conversion of chemical energy of glucose to ATP
5. Site of modification and packaging of proteins and lipids prior to export from the cell

Questions 3-5



3. Site of glucose synthesis--**A**
4. Site of conversion of chemical energy of glucose to ATP---**D**
5. Site of modification and packaging of proteins and lipids prior to export from the cell--**E**

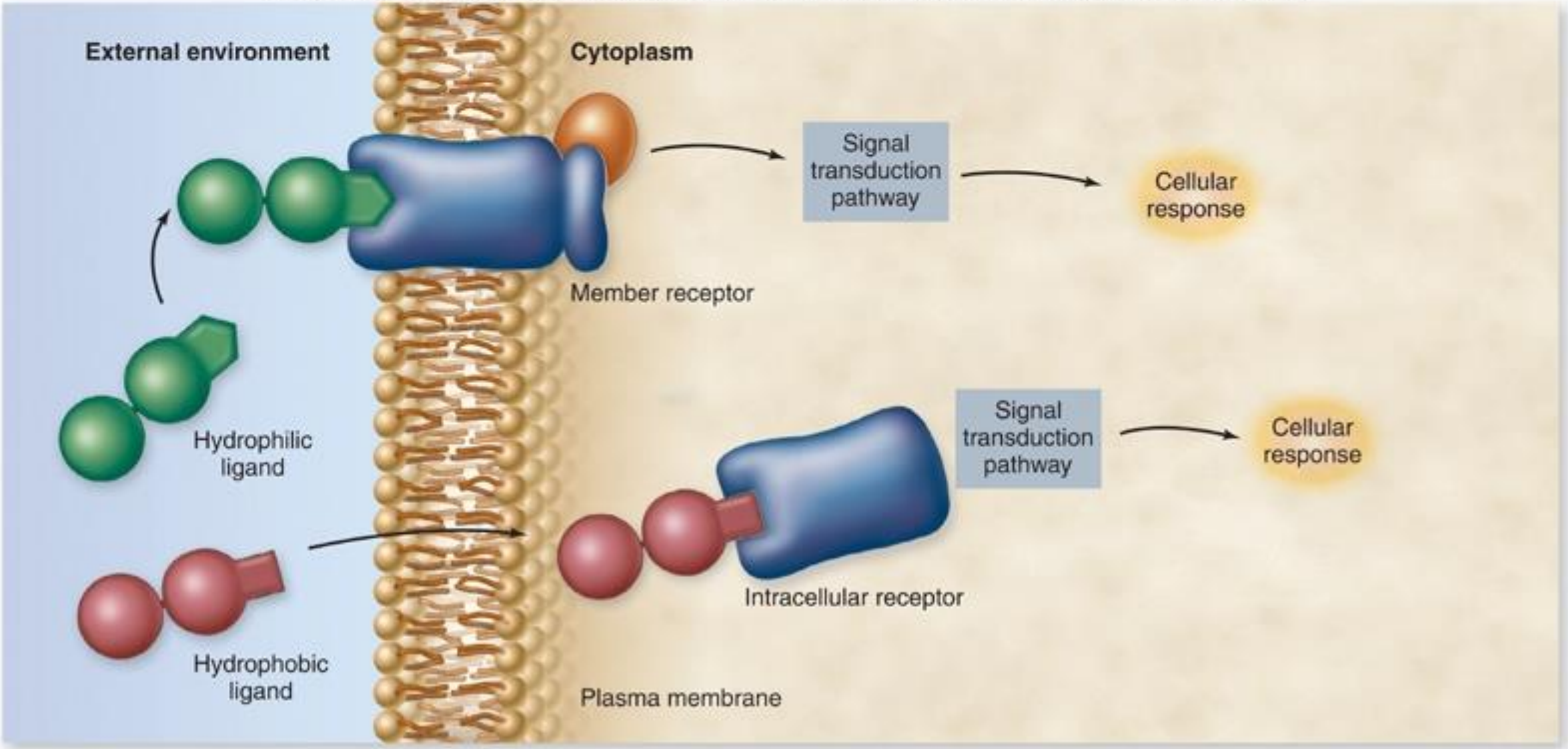
Cell Communication

Communication between cells requires:

ligand: the signaling molecule

receptor protein: the molecule to which the receptor binds

-may be on the plasma membrane or within the cell


External environment
Cytoplasm
Signal transduction pathway
Cellular response
Member receptor
Hydrophilic ligand
Signal transduction pathway
Cellular response
Intracellular receptor
Hydrophobic ligand
Plasma membrane

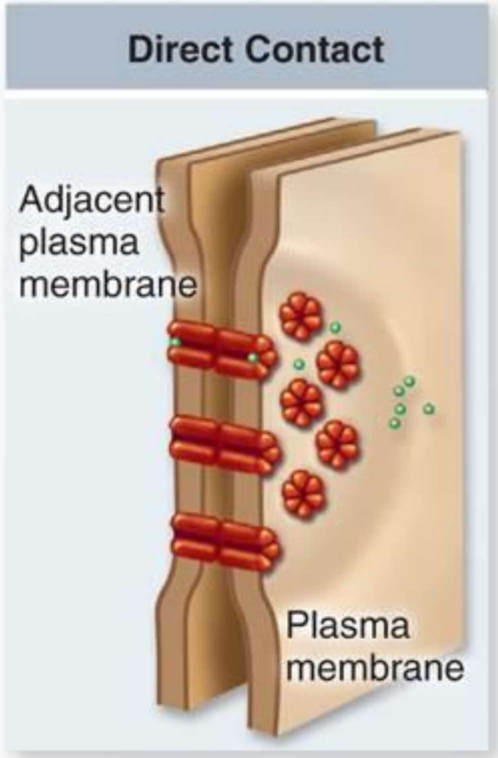
Cell Communication

There are four basic mechanisms for cellular communication:

1. direct contact
2. paracrine signaling
3. endocrine signaling
4. synaptic signaling

Cell Communication

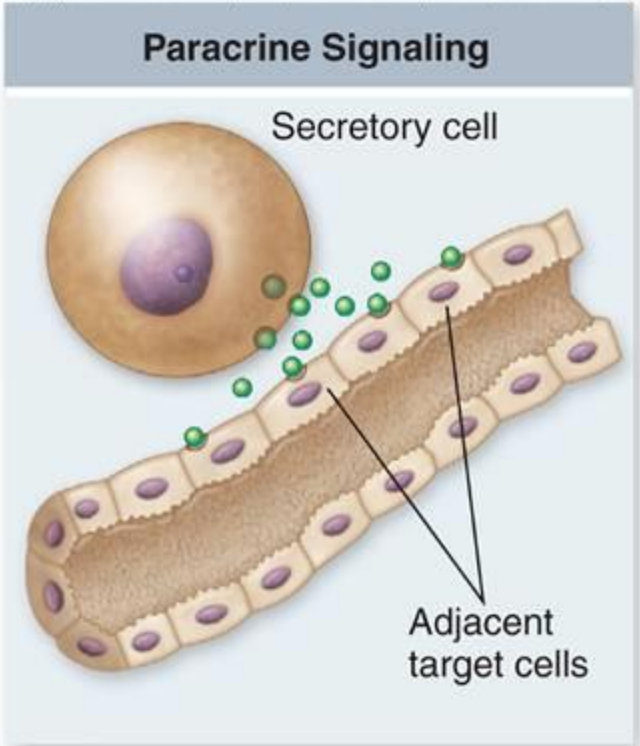
Direct contact – molecules on the surface of one cell are recognized by receptors on the adjacent cell



a.

Cell Communication

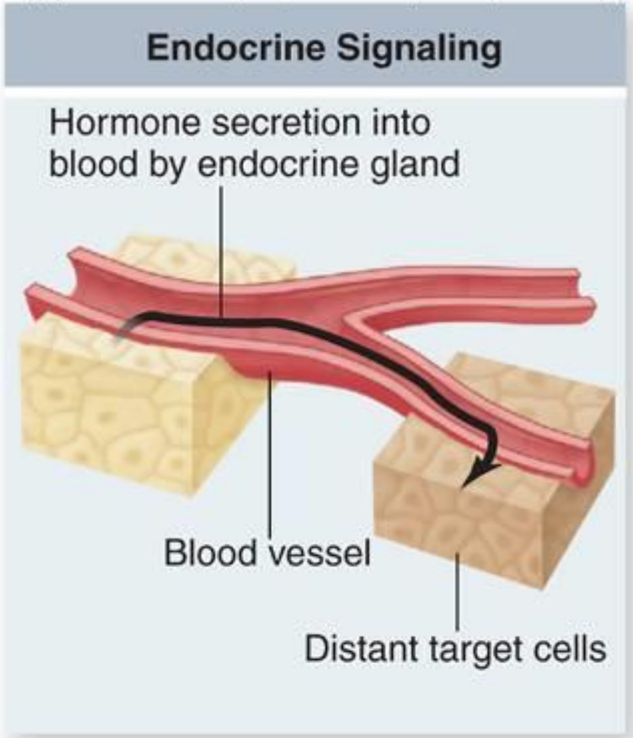
Paracrine signaling – signal released from a cell has an effect on neighboring cells



b.

Cell Communication

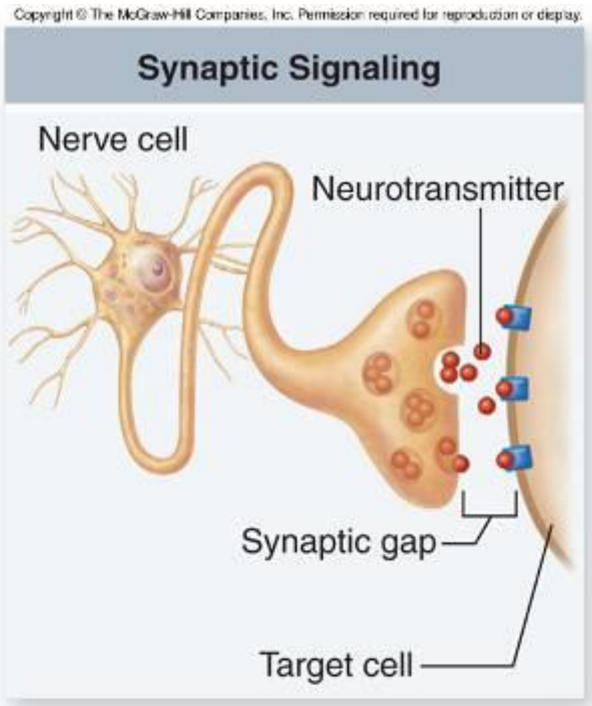
Endocrine signaling – hormones released from a cell affect other cells throughout the body



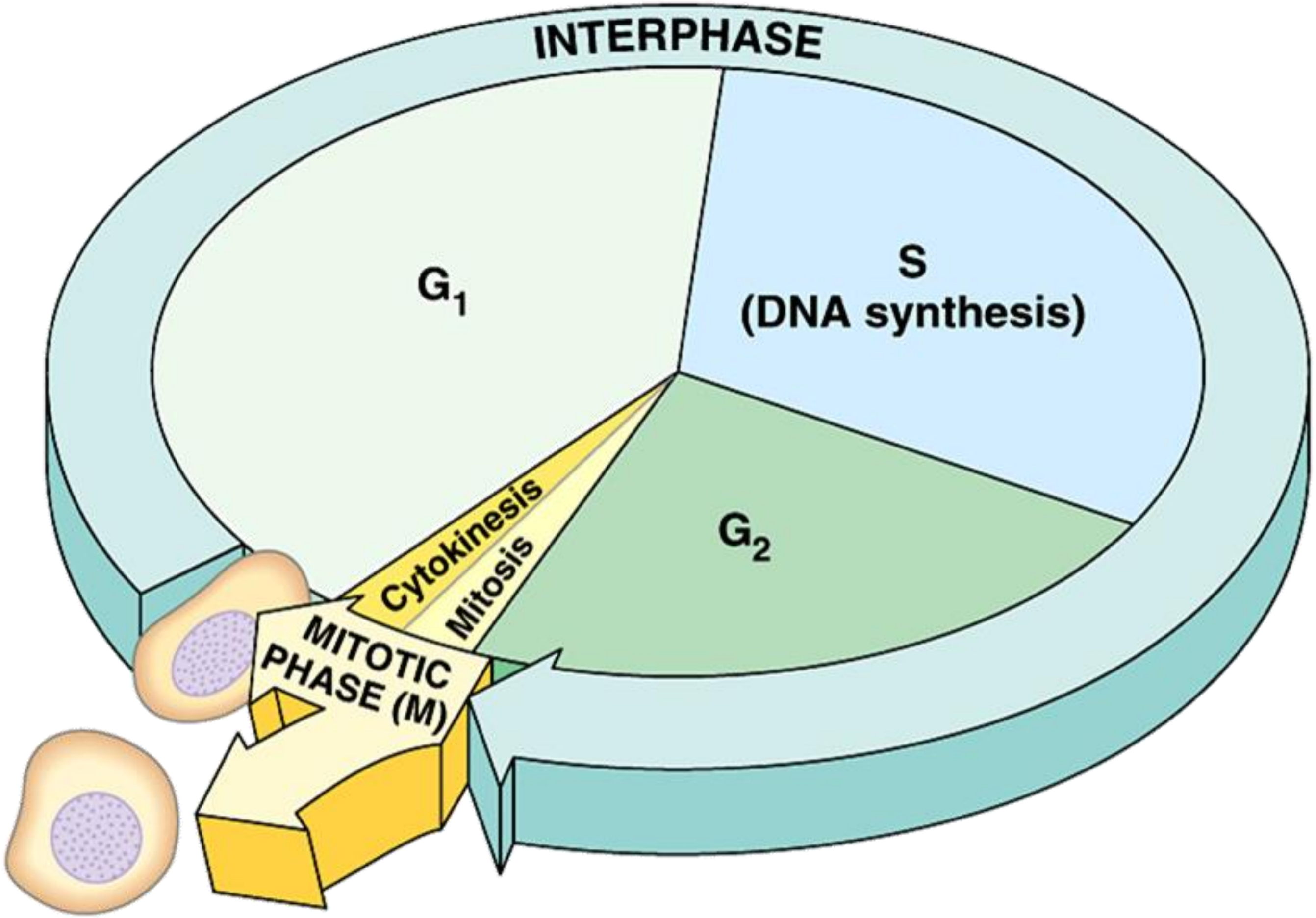
c.

Cell Communication

Synaptic signaling – nerve cells release the signal (**neurotransmitter**) which binds to receptors on nearby cells



d.



DNA Replication=S phase of the cell cycle

The Cell Cycle Clock: Cyclins and Cyclin-Dependent Kinase

•Fluctuations in the abundance and activity of cell cycle control molecules pace the sequential events of the cell cycle.

•Protein kinases, give the go-ahead signals at the G1 and G2 checkpoints

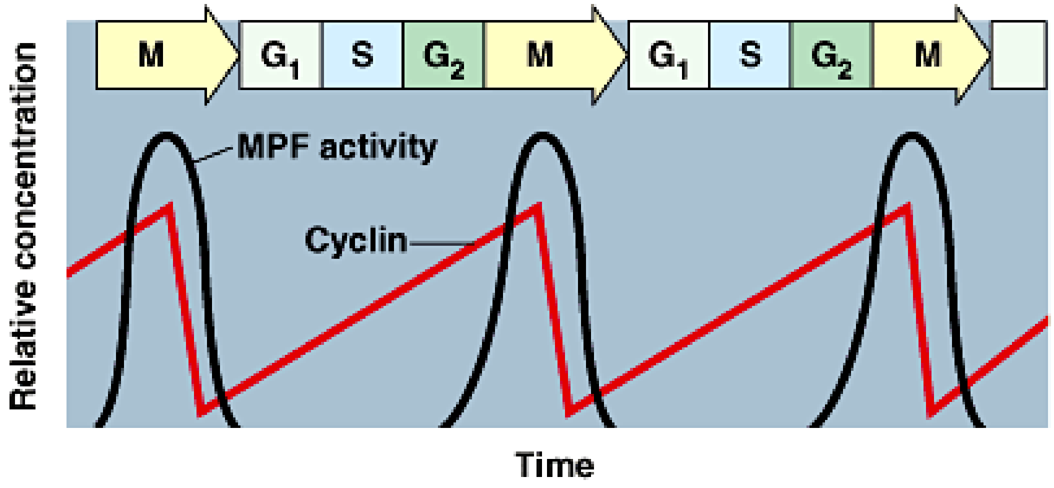
•The kinases are present at a constant concentration in the growing cell, but much of the time they are in inactive form.

•To be active, such a kinase must be attached to a cyclin, a protein that gets its name from its cyclically fluctuating concentration in the cell.

•These kinases are called cyclin-dependent kinases, or Cdks. The activity of a Cdk rises and falls with changes in the concentration of its cyclin partner.

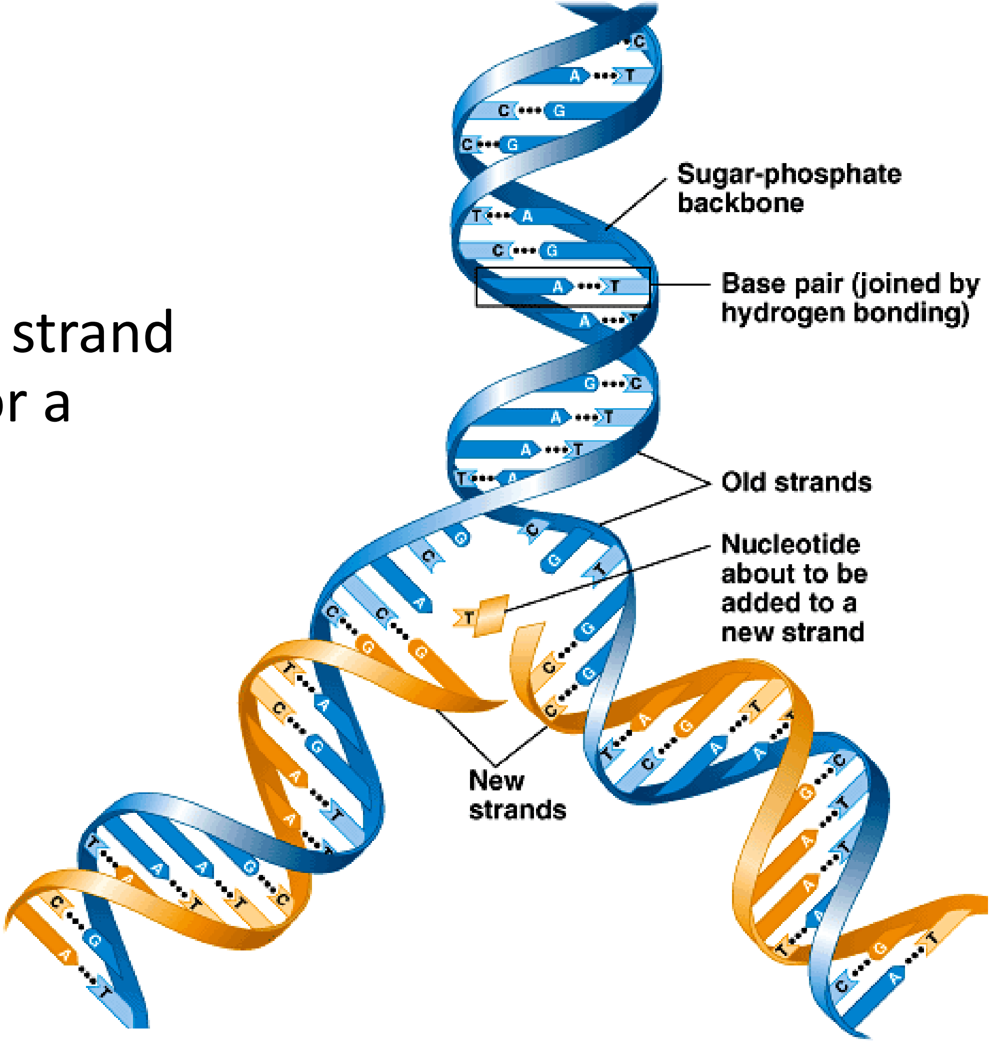
Cdks are relatively constant

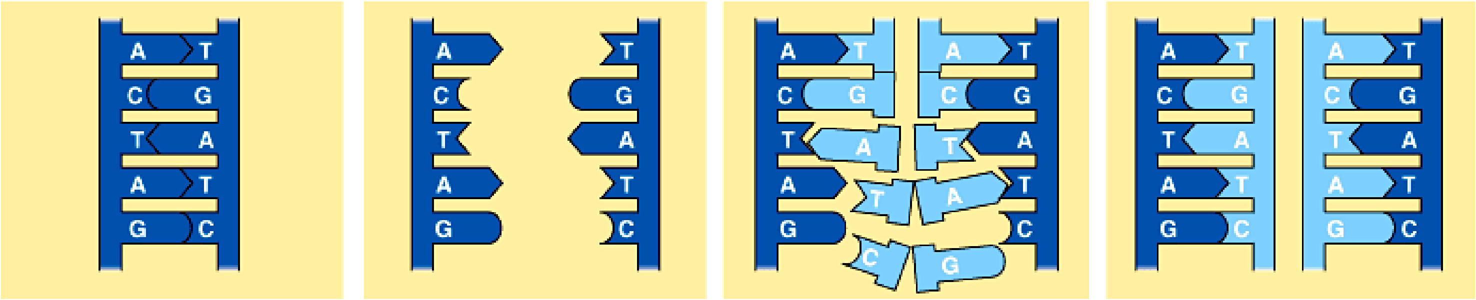
Cyclins vary in the cycle



Copying DNA

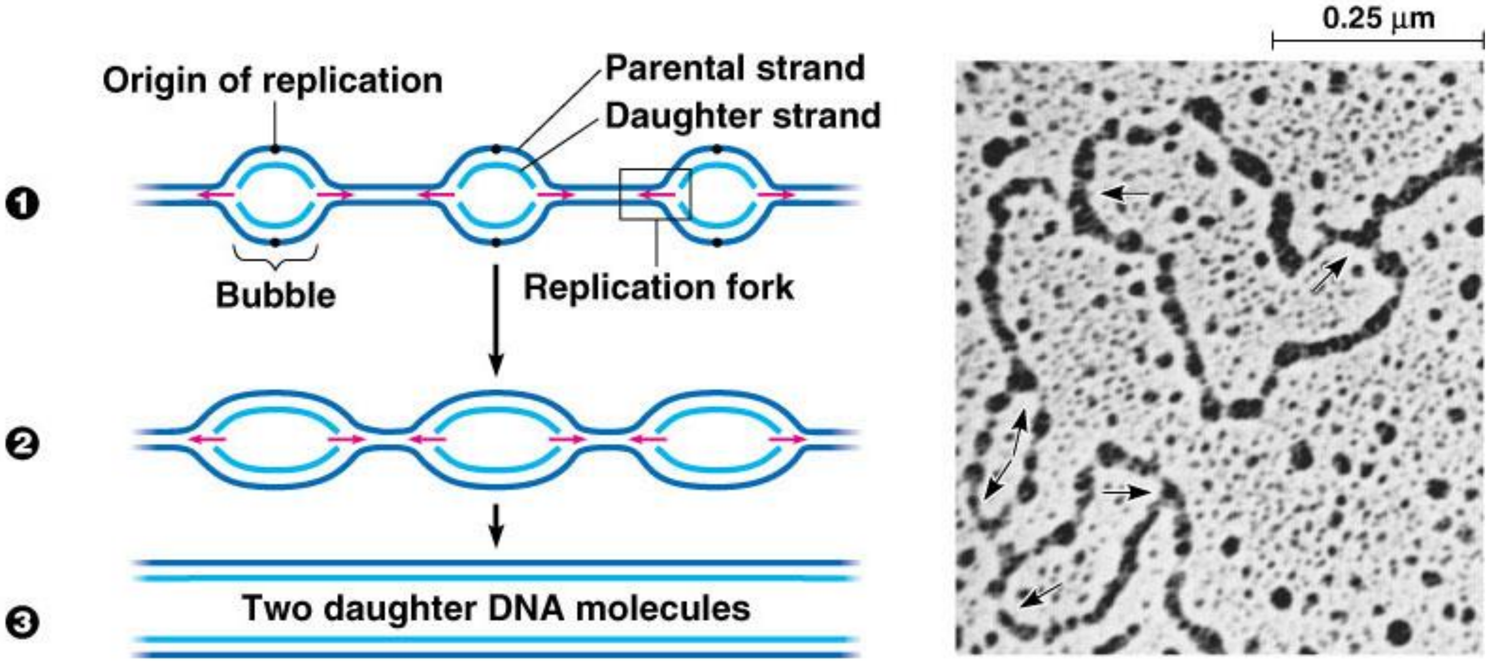
- Replication of DNA
  - base pairing allows each strand to serve as a template for a new strand
  - new strand is 1/2 parent template &
    1/2 new DNA
    - semi-conservative copy process





DNA Replication

- Large team of enzymes coordinates replication

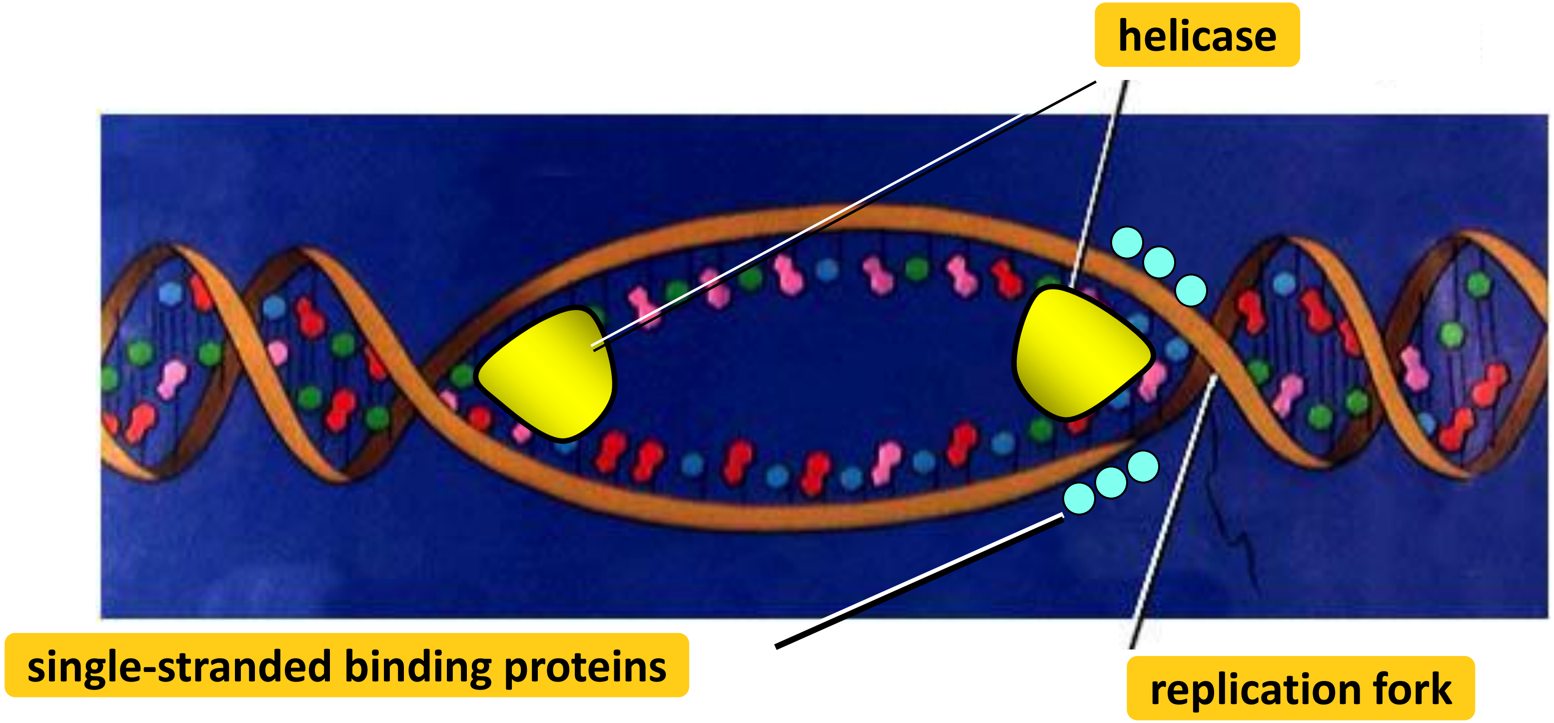


(a) In eukaryotes, DNA replication begins at many sites along the giant DNA molecule of each chromosome.

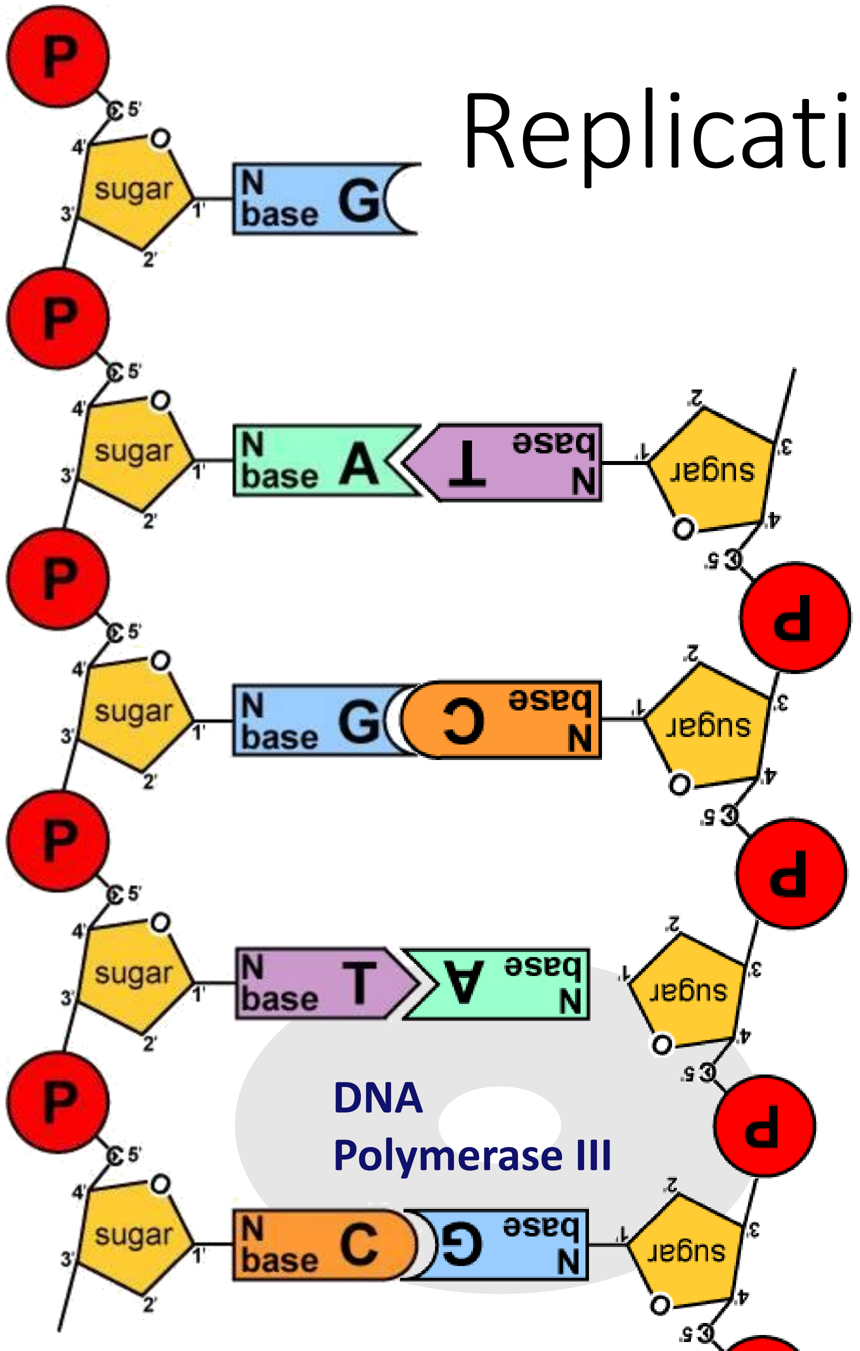
(b) In this micrograph, three replication bubbles are visible along the DNA of cultured Chinese hamster cells. The arrows indicate the direction of DNA replication at the two ends of each bubble (TEM).

Replication: 1st step

- Unwind DNA
  - helicase enzyme
    - unwinds part of DNA helix
    - stabilized by single-stranded binding proteins

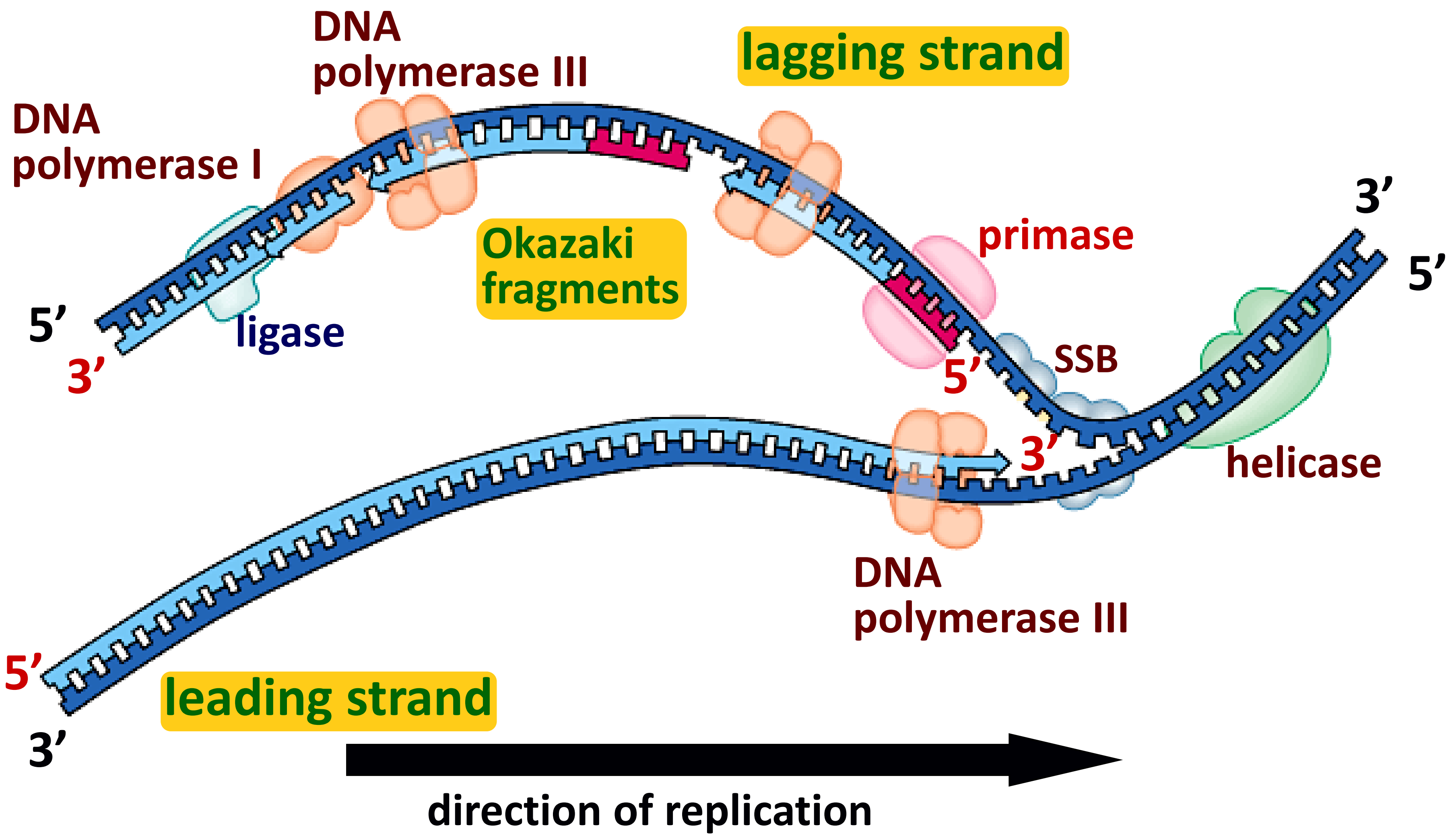


Replication: 2nd step



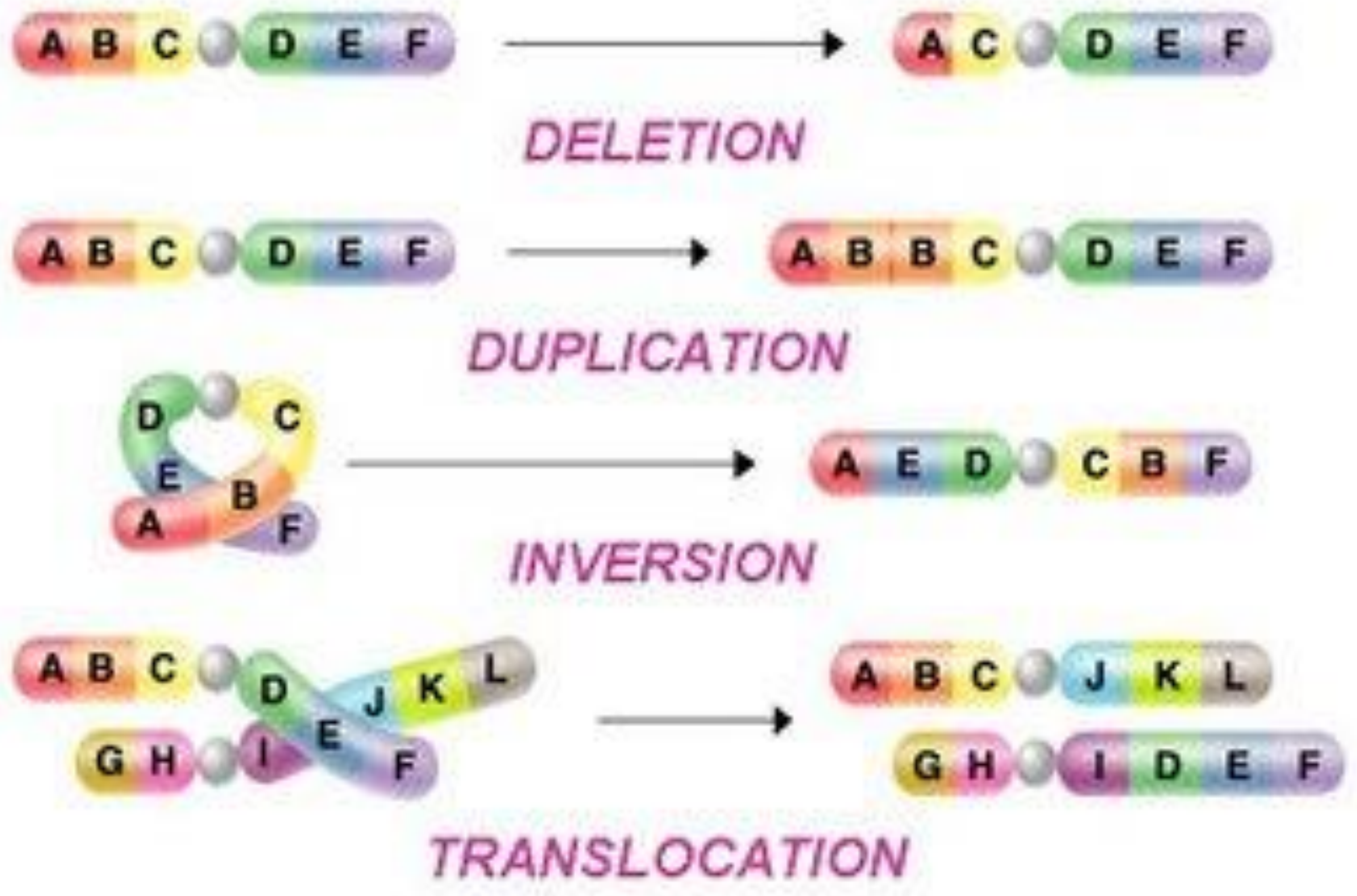
- **Build daughter DNA strand**
  - **add new complementary bases**
  - **DNA polymerase III**

Replication fork



SSB = single-stranded binding proteins

Chromosomal Mutations:



A DNA ligase
B DNA polymerase
C RNA polymerase
D Restriction enzyme
E Reverse Transcriptase

6. Enzyme used in the synthesis of mRNA

7. Enzyme used during replication to attach Okazki fragments to each other

8. Enzyme found in retrovirus that produces DNA from an RNA template

9. Enzyme used to position nucleotides during DNA replication

A DNA ligase
B DNA polymerase
C RNA polymerase
D Restriction enzyme
E Reverse Transcriptase

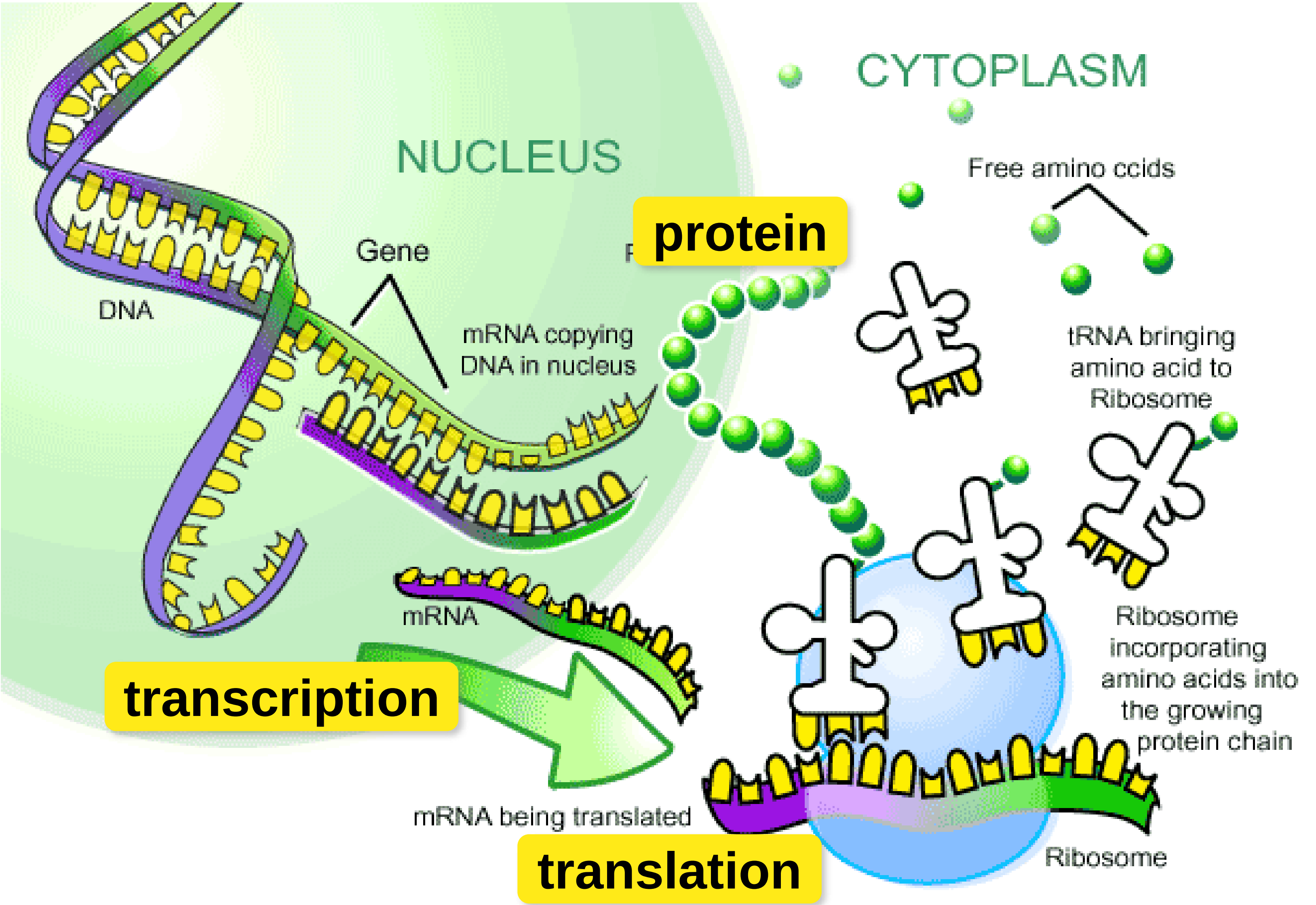
6. Enzyme used in the synthesis of mRNA **C**

7. Enzyme used during replication to attach Okazki fragments to each other **A**

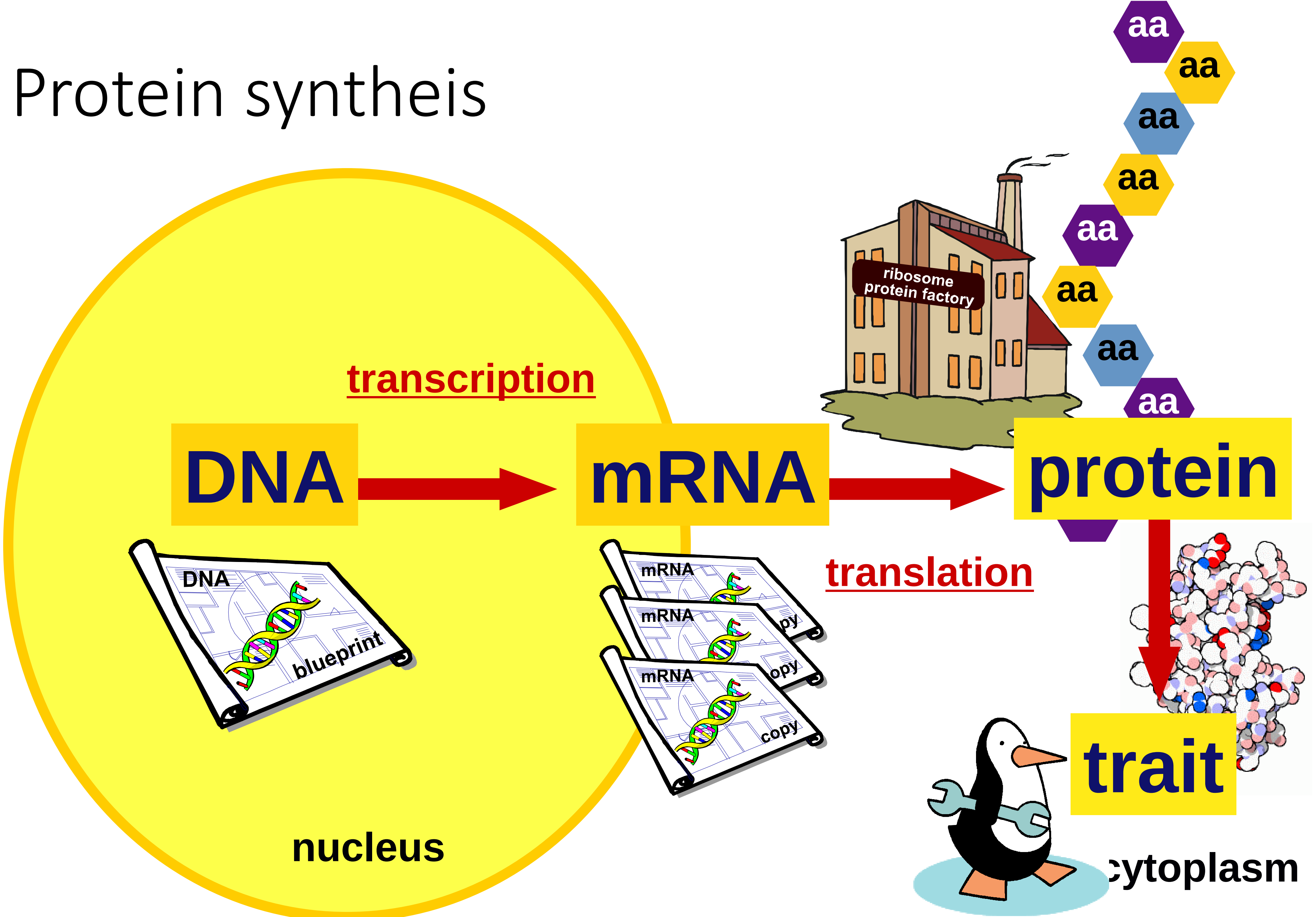
8. Enzyme found in retrovirus that produces DNA from an RNA template **E**

9. Enzyme used to position nucleotides during DNA replication **B**

From gene to protein

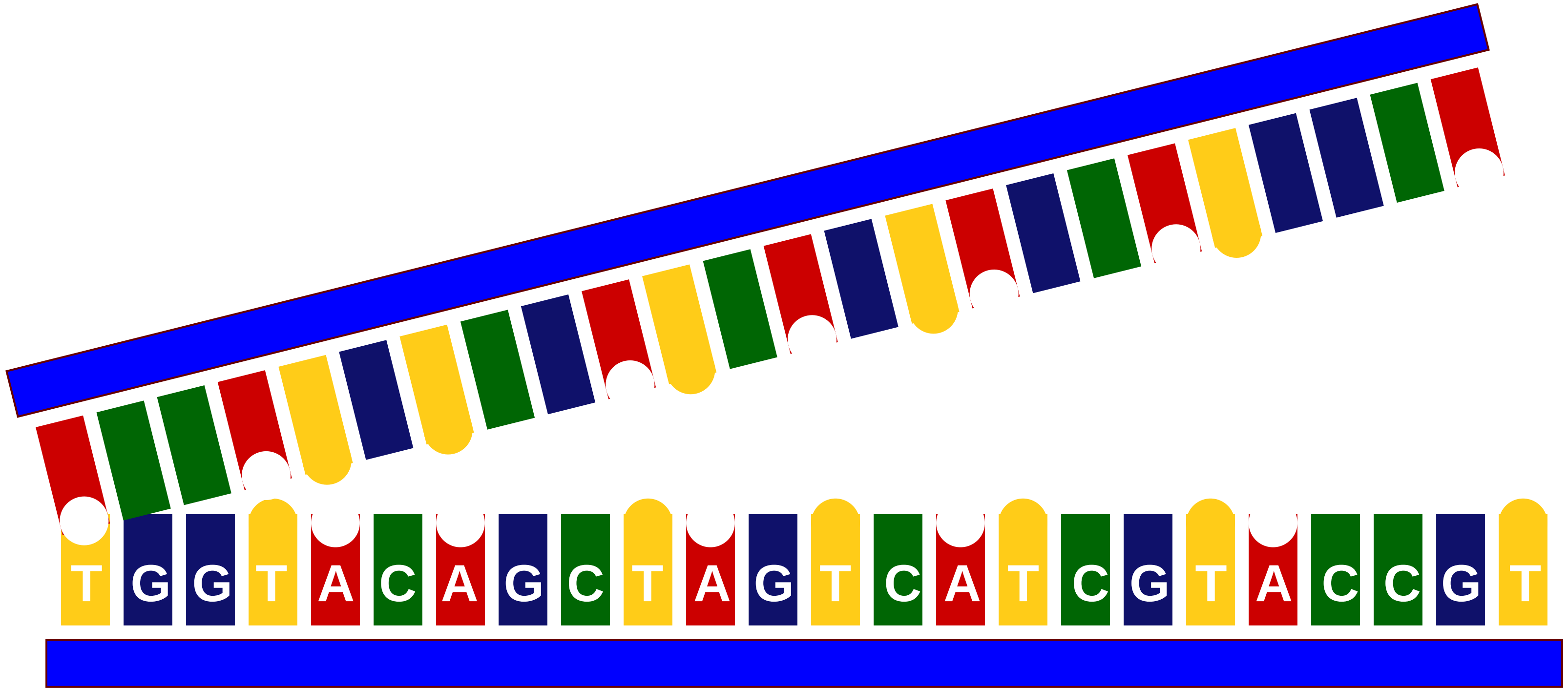


Protein syntheis



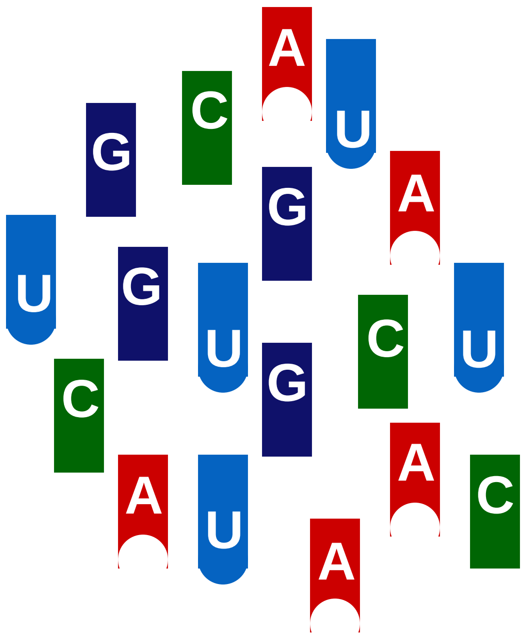
Matching bases of DNA & RNA

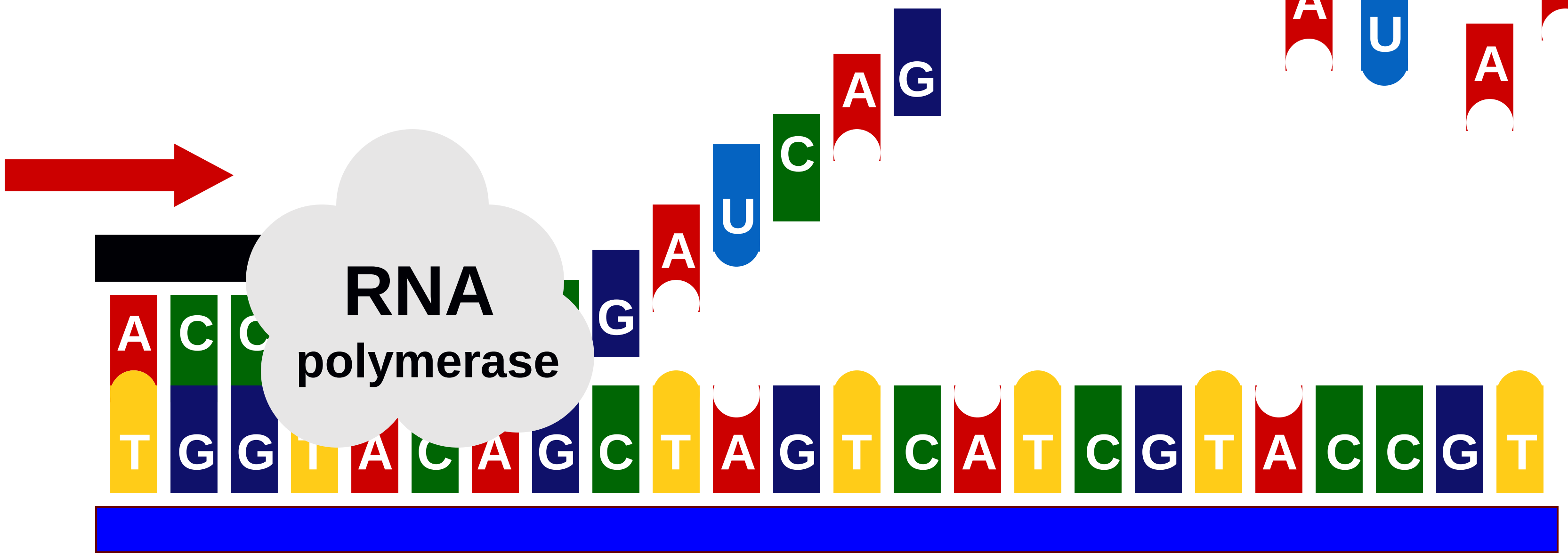
- Double stranded DNA unzips



Matching bases of DNA & RNA

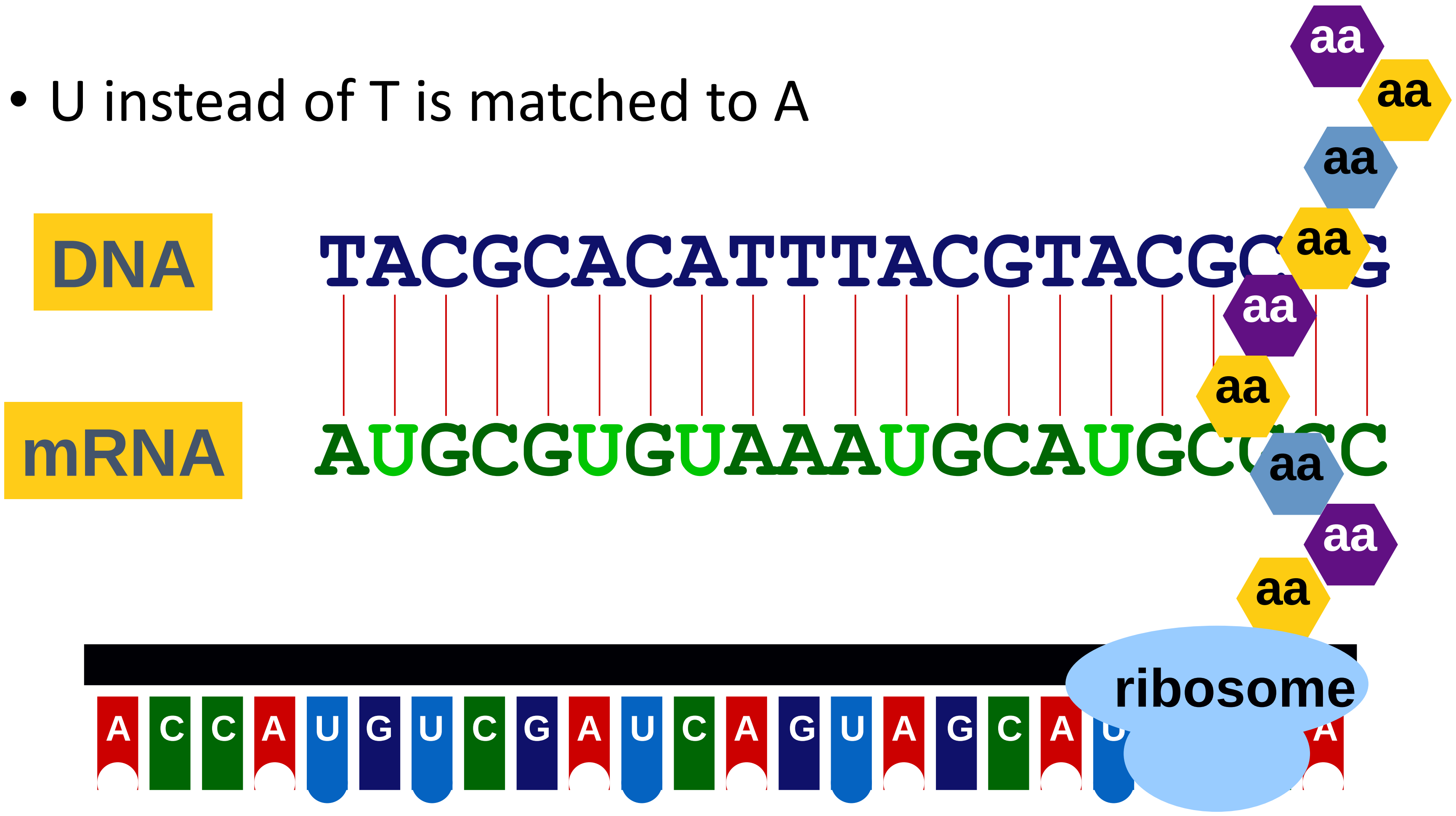
- Match RNA bases to DNA bases on one of the DNA strands



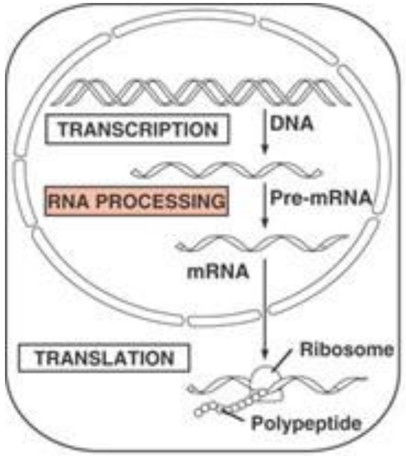


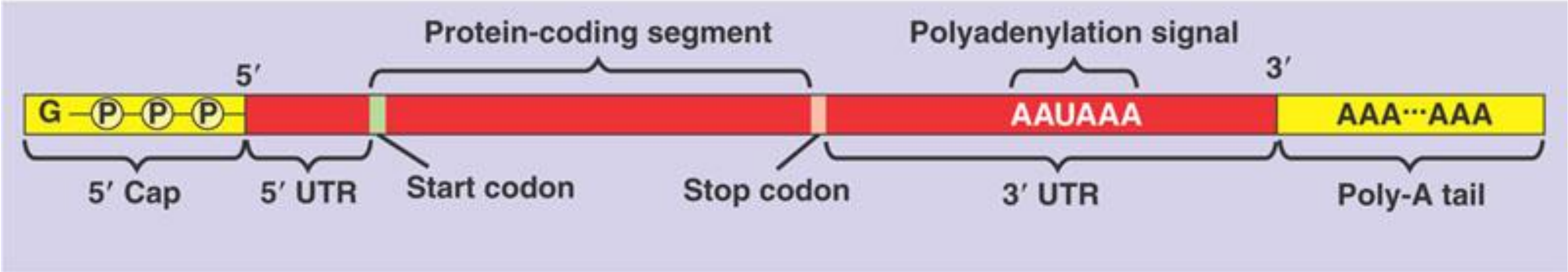
Matching bases of DNA & RNA

- U instead of T is matched to A

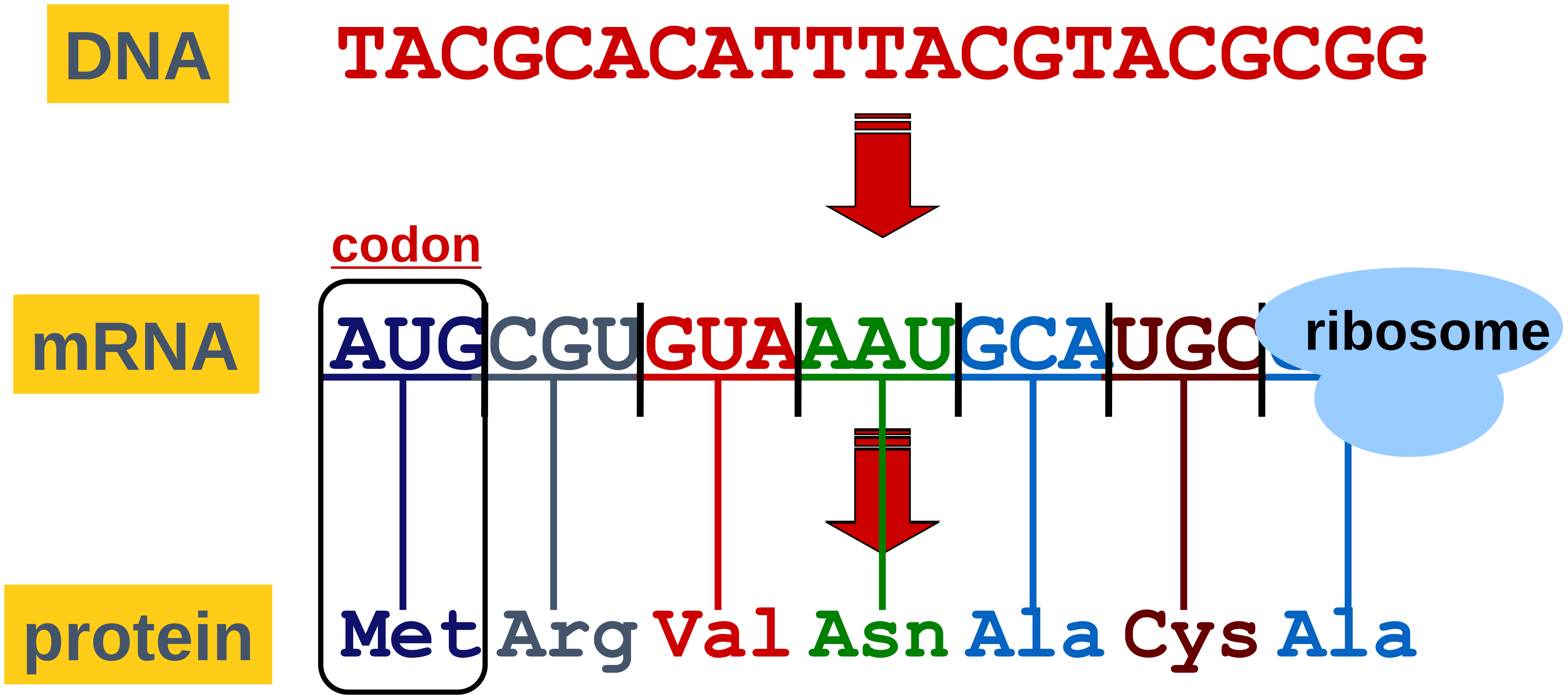


RNA Processing





mRNA codes for proteins in triplets

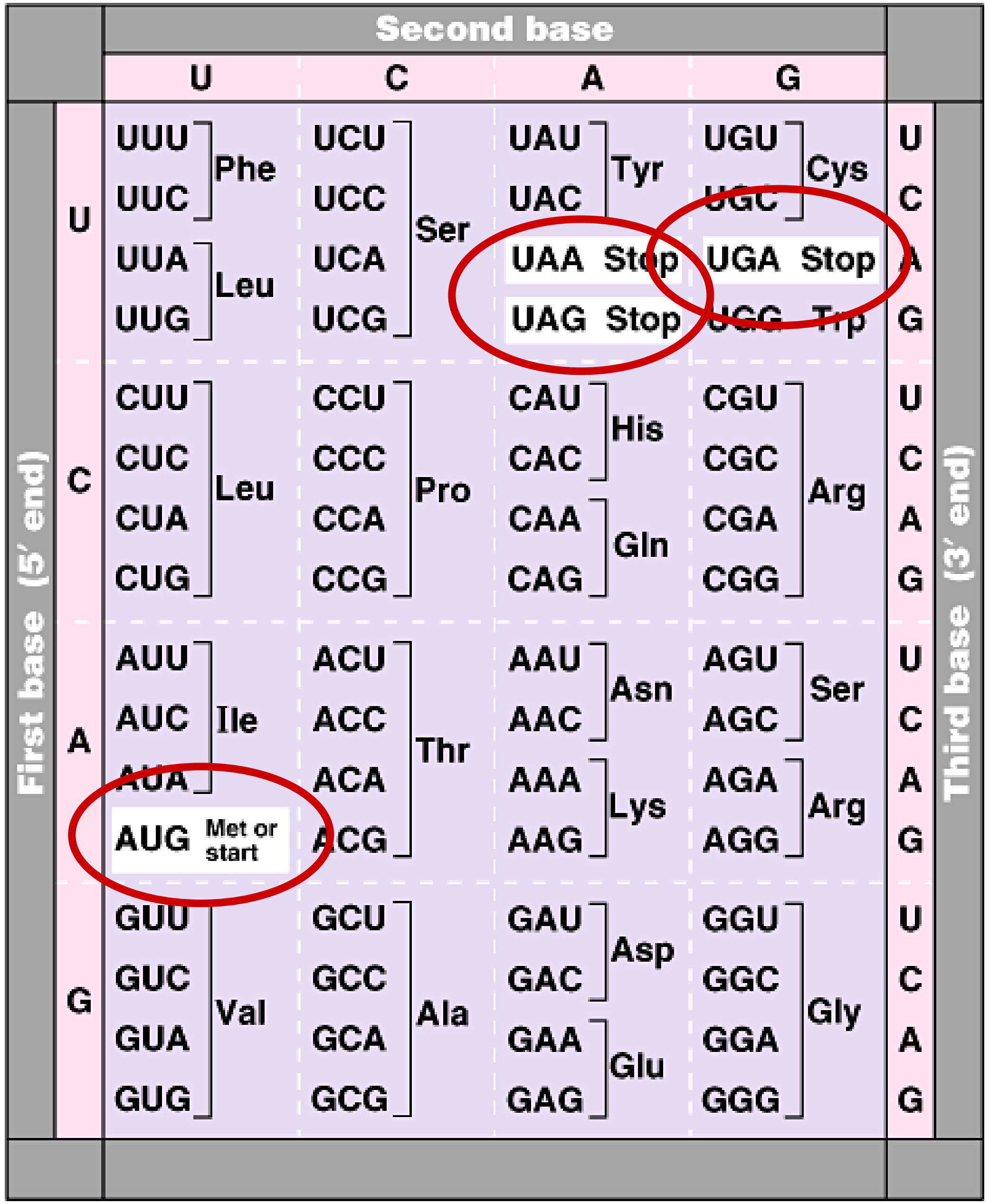


- **Codon = block of 3 mRNA bases**

The mRNA code

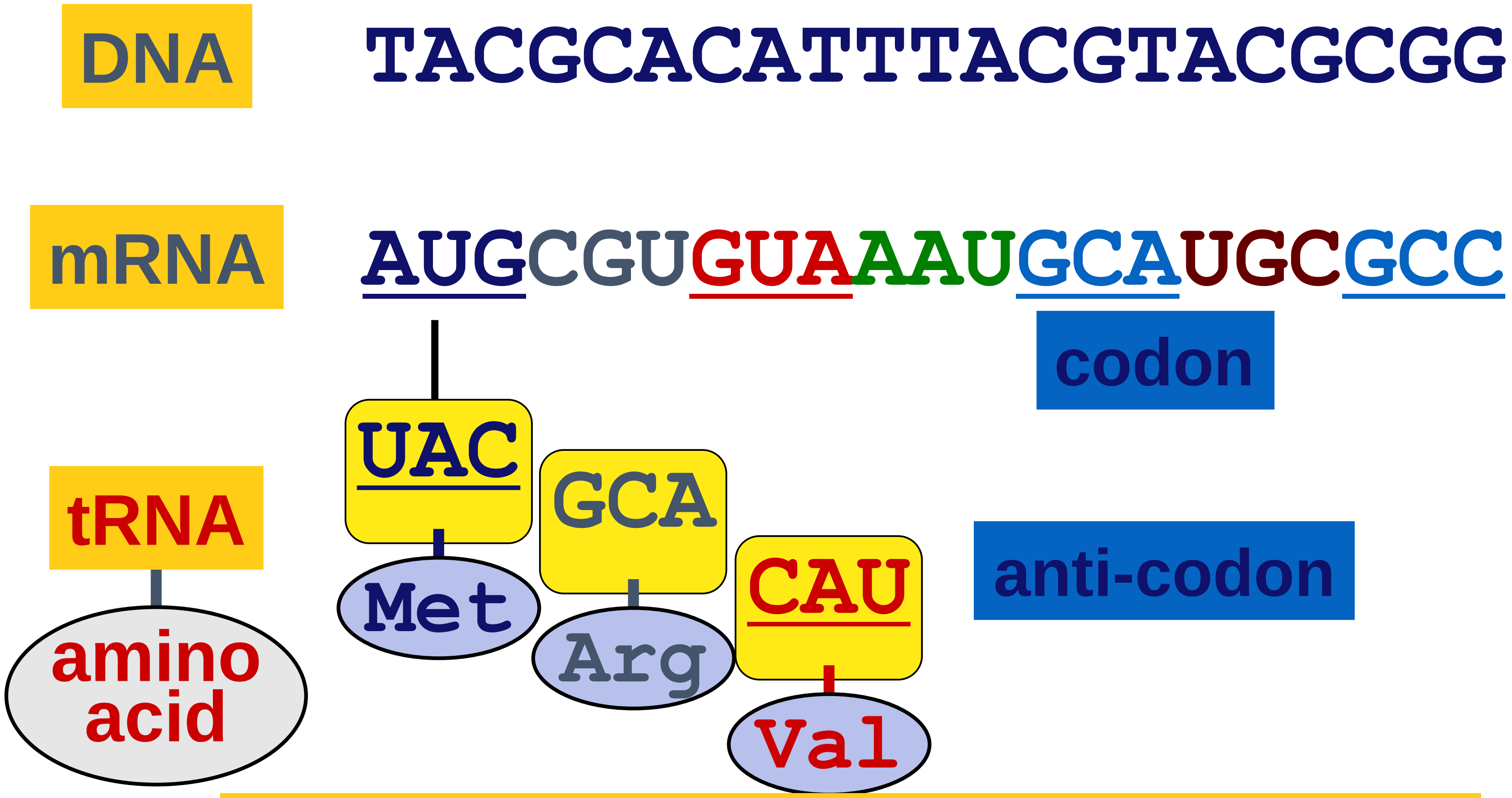
- For <u>ALL</u> life!
  - strongest support for a common origin for all life
- Code has duplicates
  - several codons for each amino acid
  - mutation insurance!

- **<u>Start codon</u>**
  - **AUG**
  - **methionine**
- **<u>Stop codons</u>**
  - **UGA, UAA, UAG**



First base (5′ end)	Second base: U	Second base: C	Second base: A	Second base: G	Third base (3′ end)
U	UUU Phe	UCU Ser	UAU Tyr	UGU Cys	U
U	UUC Phe	UCC Ser	UAC Tyr	UGC Cys	C
U	UUA Leu	UCA Ser	UAA Stop	UGA Stop	A
U	UUG Leu	UCG Ser	UAG Stop	UGG Trp	G
C	CUU Leu	CCU Pro	CAU His	CGU Arg	U
C	CUC Leu	CCC Pro	CAC His	CGC Arg	C
C	CUA Leu	CCA Pro	CAA Gln	CGA Arg	A
C	CUG Leu	CCG Pro	CAG Gln	CGG Arg	G
A	AUU Ile	ACU Thr	AAU Asn	AGU Ser	U
A	AUC Ile	ACC Thr	AAC Asn	AGC Ser	C
A	AUA Ile	ACA Thr	AAA Lys	AGA Arg	A
A	AUG Met or start	ACG Thr	AAG Lys	AGG Arg	G
G	GUU Val	GCU Ala	GAU Asp	GGU Gly	U
G	GUC Val	GCC Ala	GAC Asp	GGC Gly	C
G	GUA Val	GCA Ala	GAA Glu	GGA Gly	A
G	GUG Val	GCG Ala	GAG Glu	GGG Gly	G

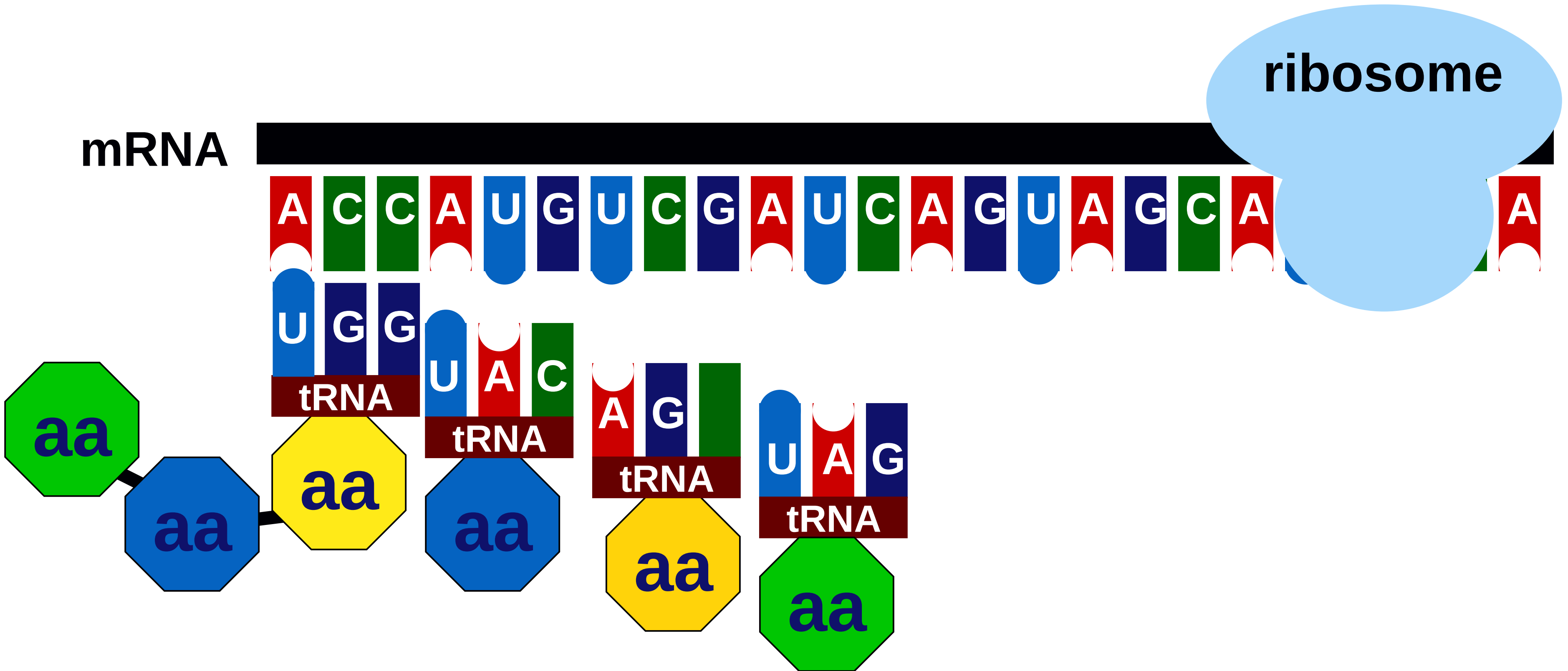
How are the codons matched to amino acids?



- Anti-codon = block of 3 tRNA bases

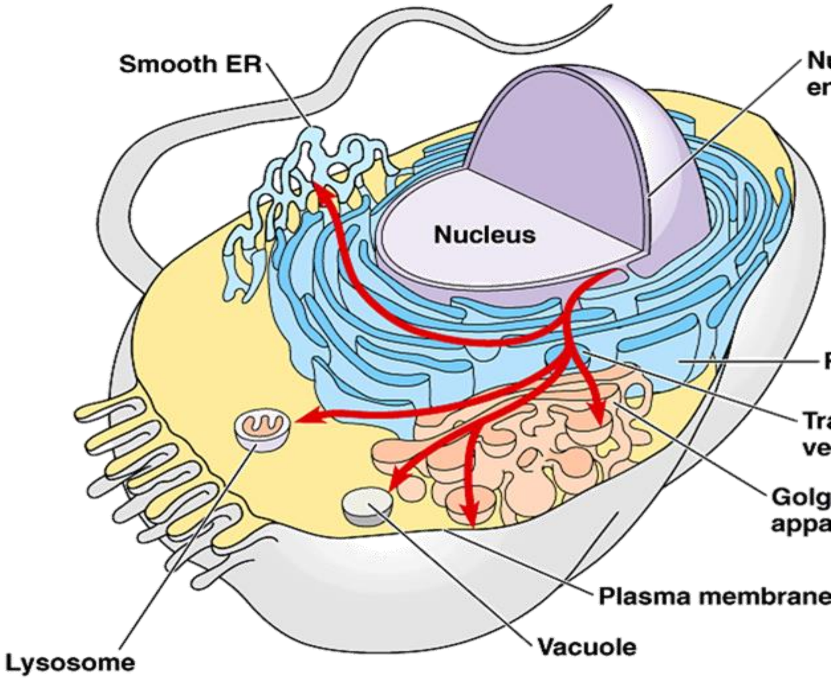
mRNA to protein = Translation

- The working instructions → mRNA
- The reader → ribosome
- The transporter → transfer RNA (tRNA)

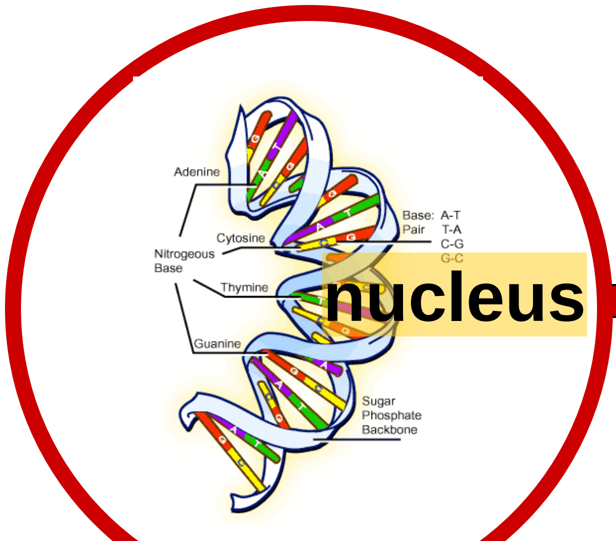


Building Proteins

- Organelles involved
  - nucleus
  - ribosomes
  - endoplasmic reticulum (ER)
  - Golgi apparatus
  - vesicles

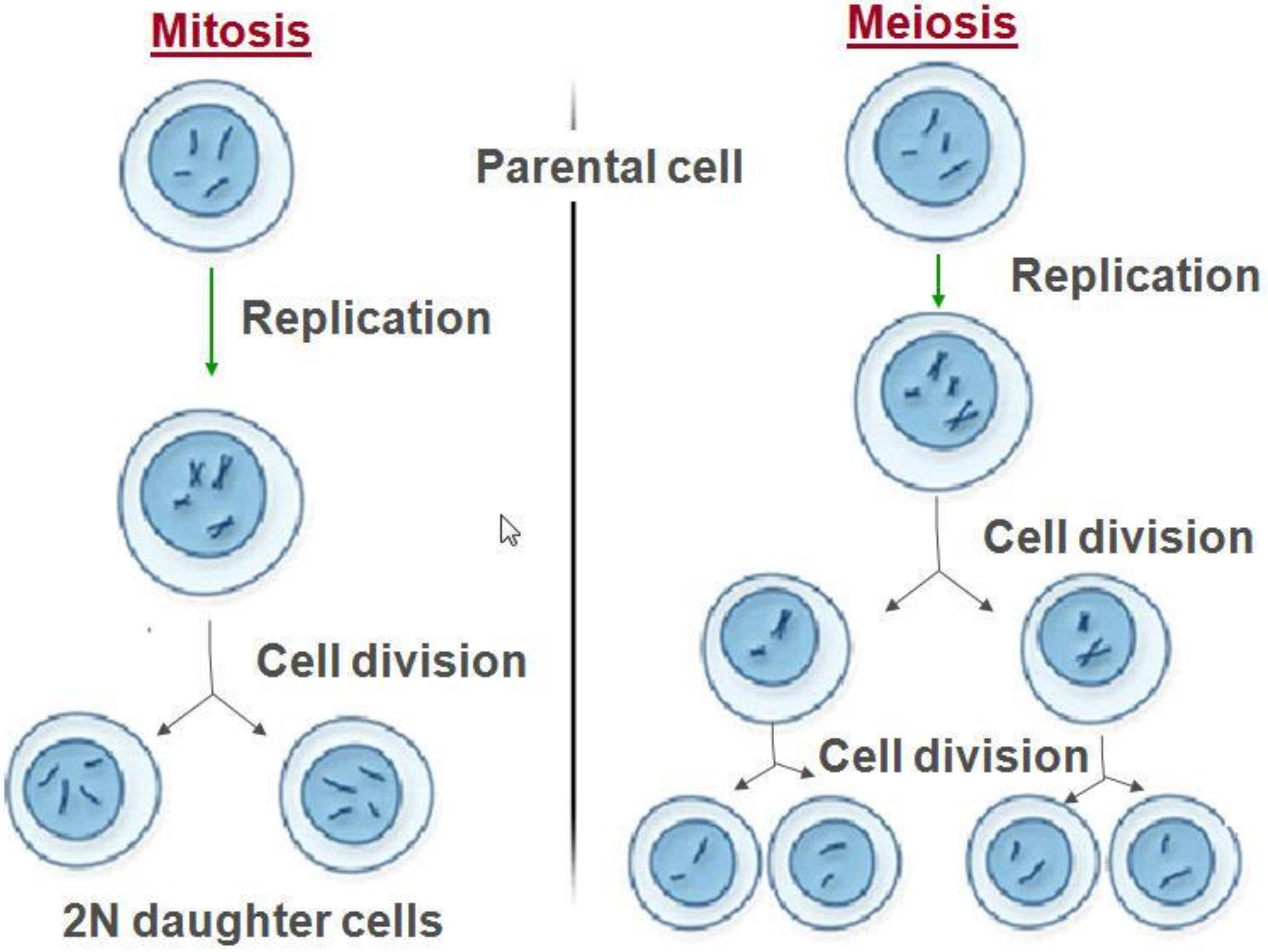


The Protein Assembly Line



nucleus → ribosome → ER → Golgi apparatus → vesicles

Mitosis vs. Meiosis Side By Side



Question 10: Which of the following is true of mitosis?

(A) It is also known as cytokinesis

(B) It maintains the same chromosome number in the daughter cells as in the parent cell.

(C) It is the last phase of interphase.

(D) It regulates the transfer of genetic information from one daughter cell to another.

(E) It moves homologous chromosomes to opposite poles

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QUESTION 12: A biologist counted 2,500 cells from an embryo on a microscope slide and recorded the following data.

Stage	Number of Cells
Prophase	125
Metaphase	50
Anaphase	50
Telophase	25
Interphase	2,250
Total	2,500

If these cells had been dividing randomly, it could be reasonably concluded that

(A) The duration of anaphase is approximately one-half that of telophase

(B) prophase is approximately 3 times as long as telophase

(C) Metaphase is the shortest stage of the cell cycle

(D) Interphase is the longest stage of the cell cycle

(E) the chromosome can first be seen in prophase

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