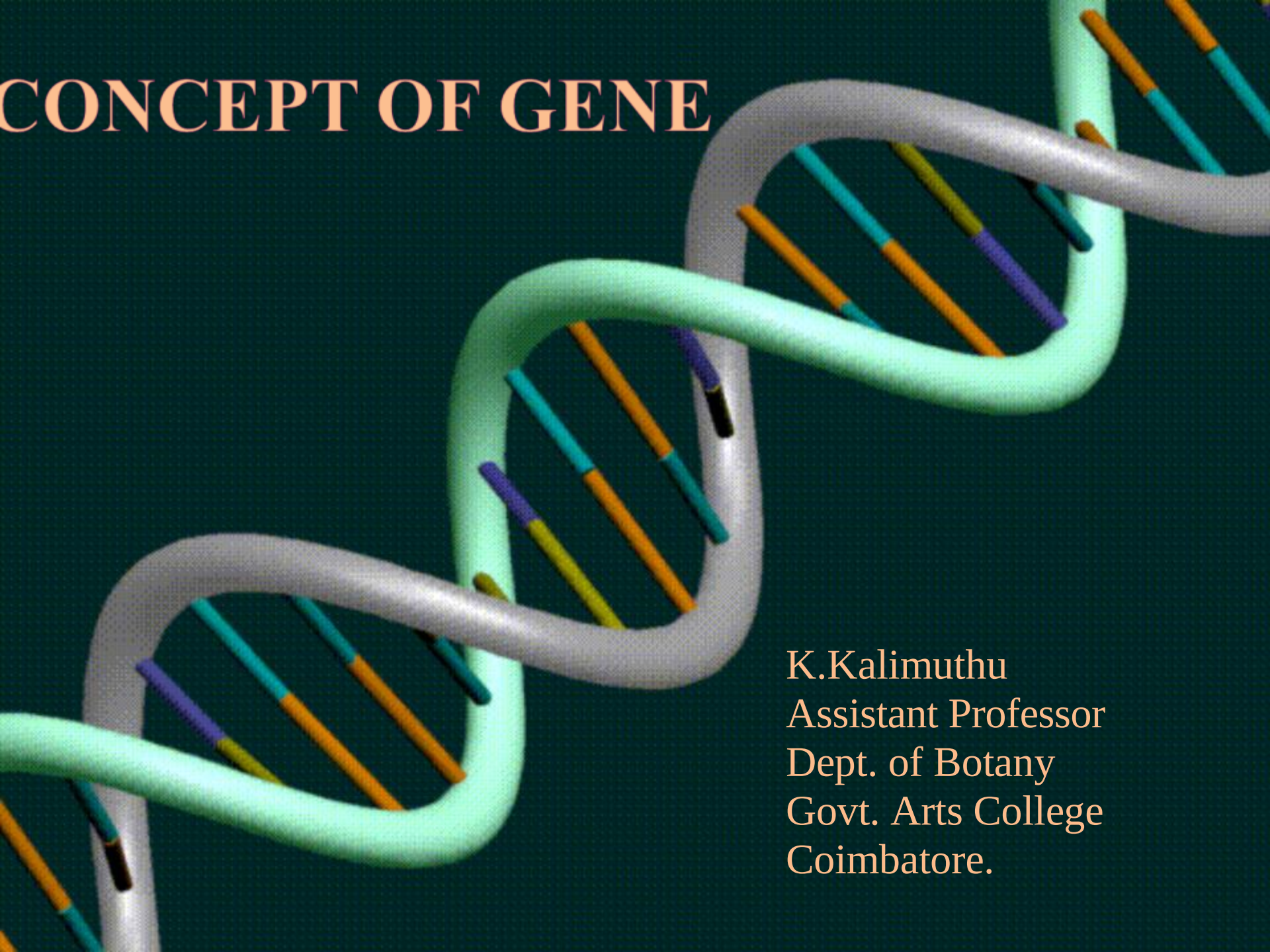
CONCEPT OF GENE



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HISTORY

- Gene was coined by W Johansen in 1909
- E R Garrod (1908) proposed One gene – one product hypothesis
- Gene theory was proposed by T H Morgan in 1911
- L Pauling and Ingram(1949) established the role of genes in protein synthesis

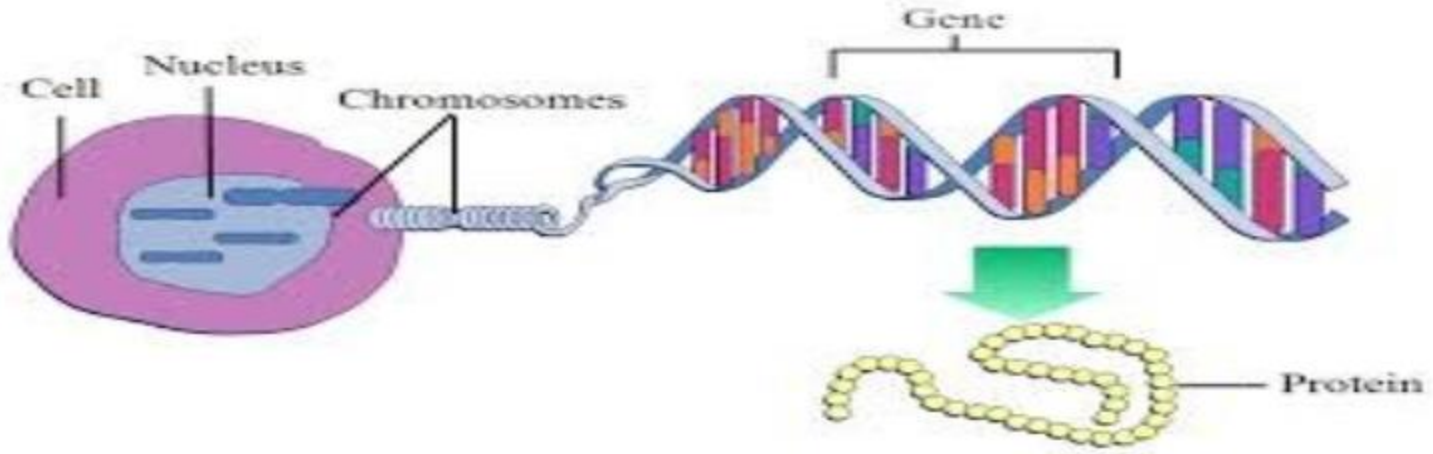
- G W Beadle and E L Tatum (1948) proposed One gene – one enzyme hypothesis
- The fine structure of gene was proposed by Seymour Benzere(1962)
- Yanofsky (1965) proposed One gene (cistron) – one polypeptide hypothesis
- Gene Concept was given by SUTTON

SUMMARY OF EVOLUTION OF GENE CONCEPT

YEAR	SCIENTIST	GENE CONCEPT
1866	G.J. MENDEL	A UNIT FACTOR THAT CONTROLS SPECIFIC PHENOTYPIC TRAIT
1902	SIR A.E.GARROD	ONE GENE – ONE METABOLIC BLOCK THEORY
1940	BEADLE & TATUM	ONE GENE-ONE ENZYME THEORY
1957	U.M.INGRAM	ONE GENE-ONE POLYPEPTIDE THEORY.GENE IS A
1960s	C.YANOFSKY & CO-WORKERS	

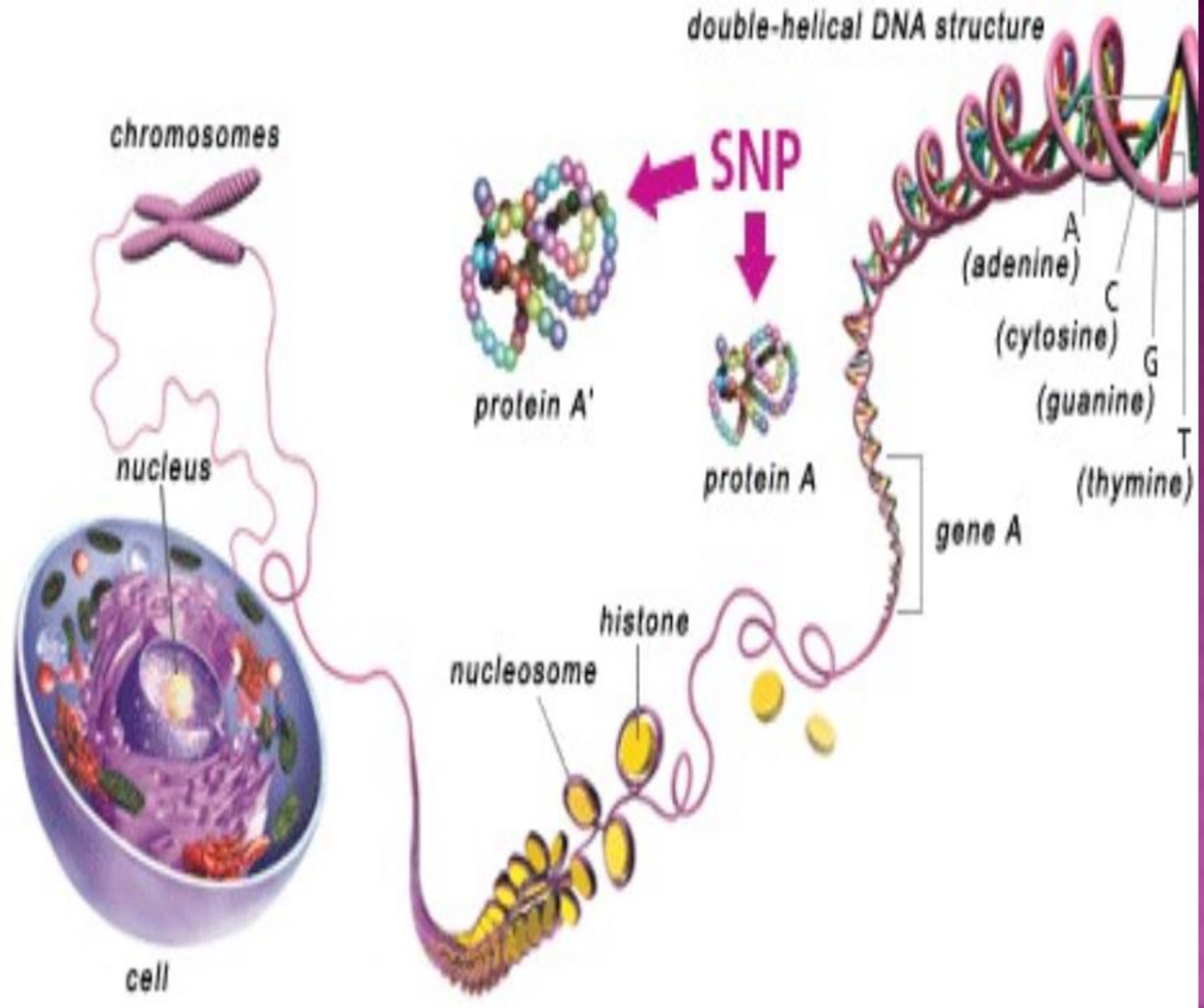
DEFINITIONS OF THE GENE

- The gene is to genetics what the atom is to chemistry.
- The gene is the unit of genetic information that controls a specific aspect of the phenotype.
- The gene is the unit of genetic information that specifies the synthesis of one polypeptide.



- genes are the fractions or part of DNA molecule which regarded as the genetic material.

- T.M Morgan proposed the gene theory which state that:
  - i) Chromosomes are bearers of hereditary units and each chromosome carries hundreds or thousands of genes.
  - ii) The genes are arranged on the chromosomes in the linear order and on the special regions or locus.


double-helical DNA structure
chromosomes
SNP
protein A'
protein A
A
(adenine)
C
(cytosine)
G
(guanine)
T
(thymine)
nucleus
gene A
histone
nucleosome
cell

GENES ARE BOTH THE BASIC FUNCTIONAL UNIT AND THE SMALLEST GENETIC STRUCTURAL UNIT

- Until 1940, the gene was considered as the basic unit of genetic information as defined by following criteria.

- The unit of function, controlling the inheritance of one “character” or phenotypic attribute.

- The unit of structure, operationally defined by recombination and by mutation.

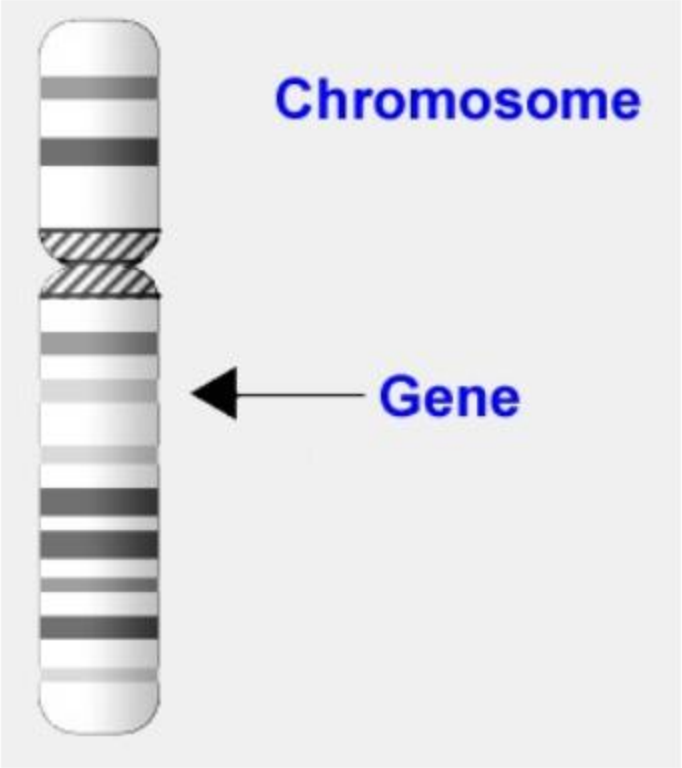
TERMS RELATED TO GENE

- **RECON** - It is the smallest unit of DNA capable of undergoing Crossing Over and Recombination.
- **MUTON** - It is the smallest unit of DNA which can undergo Mutation.
- **CISTRON** - It is the unit of Function. It is the Gene in real sense capable of synthesizing a Polypeptide chain of an Enzyme.
- **COMPLON** - It is the unit of Complementation.

CLASSICAL DEFINITION OF GENE

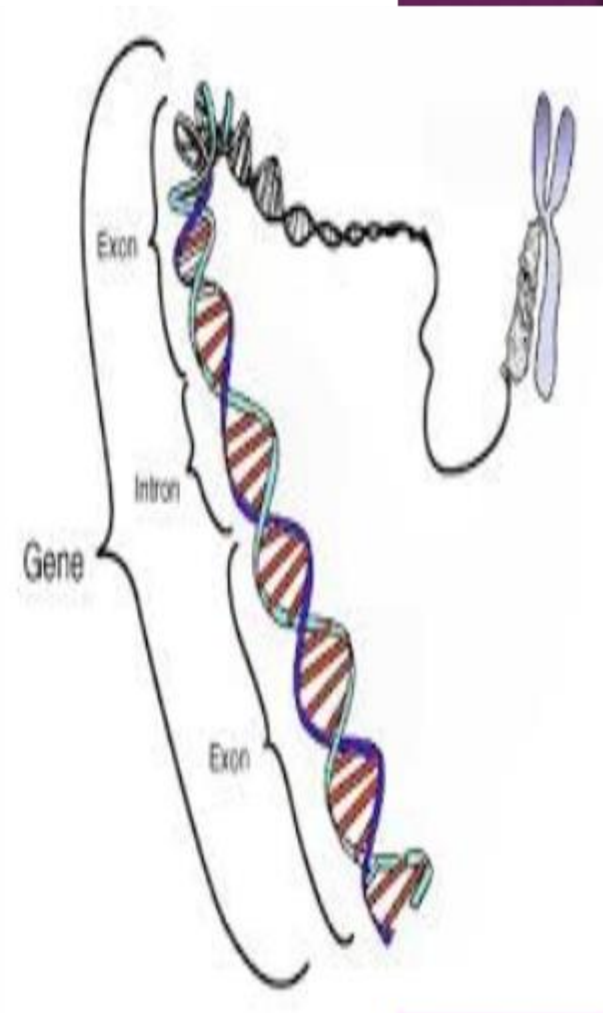
- Gene is the Unit of Function (one gene specifies one character),

  Recombination, and Mutation.



CLASSICAL CONCEPT OF GENE

- introduced by Sutton (1902) and was elaborated by Morgan (1913). Bidge (1923), Muller (1927) and others which outlined as follows: Genesare discrete particles inherited in mendelian fashion that occupies a definite locus in the chromosome and responsible for expression of specific phenotypic character.

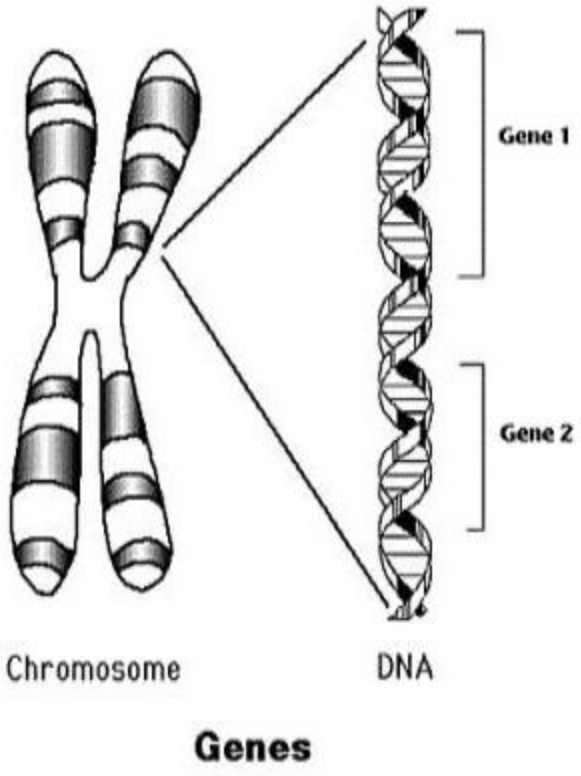


- Number of genes in each organism is more than the number of chromosomes; hence several genes are located on each chromosome.
- The genes are arranged in a single linear order like beads on a string.
- Each gene occupies specific position called locus.
- If the position of gene changes, character changes.

- Genes can be transmitted from parent to off springs.
- Genes may exist in several alternate formed called alleles.
- Genes are capable of combined together or can be replicated during a cell division.
- Genes may under for sudden changes in position and composition called mutation.
- Genes are capable of self duplication producing their own exact copies.

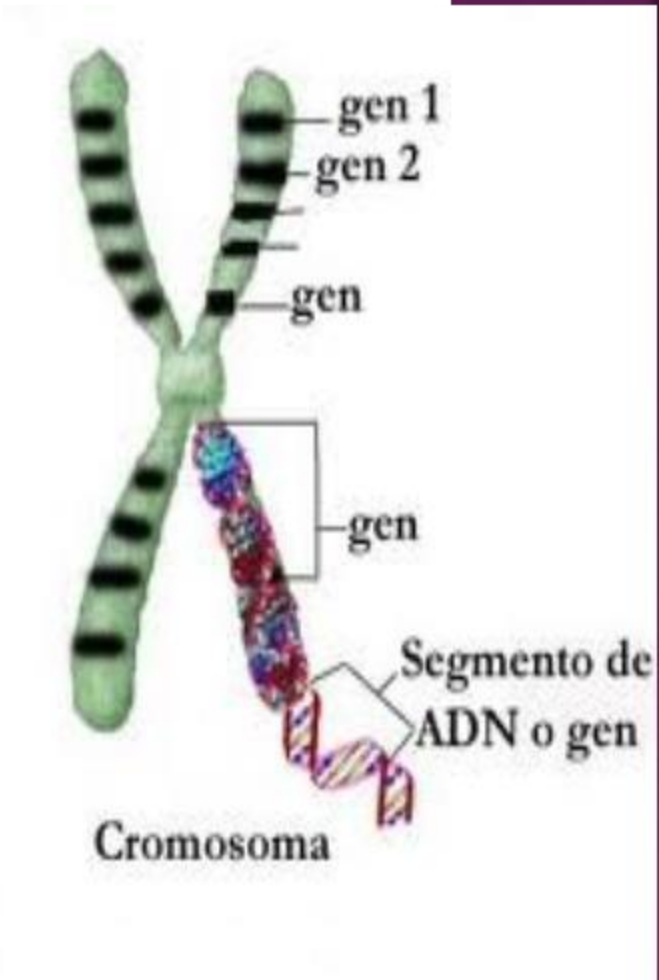
MORDERN DEFINITION OF GENE

- Gene is the Unit of Genetic Information, i.e., the sequence of DNA that specifies one polypeptide.
- Includes coding as well as non-coding regulatory sequences.



MODERN CONCEPT OF GENE

- S. Benzer (1957) coined different terms for different nature of gene and genetic material in relation to the chromosome on the basis of genetic phenomena to which they involve.
  - i) Genes as unit of transmission or cistron
  - ii) Genes as unit of recombination or recon
  - iii) Gene as unit of mutation or muton



I) GENES AS UNIT OF TRANSMISSION OR CISTRON

- The part of DNA specifying a single polypeptide chain is termed as cistron.
- A cistron can have 100 nucleotide pairs in length to 30,000nucleotide pairs.
- It transmits characters from one generation to other as unit of transmission.

II) GENES AS UNIT OF RECOMBINATION OR RECON

- The smallest segment of DNA capable of being separated and exchange with other chromosome is called recon.

- A recon consists of not more than two pairs of nucleotides.

III) GENE AS UNIT OF MUTATION OR MUTON

- Muton is the smallest unit of genetic material which when changed or mutated produce a phenotypic trait.

- muton is delimited to a singlenucleotide.

GENE TYPES

- On the basis of their behaviour the genes may be categorized into the following types:

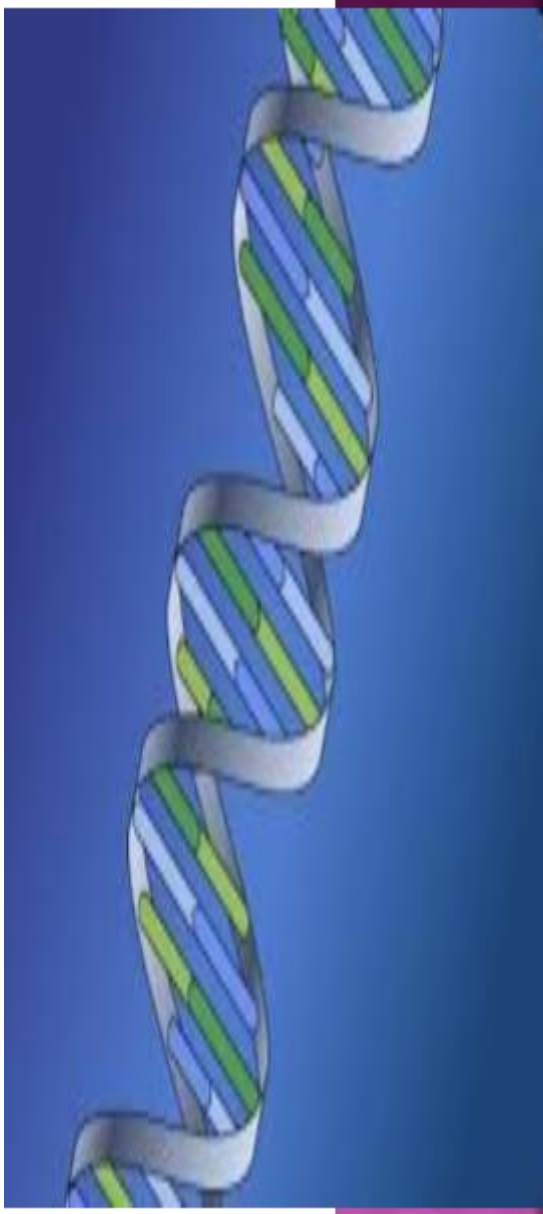
- i) Basic genes: These are the fundamental genes that bring about expression of particular character.

- ii) Lethal genes: These bring about the death their possessor.

- iii) Multiple gene: When two or more pairs of independent genes act together to produce a single phenotypic trait.

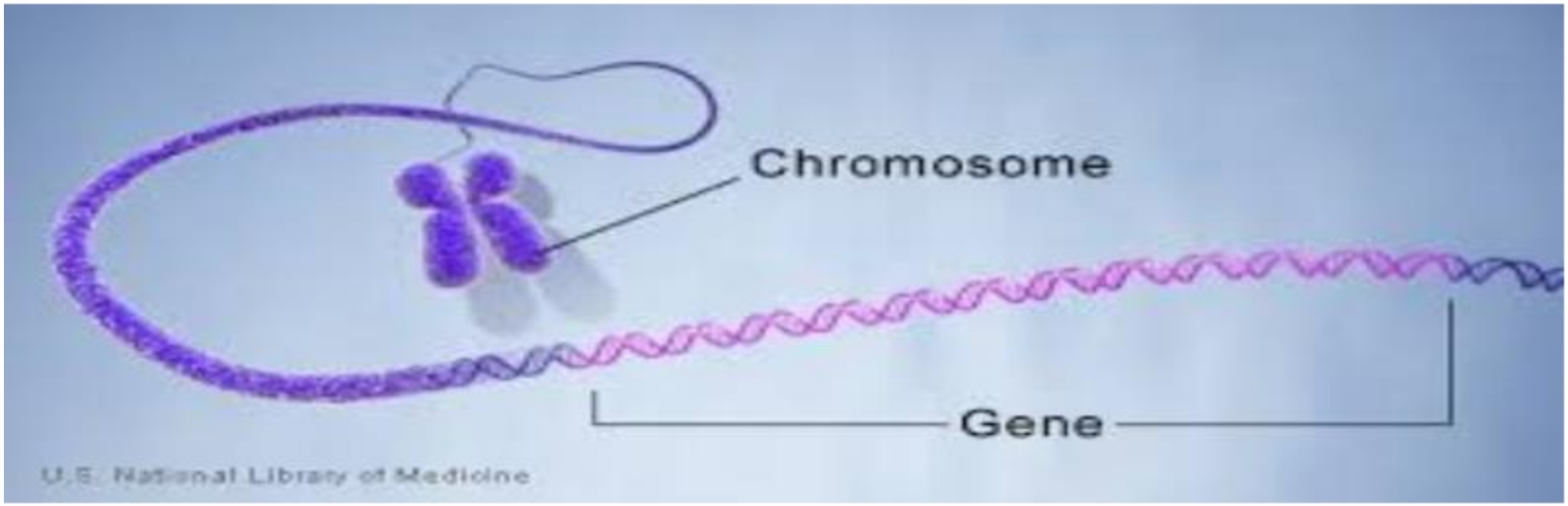
- iv) Cumulative gene: Some genes have additive effects on the action of other genes. These are called cumulative genes.

- v) Pleiotropic genes: The genes which produce changes in more than one character is called pleiotropic gene.



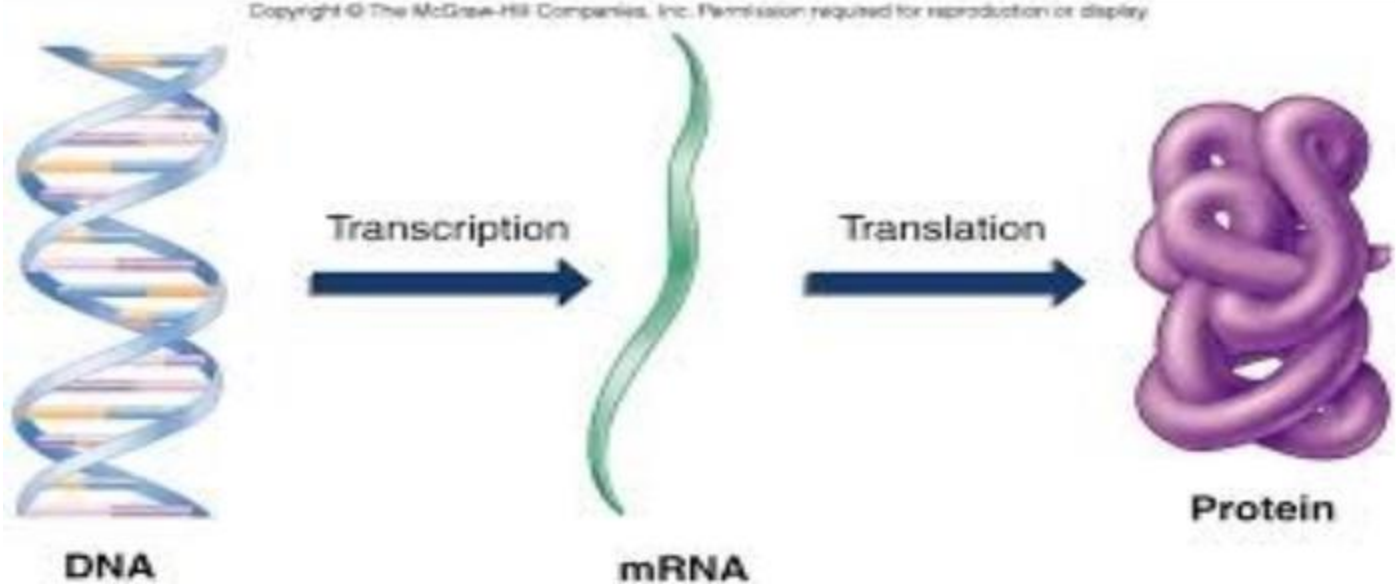
- **vi) Modifying gene:** The gene which cannot produce a character by itself but interacts with other to produce a modified effect is called modifier gene.

- **vii) Inhibitory gene:** The gene which suppresses or inhibits the expression of another gene is called inhibitory gene



GENE ACTION

- the influence of gene resulting in the expression of a genetic character is called gene action.
- The genes are generally associated with the production of enzymes, which they synthesize from chemical substance available in the body cells through a process of autocatalysis.



- As a rule one gene affects one enzyme. The various actions of genes are expressed in their development of
  - pigments
  - Colours
  - hormones
  - form and size
  - production of proteins
  - antigen and antibody
- production decisive effect on human disease like
  - albinism,
  - tyrosinosis
  - etc.

GENES IN PROTEIN SYNTHESIS

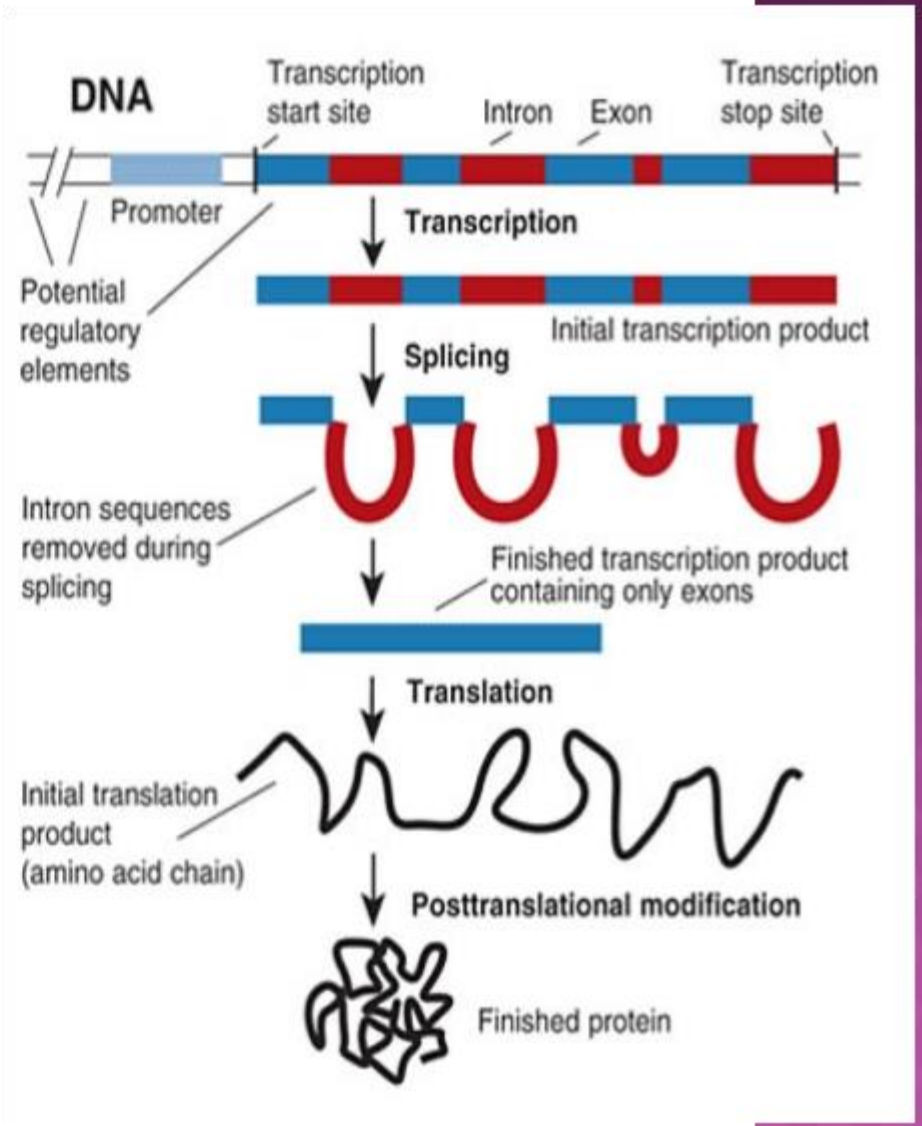
- Jacob and monad proposed "Operon model" To explain the mechanism of gene action

- protein synthesis is regulated by three specific genes located on chromosomes

i) Structural genes

ii) Operator genes

iii) Regulator genes



Structural genes:

- It regulates to produce specific mRNA
- determine the kind of protein to be synthesized.

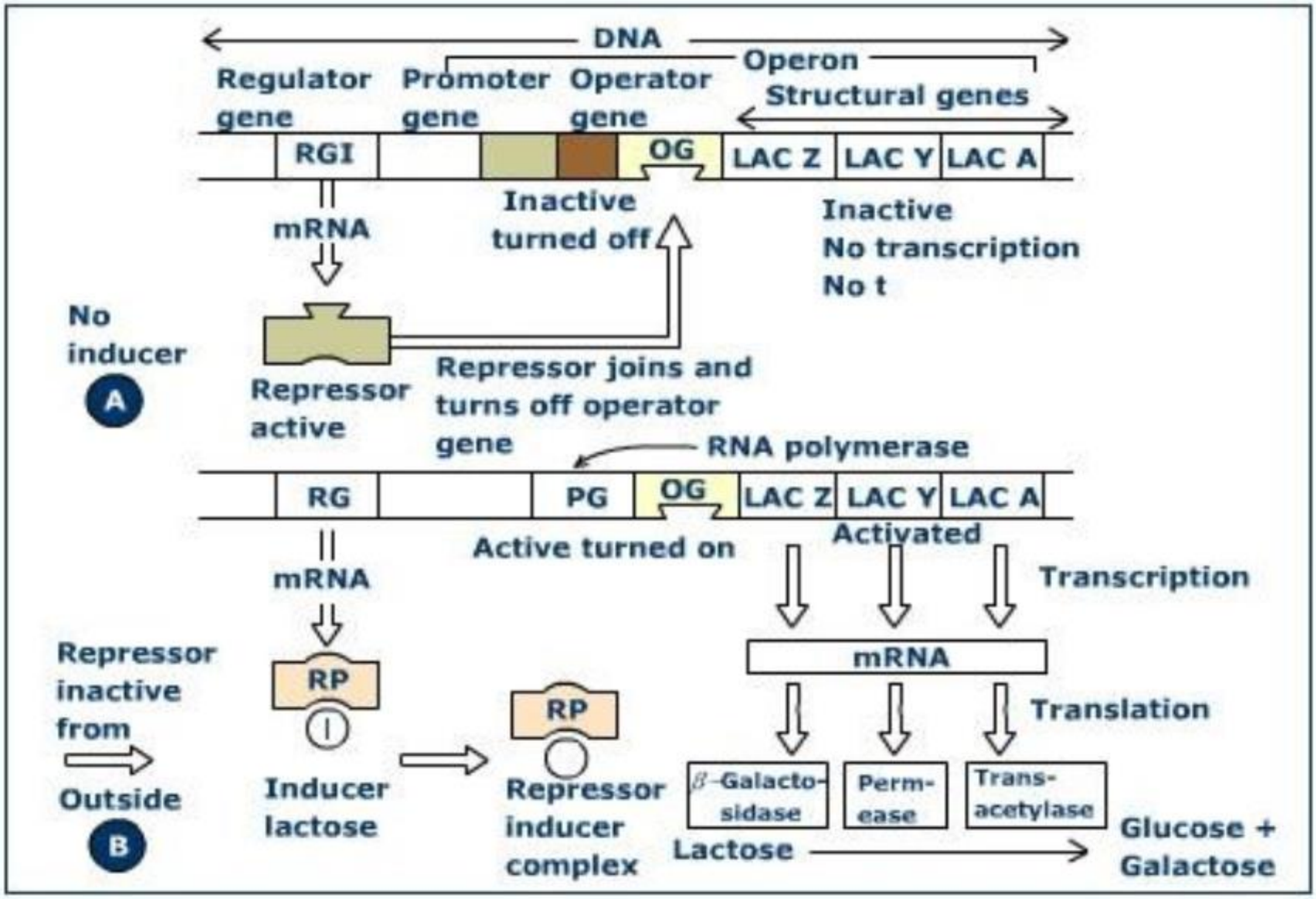
Operator genes:

- These genes act as switches to turn on or turn off the activities of structural genes elongation the regulating and termination of polypeptide chain.

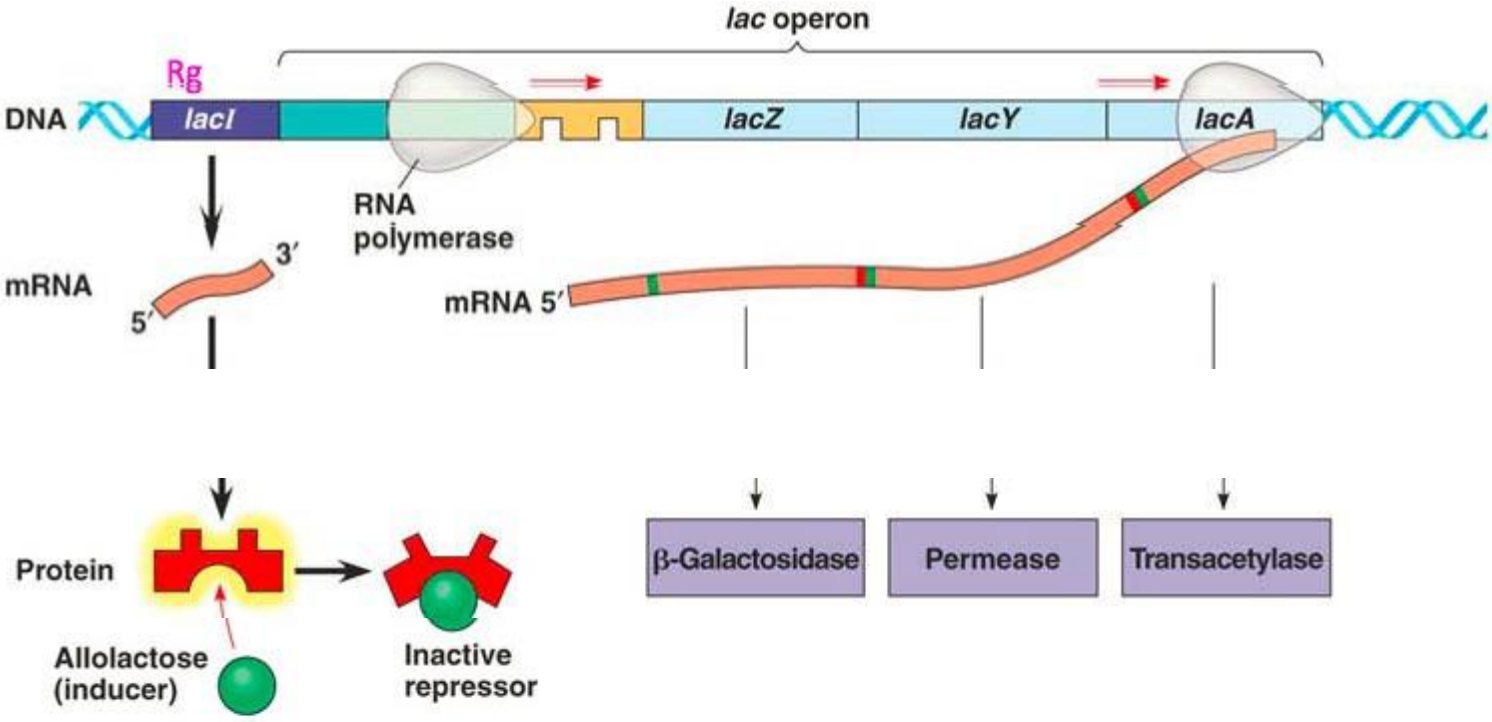
Regulator genes:

- These genes produce certain proteinacous substance called repressures, which prevent the operator genes from their action.

GENE REGULATION

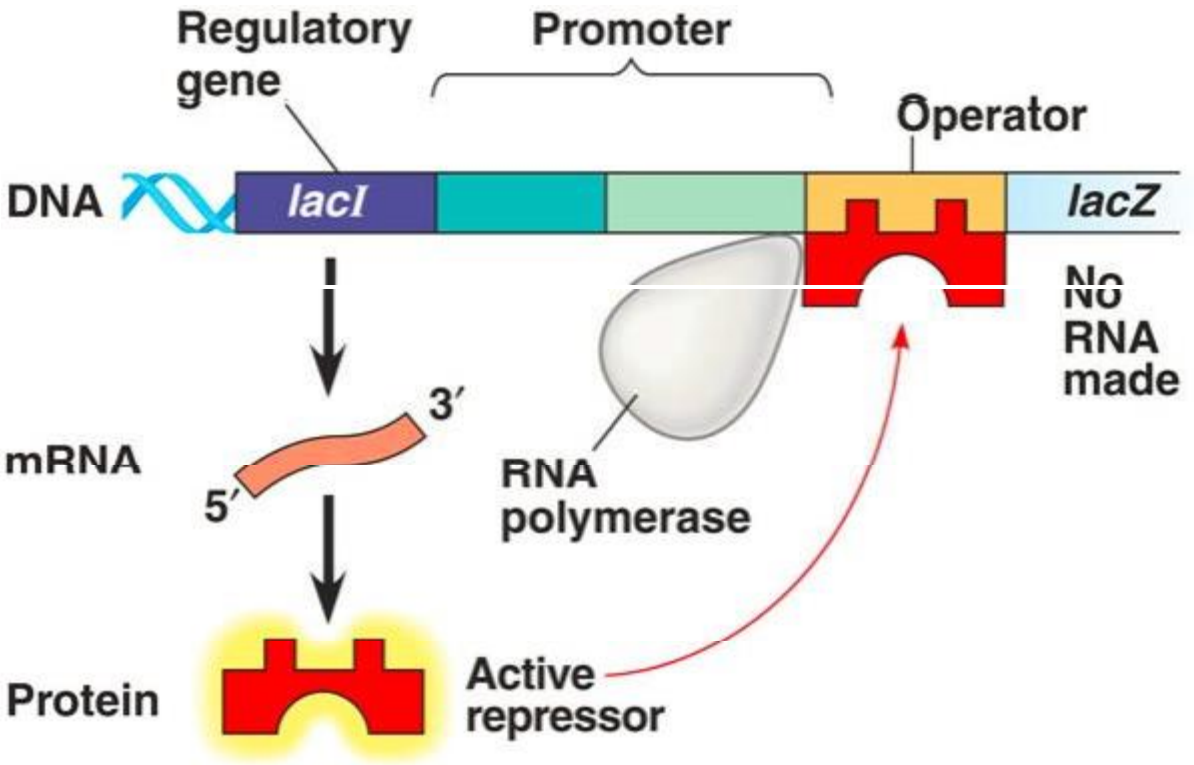


LAC OPERON - SWITCHED ON



(b) Lactose present, repressor inactive, operon on

LAC OPERON – SWITCHED OFF



(a) Lactose absent, repressor active, operon off

ESSENTIAL FEATURES

- Determines the physical as well as physiological characters.
- Situated in the chromosome.
- Occupies a specific position known as Locus.
- Arranged in single linear order.
- Occur in functional states called Alleles.
- Some have more than 2 alleles known as Multiple Alleles.

- Some may undergo sudden change in expression called as Mutant Gene (Mutation).
- May be transferred to its homologous (CrossM over) or non-homologous counterpart (Translocation).
- Can duplicate themselves very accurately (Replication).
- Synthesizes a particular Protein.
- Determines the sequence of amino acid in the polypeptide chain (The Genetic Code).

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Thank You

DNA REPLICATION

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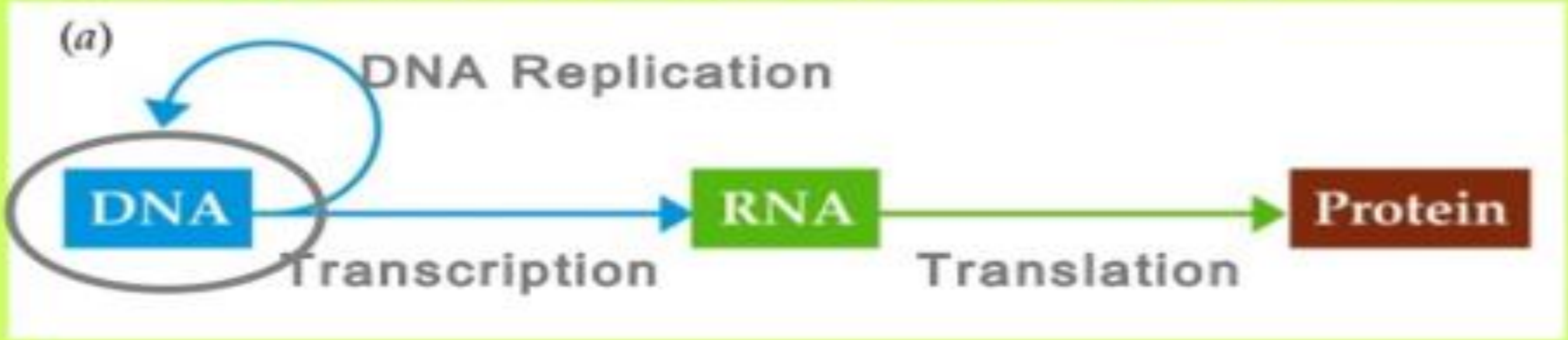
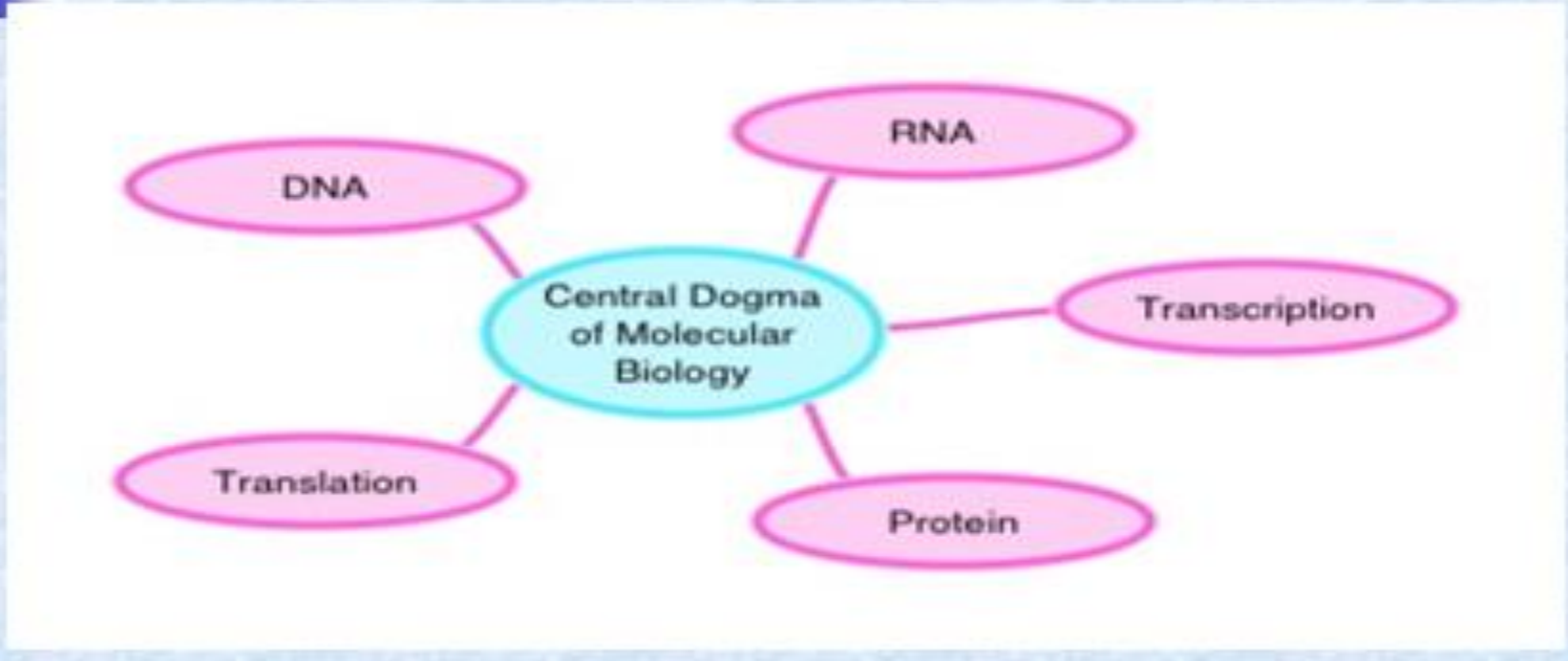
06.08.2020

The Central Dogma

- The Flow of Information: DNA → RNA →



- A gene is expressed in two steps:
  - DNA is transcribed to RNA
  - Then RNA is translated into protein.


RNA
DNA
Central Dogma of Molecular Biology
Transcription
Translation
Protein

`It has not escaped our notice that the specific pairing we have postulated immediately suggests a possible copying mechanism for the genetic material'

Original drawing by Francis Crick

Watson & Crick

Nature (1953)

Four requirements for DNA to be genetic material

Must carry information
- Cracking the genetic code

Must replicate
- DNA replication

Must allow for information to change
- Mutation

Must govern the expression of the phenotype
- Gene function

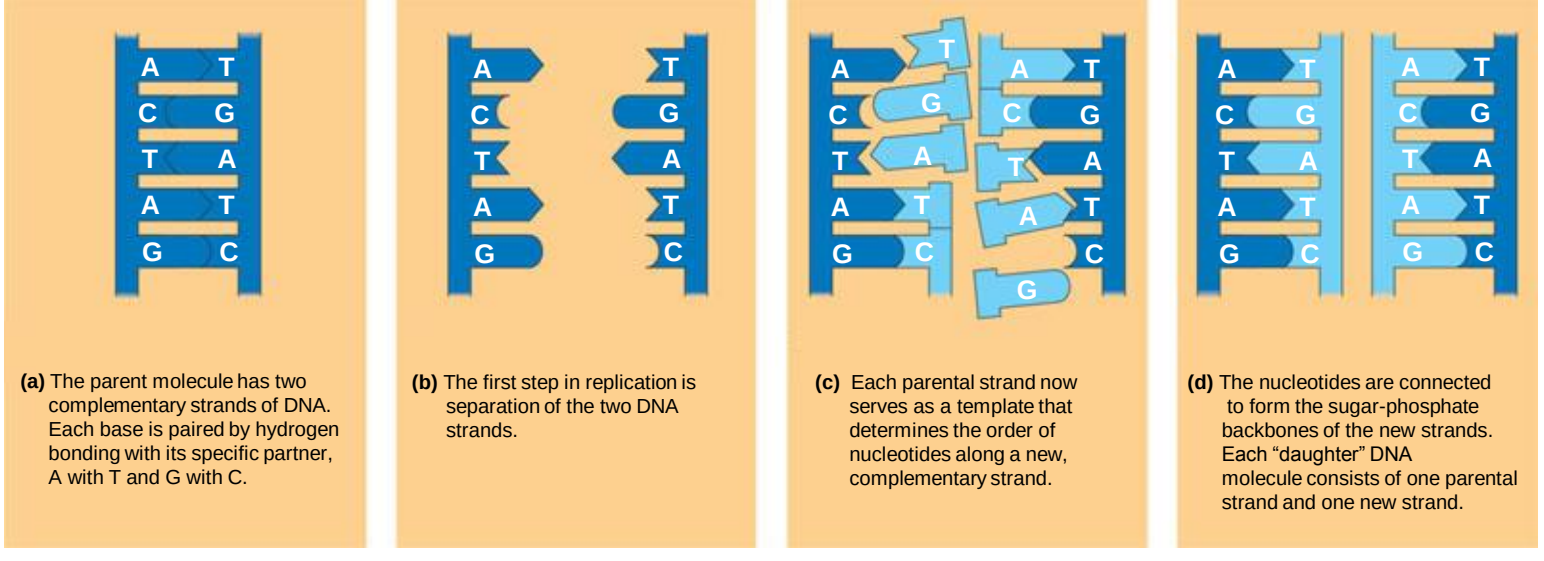
DNA Replication

Process of duplication of the entire genome prior to cell division

Biological significance

- extreme accuracy of DNA replication is necessary in order to preserve the integrity of the genome in successive generations
- In eukaryotes , replication only occurs during the S phase of the cell cycle.
- Replication rate in eukaryotes is slower resulting in a higher fidelity/accuracy of replication in eukaryotes

- In DNA replication
  - The parent molecule unwinds, and two new daughter strands are built based on base-pairing rules



(a) The parent molecule has two complementary strands of DNA. Each base is paired by hydrogen bonding with its specific partner, A with T and G with C.

(b) The first step in replication is separation of the two DNA strands.

(c) Each parental strand now serves as a template that determines the order of nucleotides along a new, complementary strand.

(d) The nucleotides are connected to form the sugar-phosphate backbones of the new strands. Each "daughter" DNA molecule consists of one parental strand and one new strand.

Figure 16.9 a–d

Type of DNA Replication

- **Conservative**
- **Semiconservative**
- **Dispersive**

Conservative model. The two parental strands associate after acting as templates for new strands, thus restoring the parental double helix.

Semiconservative model. The two strands of the parental molecule separate, and each functions as a template for synthesis of a new, complementary strand.

Dispersive model. Each strand of *both* daughter molecules contains a mixture of old and newly synthesized DNA.

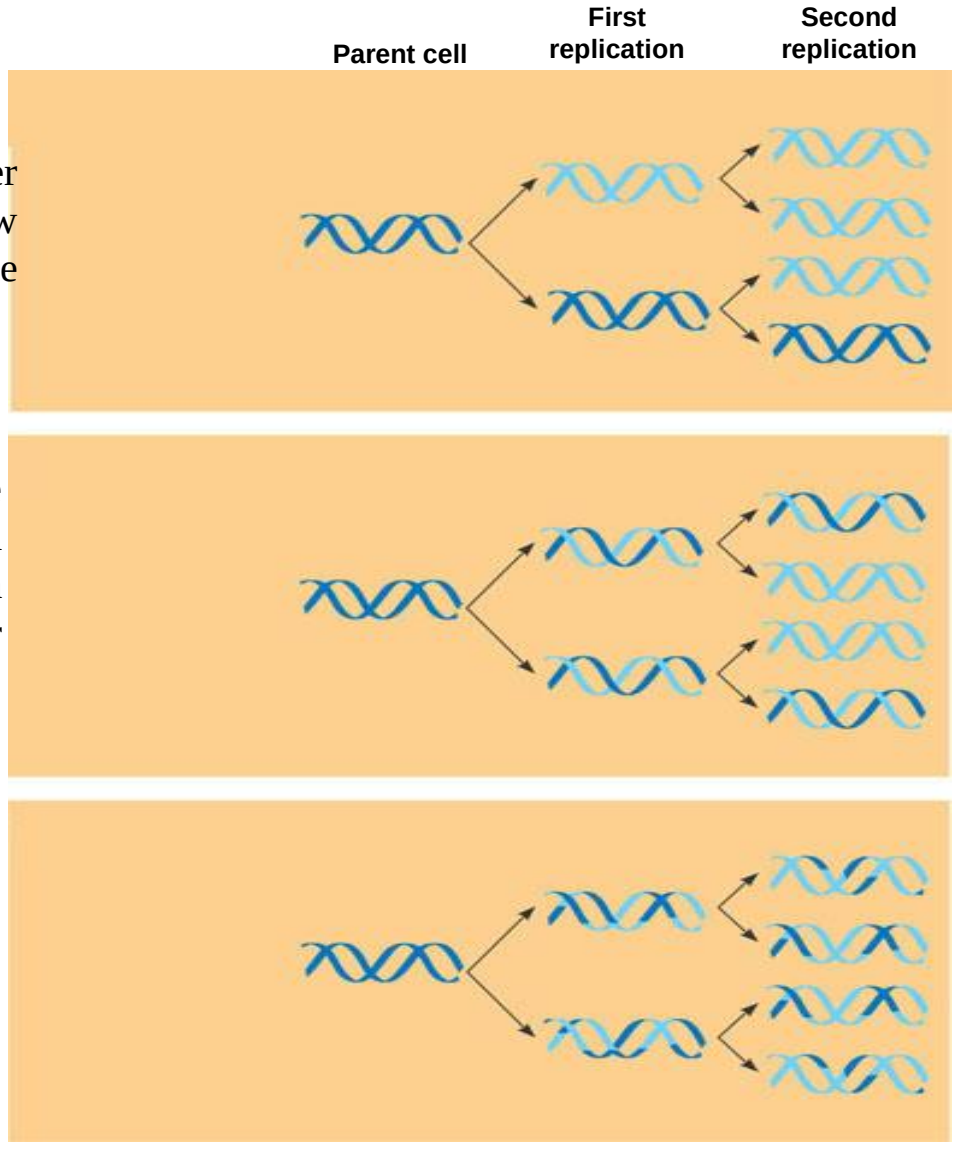
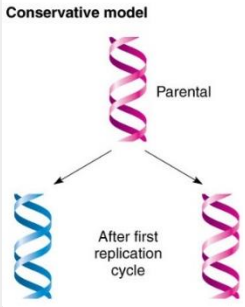
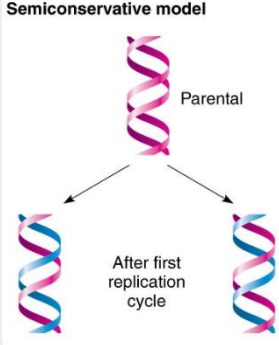


Figure 16.10 a–c

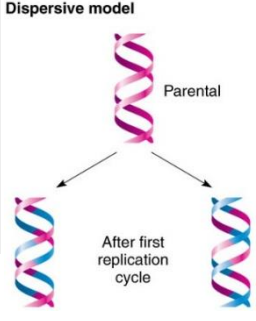
•**Conservative replication**: In this type, both strands of parent double helix would be conserved and the new DNA molecule would consist of two newly synthesized strands.



•**Semi-conservative replication**: In this type, out of the two strands of newly synthesized DNA, one is new and the other is retained or conserved from the original(parent) molecule.

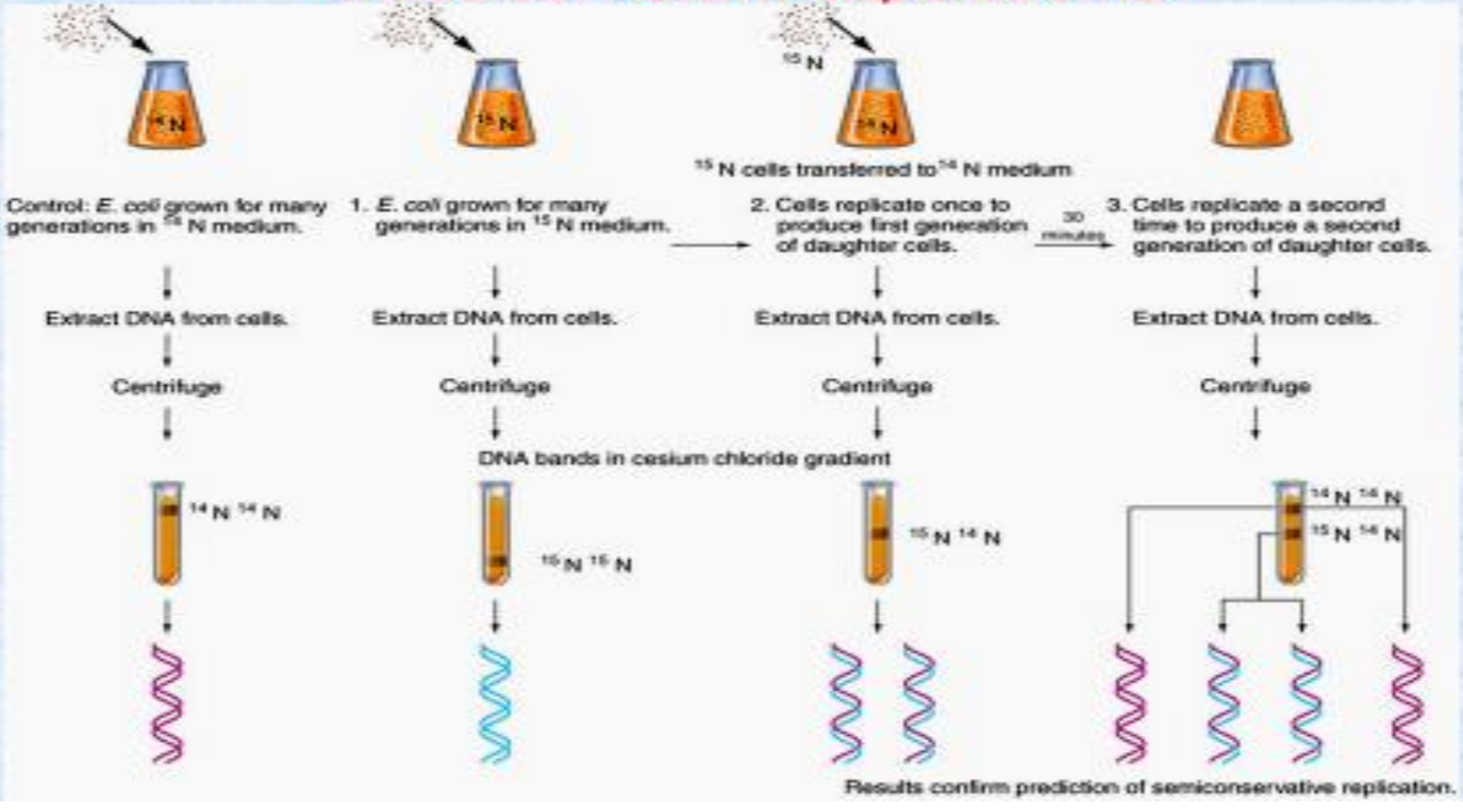


•**Dispersive Replication**: This type involves fragmentation of the parent double helix, and intermixing of pieces of the parent strand with newly synthesized pieces, thereby forming two new double helices.



- DNA replication is semiconservative
  - Each of the two new daughter molecules will have one old strand, derived from the parent molecule, and one newly made strand

How do we know that DNA replication is semiconservative?
Meselson-Stahl experiments

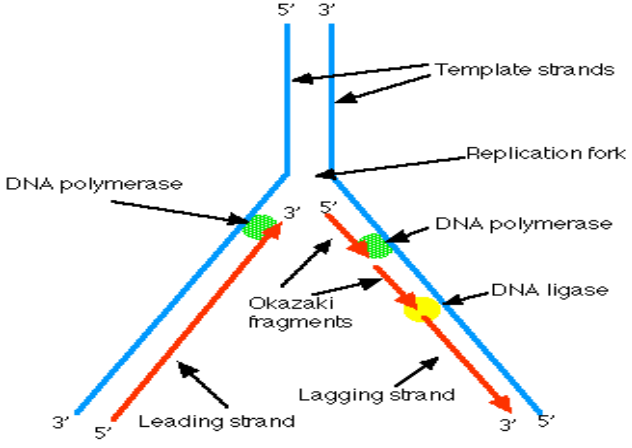


DNA Replication: *A Closer Look*

- The copying of DNA
  - Is remarkable in its speed and accuracy
- More than a dozen enzymes and other proteins
  - Participate in DNA replication

DNA - replication

- DNA can replicate by splitting, and rebuilding each strand.
- Note that the rebuilding of each strand uses slightly different mechanisms due to the 5’ 3’ asymmetry, but each daughter strand is an exact replica of the original strand.



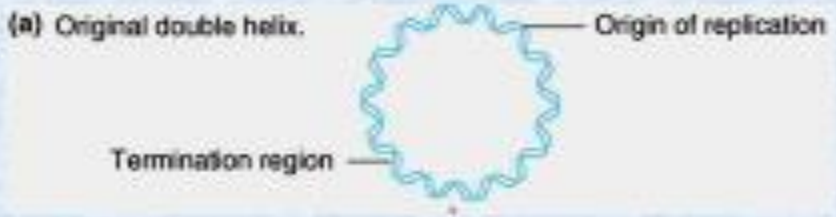
B) Starts at origin

Initiator proteins identify specific base sequences on DNA called sites of origin

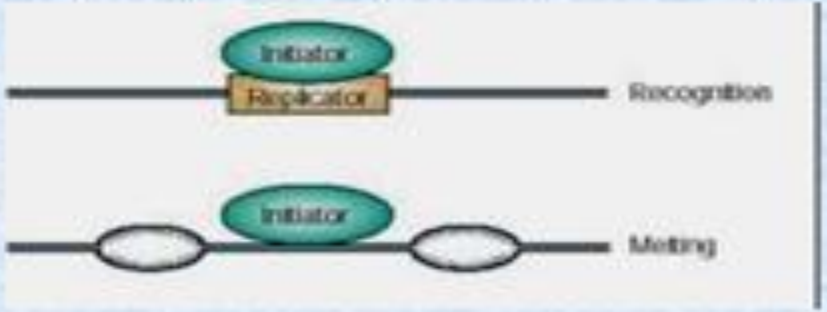
Prokaryotes – single origin site E.g *E.coli* - *oriC*

Eukaryotes – multiple sites of origin (replicator)

E.g. yeast - ARS (autonomously replicating sequences)



Prokaryotes



Eukaryotes

Why does DNA replication only occur in the 5' to 3' direction?

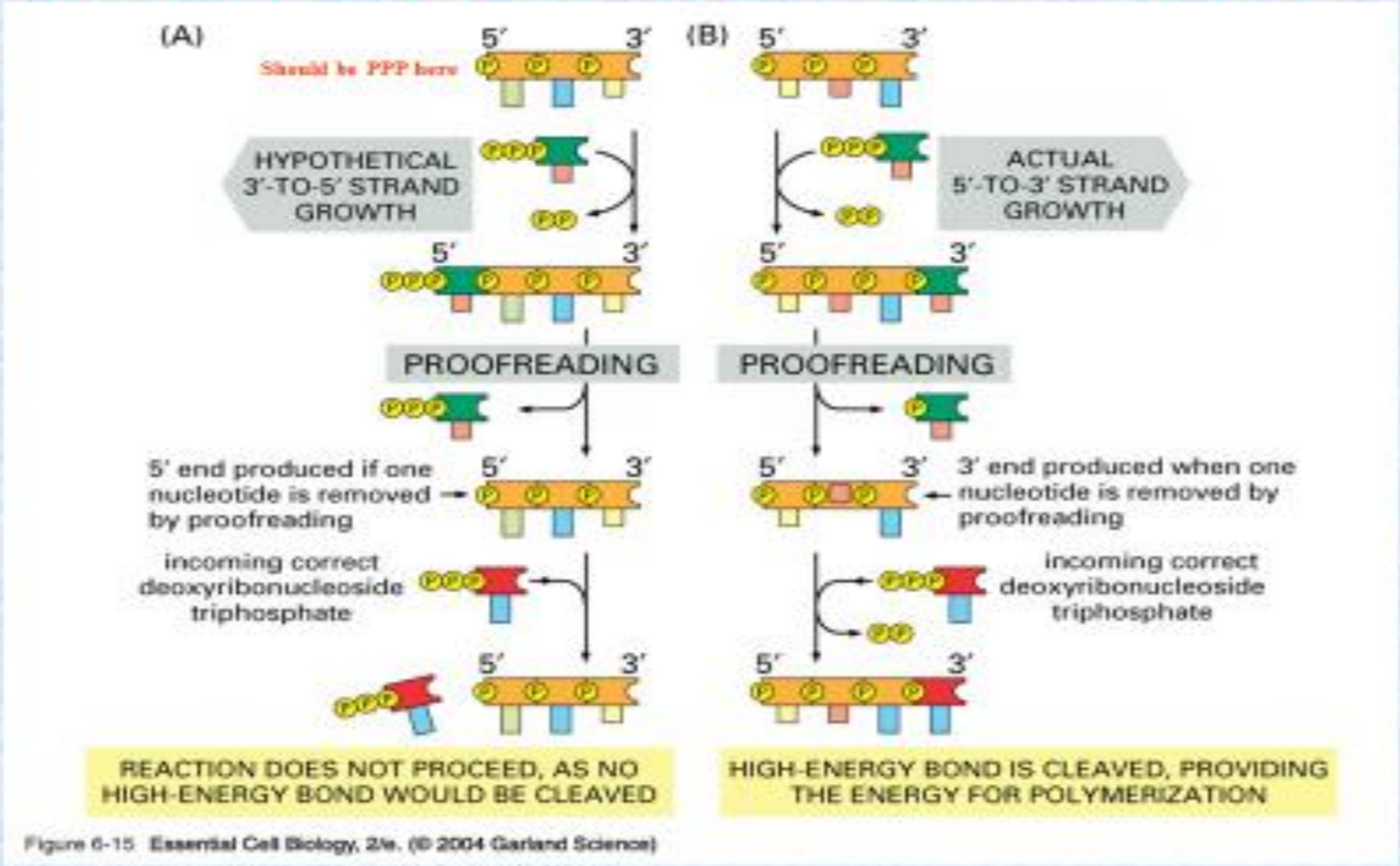
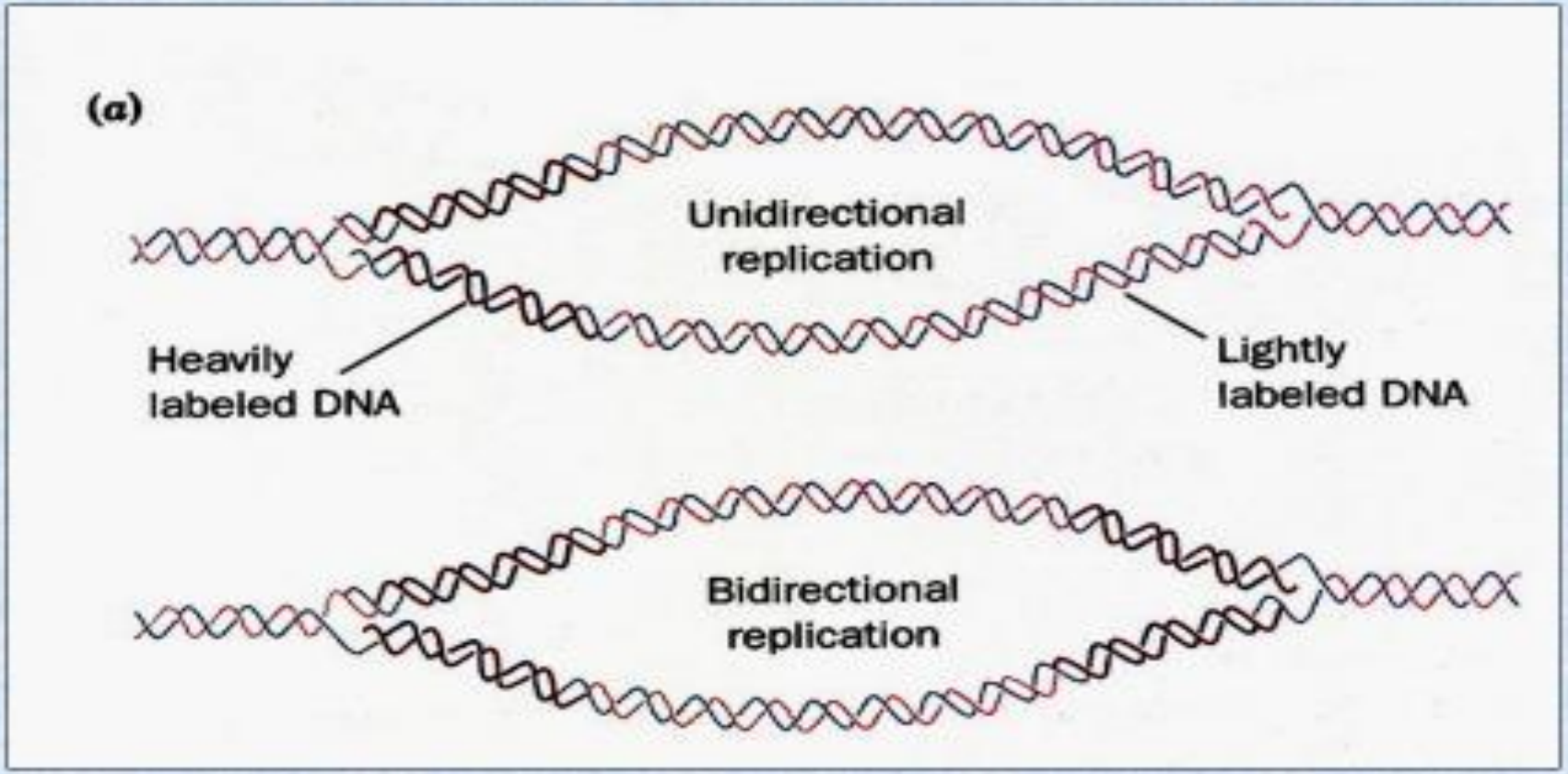


Figure 6-15 Essential Cell Biology, 2/e. (© 2004 Garland Science)

D) Uni or bidirectional

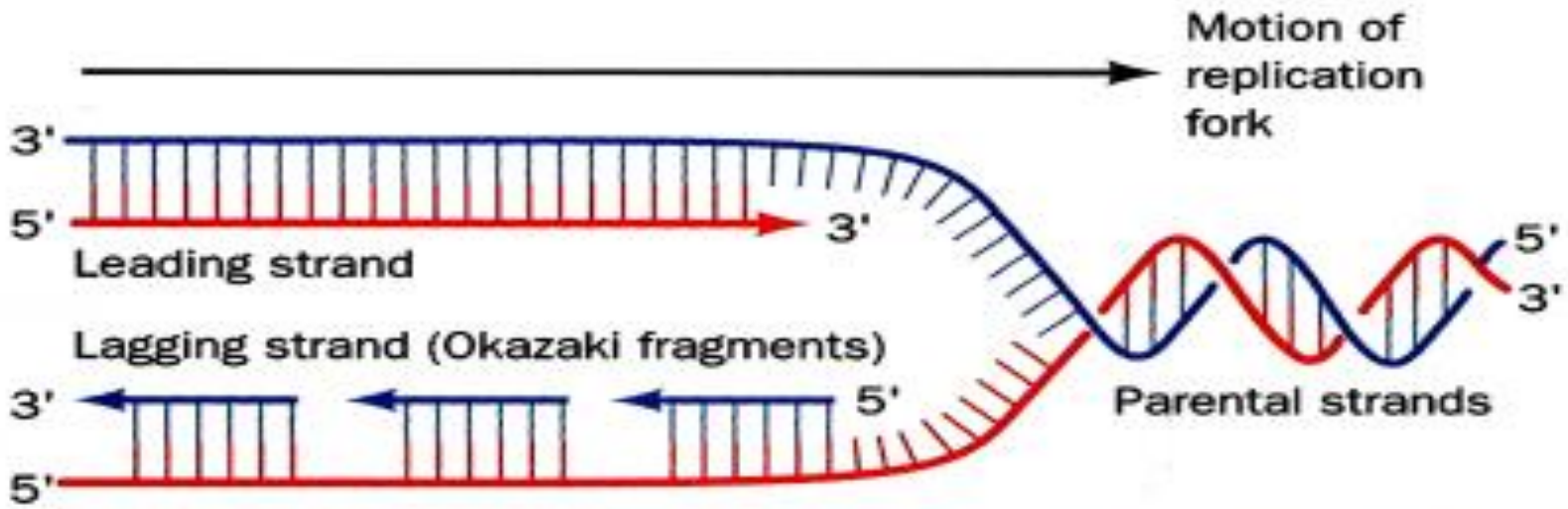
- Replication forks move in one or opposite directions



E) Semi-discontinuous replication

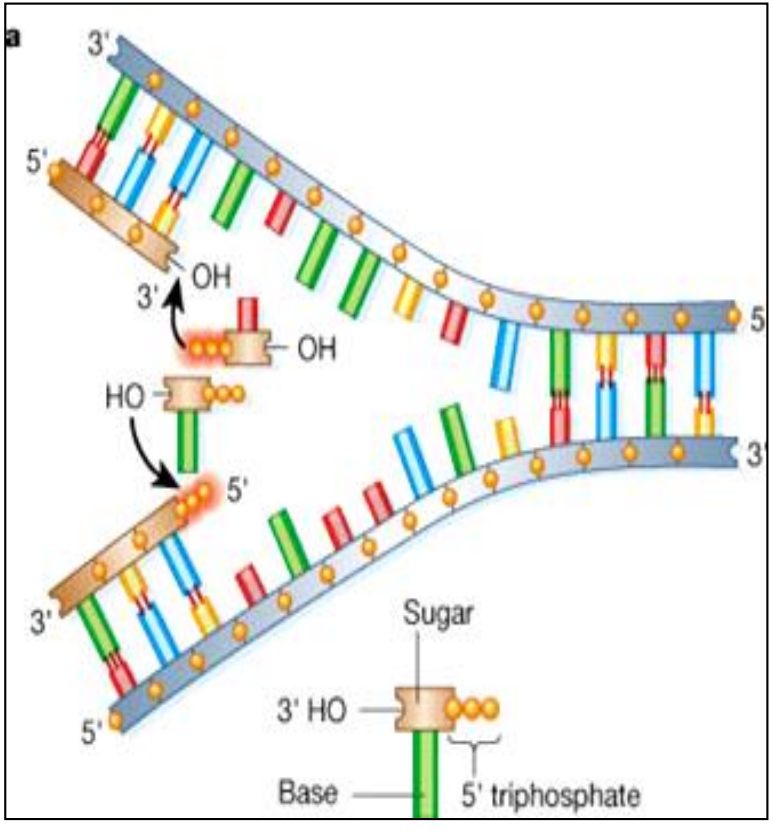
Anti parallel strands replicated simultaneously

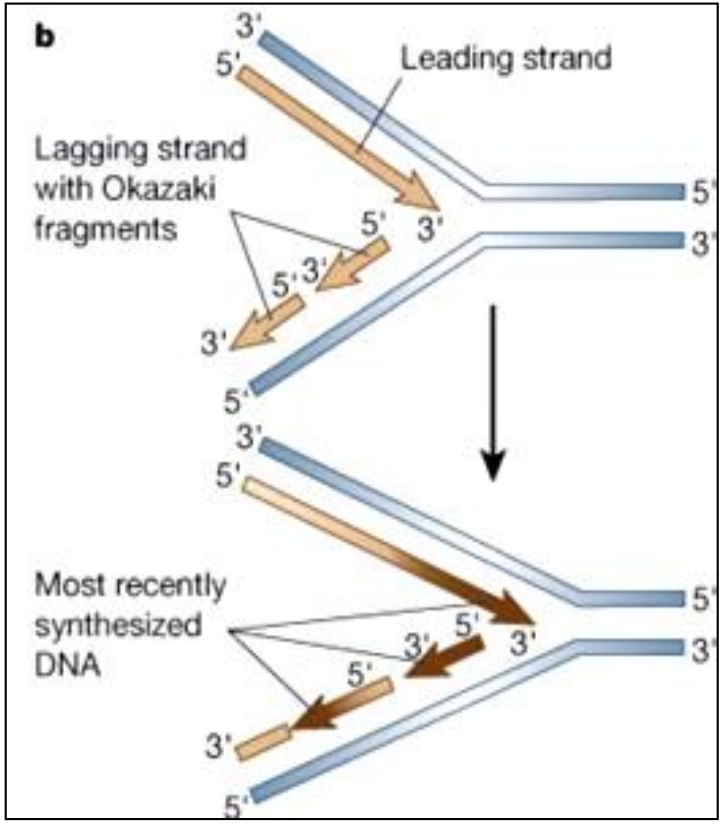
- Leading strand synthesis **continuously** in 5'– 3'
- Lagging strand synthesis in **fragments** in 5'-3'



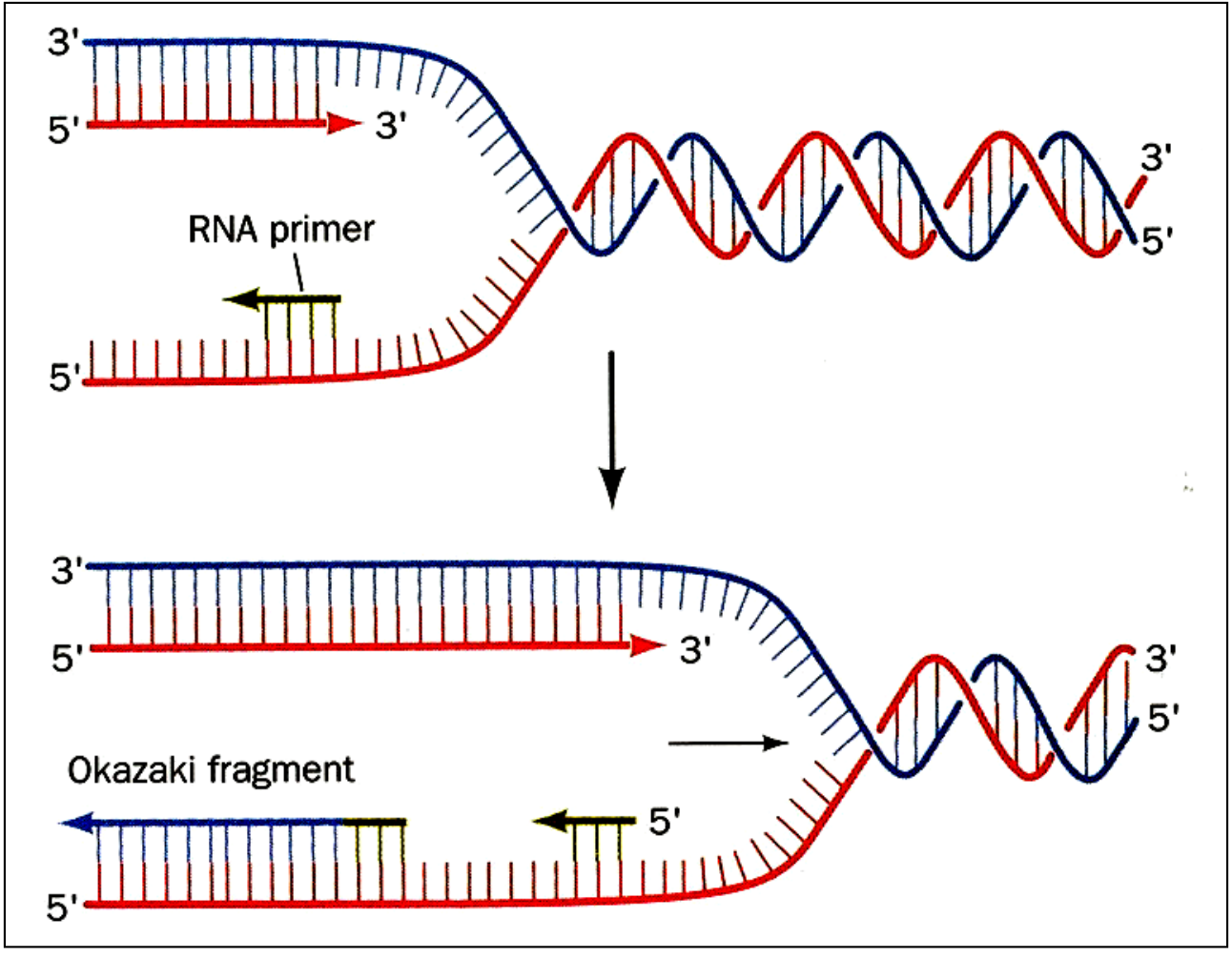
Semi-discontinuous replication

New strand synthesis always in the 5’-3’ direction





F) RNA primers required



Core proteins at the replication fork

Topoisomerases	**- Prevents torsion by DNA breaks**
Helicases	**- separates 2 strands**
Primase	**- RNA primer synthesis**
Single strand binding proteins	**- prevent reannealing of single strands**
DNA polymerase	**- synthesis of new strand**
Tethering protein	**- stabilises polymerase**
DNA ligase	**- seals nick via phosphodiester linkage**

The mechanism of DNA replication

Arthur Kornberg, a Nobel prize winner and other biochemists deduced steps of replication

- Initiation
  - Proteins bind to DNA and open up double helix
  - Prepare DNA for complementary base pairing
- Elongation
  - Proteins connect the correct sequences of nucleotides into a continuous new strand of DNA
- Termination
  - Proteins release the replication complex

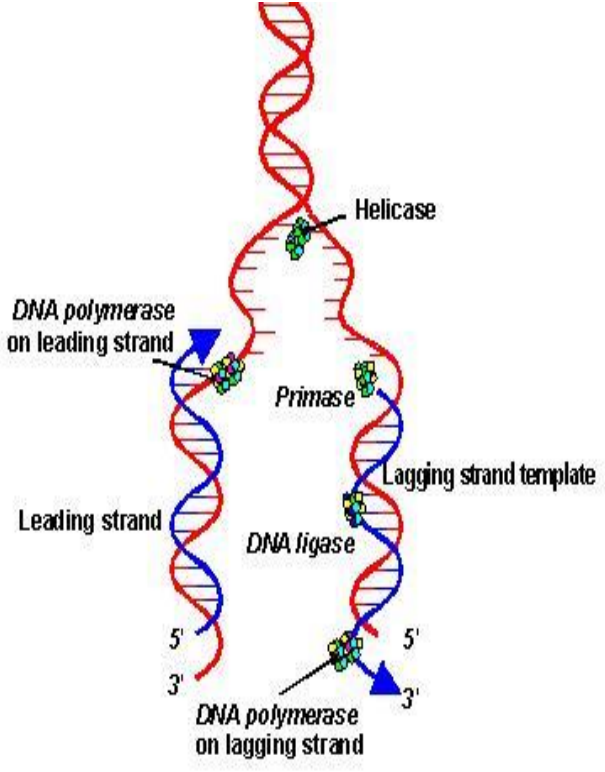
DNA replication steps

1:Initiation and Unwinding
2:Primer Synthesis
3:Elongation

DNA Replication
1: Initiation and Unwinding

Initiation and Unwinding

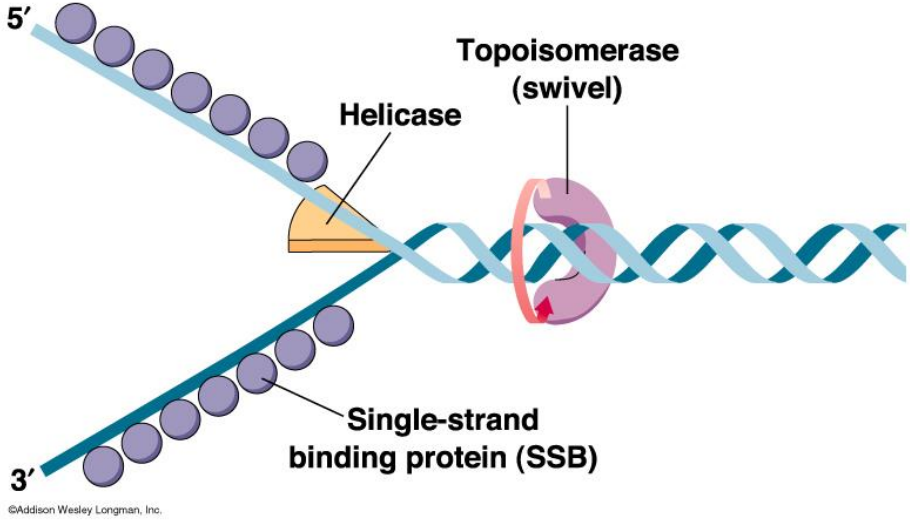
- DNA replication occurs when the complementary strands of DNA break apart and unwind.
- This is accomplished with the help of enzymes called ***helicases***.
- Each half will then be the template for a new, complementary strand.
- Because the newly unwound single strands have a tendency to rejoin, another group of proteins, the ***single-strand binding proteins***, keep the single strands stable until elongation begins.



DNA Replication

•A third family of proteins, the ***topoisomerases***, change DNA supercoiling by inserting or removing superhelical twists.

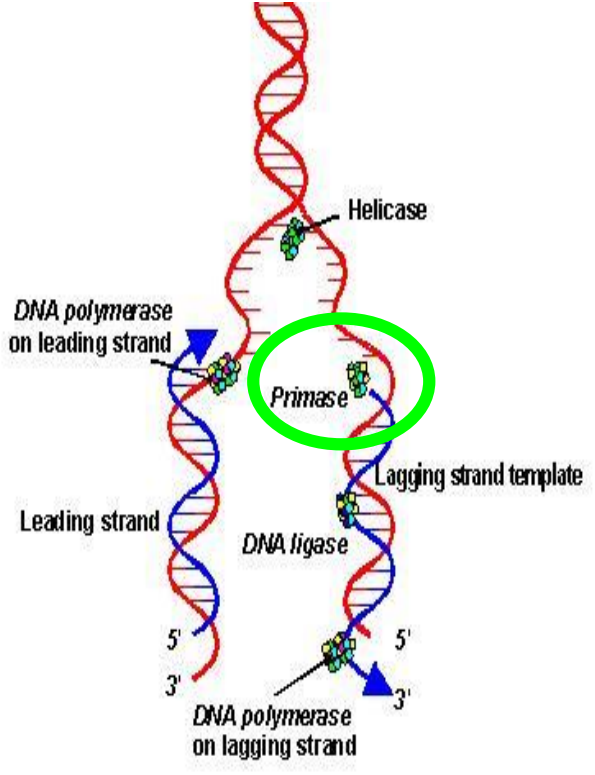
•The point at which the double helix separates is called the ***replication fork***, because of the shape of the molecule.



DNA Replication
2:Primer Synthesis

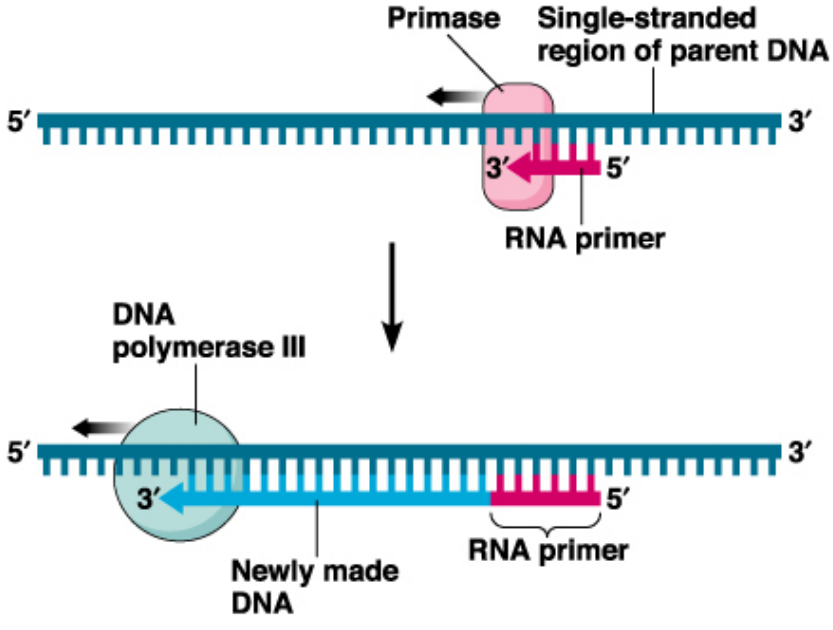
Primer Synthesis

- ***Primase*** enzyme starts the actual synthesis of the new DNA molecule.
- ***Primase*** synthesize **primers** (A short segment of nucleotides - about 10 to 12 bases - used to initiate DNA synthesis in the polymerase chain reaction).
- Primer synthesis marks the beginning of the actual synthesis of the new DNA molecule.



DNA Replication

- ***Primase*** are required because ***DNA polymerases***, the enzymes responsible for the actual addition of new nucleotides to the new DNA strand, can only add deoxyribonucleotides to the 3'-OH group of an existing chain and cannot begin synthesis *de novo*.
- DNA replication can proceed only in the 5'-to-3' direction.

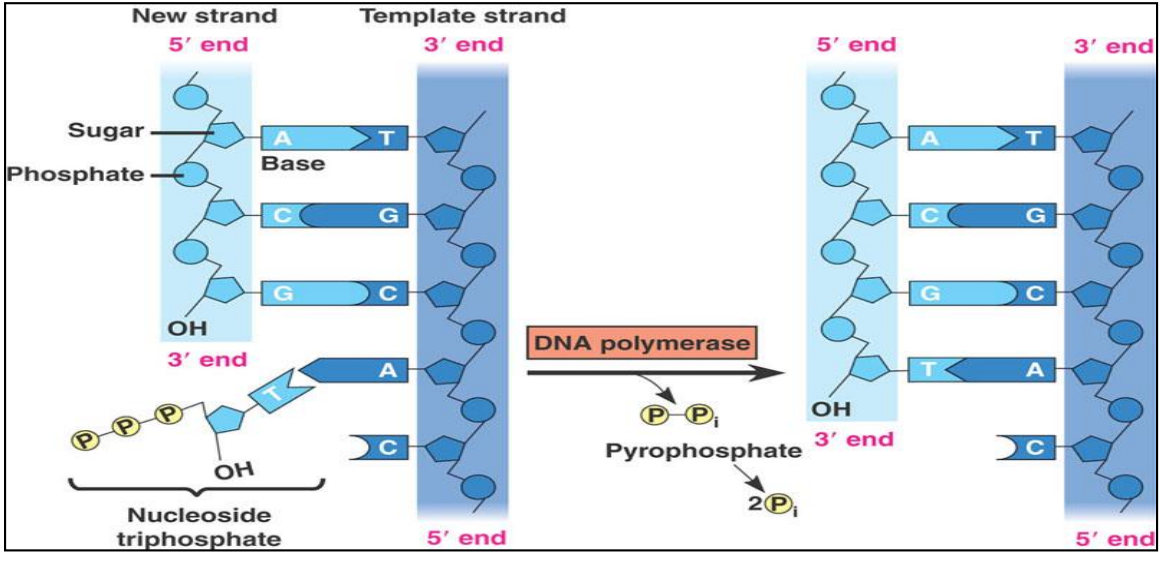


DNA Replication

3: Elongation

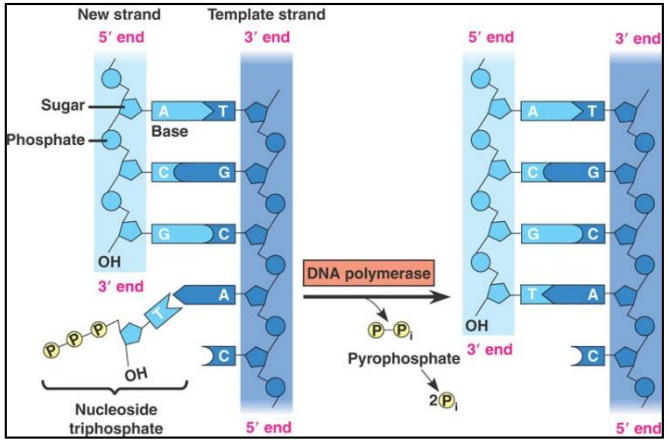
Elongation

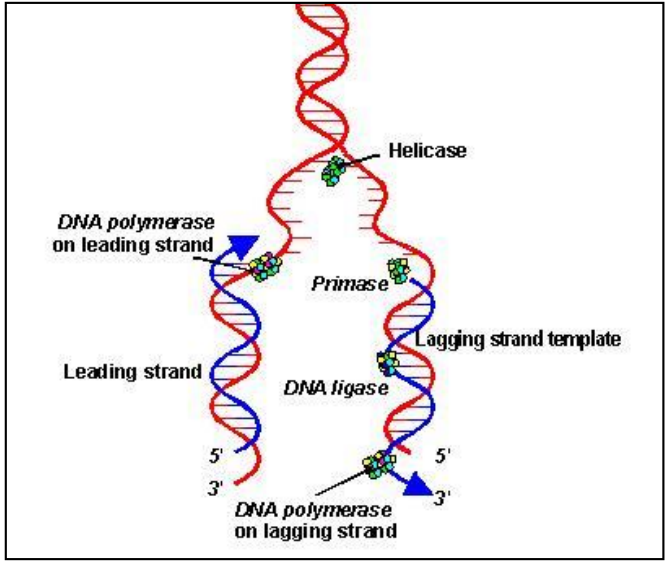
- At this point enzymes called ***DNA polymerases*** move along each of the separated DNA strands, adding nucleotides to the exposed bases according to the base pairing rules.

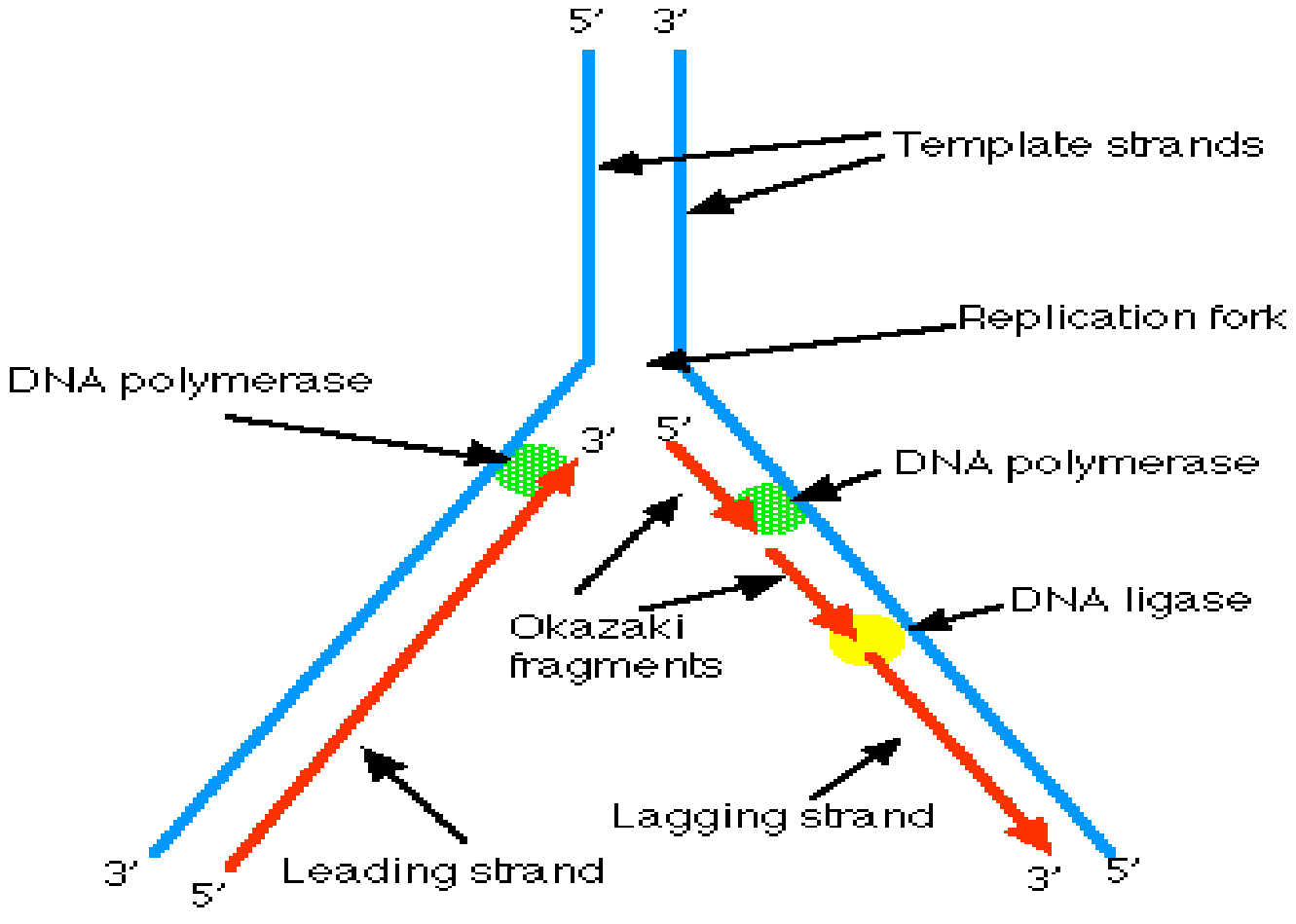


DNA Replication

- **DNA is always synthesized in the 5'-to-3' direction**, meaning that nucleotides are added only to the 3' end of the growing strand.
- As shown in Figure, the 5'-phosphate group of the new nucleotide binds to the 3'-OH group of the last nucleotide of the growing strand.
- Consequently, synthesis proceeds immediately only along the so-called **leading strand**. This immediate replication is known as **continuous replication.**



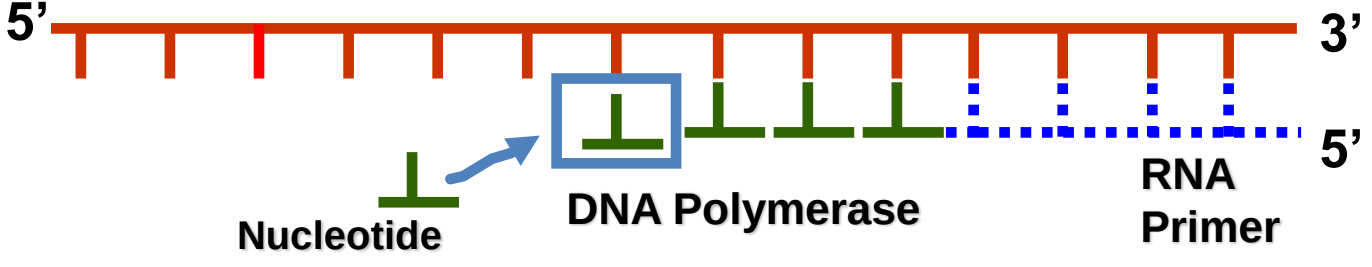



5′
3′
Template strands
Replication fork
DNA polymerase
3′
5′
DNA polymerase
Okazaki
fragments
DNA ligase
Lagging strand
3′
5′
Leading strand
3′
5′

DNA Replication

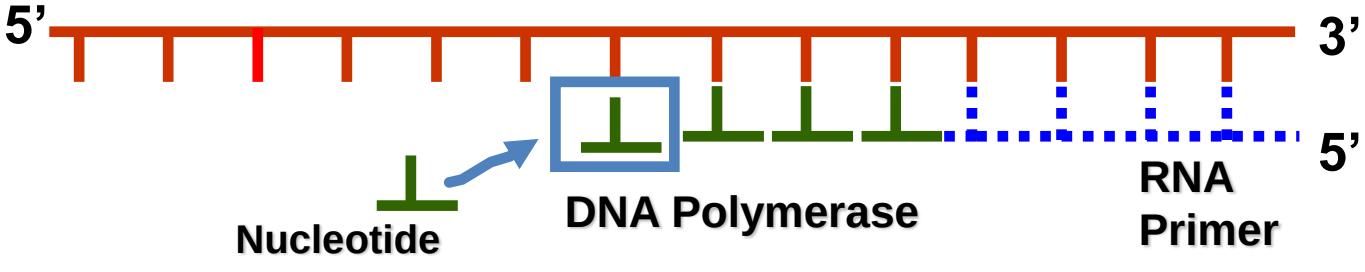
- **Synthesis of the new DNA Strands:**

  1. DNA Polymerase: with a **RNA primer** in place, DNA Polymerase (enzyme) catalyze the **synthesis of a new DNA strand in the 5' to 3' direction**.



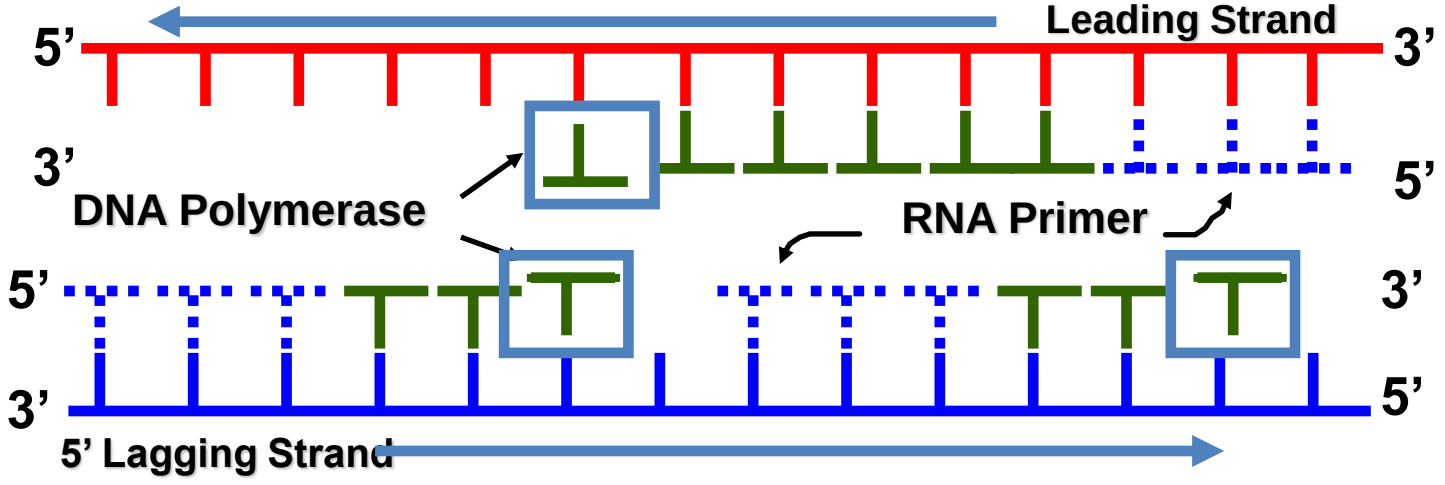
DNA Replication

2. Leading Strand: synthesized as a **single polymer** in the **5' to 3' direction**.



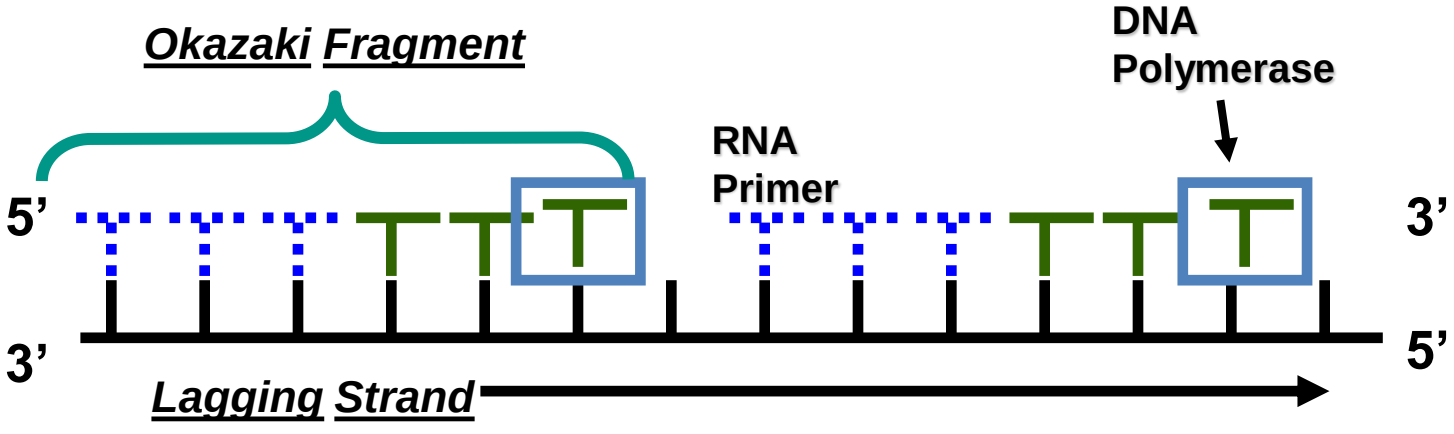
DNA Replication

3. **Lagging Strand**: also synthesized in the **5' to 3' direction**, but **discontinuously** against overall direction of replication.



DNA Replication

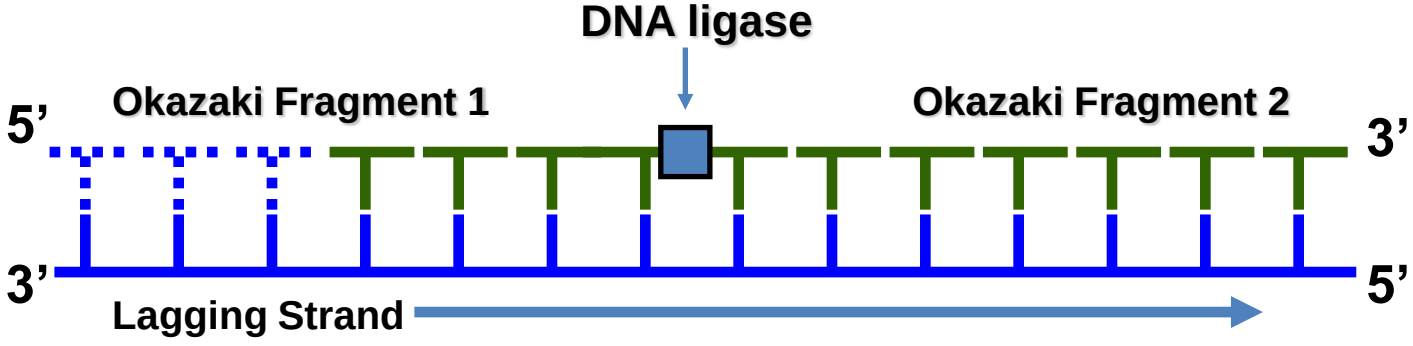
4. ***Okazaki Fragments***: series of short segments on the **lagging strand.**



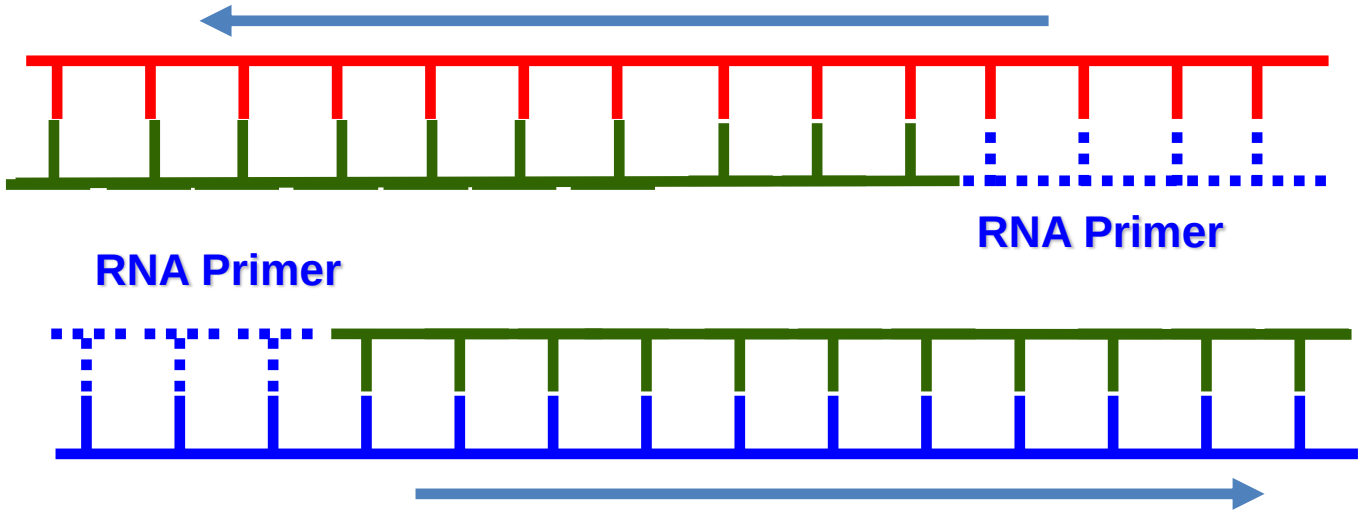
DNA Replication

5. *DNA ligase*: a linking enzyme that catalyzes the formation of a covalent bond from the 3' to 5' end of joining stands.

Example: joining two Okazaki fragments together.

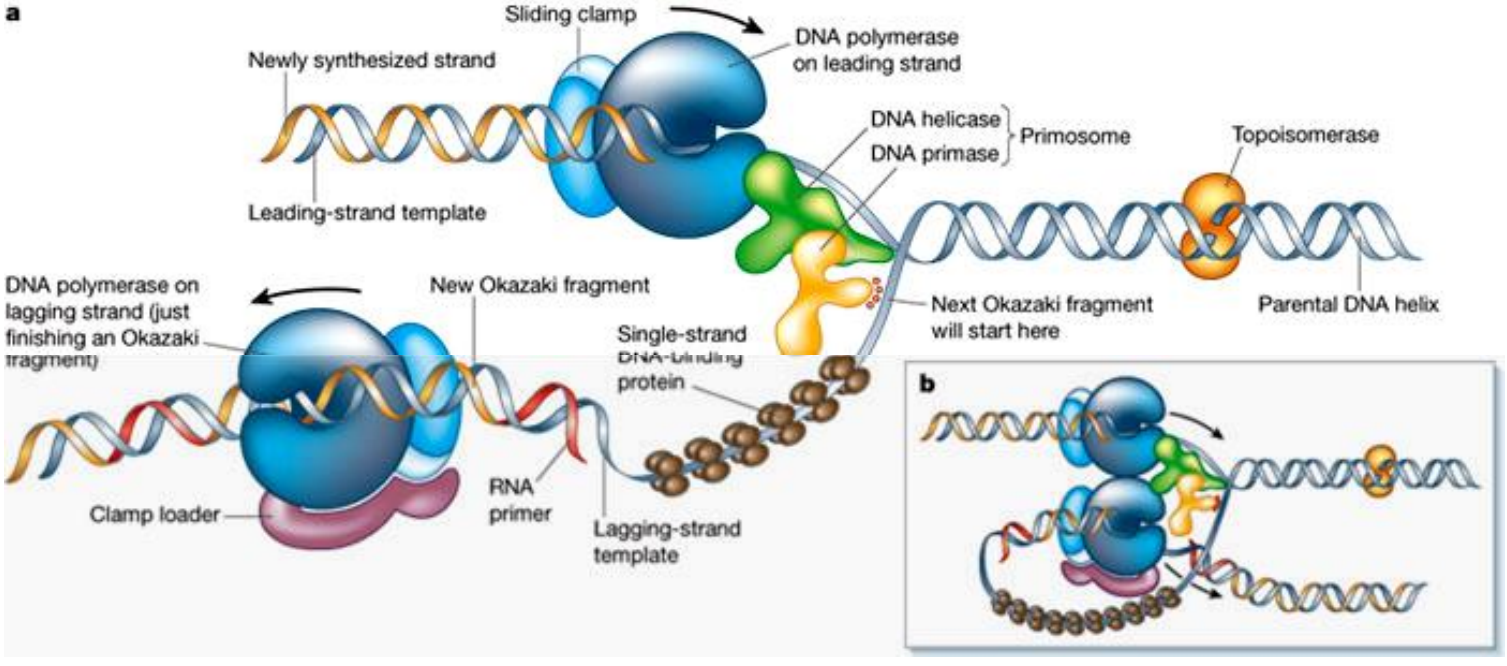


How are the ends of linear chromosomes replicated ?



- Leading strand synthesis can proceed to the end of the chromosome (*top*).
- However, DNA polymerase cannot synthesize the extreme 5’ end of the lagging strand because it can only extend an RNA primer that is paired with the 3’ end of a template strand (*bottom*).
- Removal of the primer and degradation of the remaining single-stranded extension would cause the chromosome to shorten with each round of replication.

Core proteins at the replication fork



Nature (2003) vol 421,pp431-435

Figure in ‘Big’ Alberts too

One Gene- One Enzyme/Polypeptide Theory

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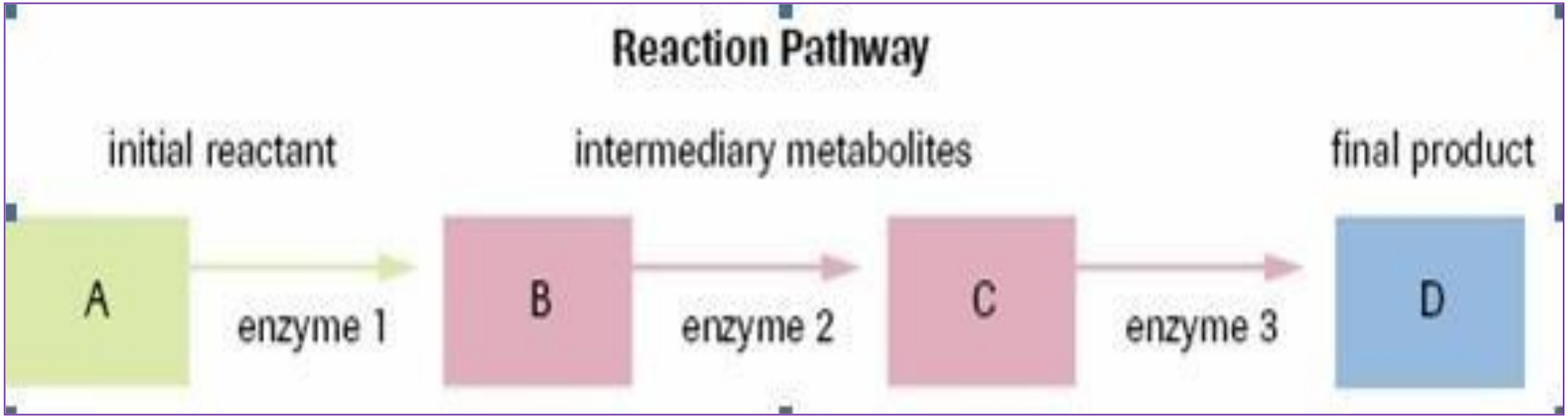
Garrod's Hypothesis

In 1902, **Archibald Garrod** published a study linking genes and proteins.

- studied the disease alkaptonuria and hypothesized that a defective enzyme caused an "inborn error of metabolism" along a reaction pathway

If there is an accumulation of Substance B then enzyme 2 must be defective.



- The disease alcaptonuria causes a patient’s urine to turn black when it is exposed to air.

- This colour change is due to the build-up of homogentisic acid, an intermediate molecule produced during the catabolism of the amino acid phenylalanine.

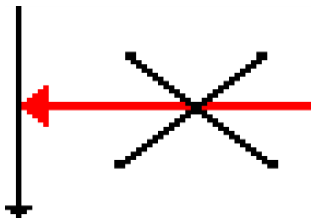
Pathway:

Phenyldanine

Tyrosine

p-Hydroxylphenylpyruvic acid

Homogentisic acid



Homogentisic acid oxidase

Mdeylacetoacetic acid

He reached the conclusions:

- Disease caused by a recessive inheritance factor.
- Having this factor would result in the production of the defective enzyme.
- This conclusion laid the foundations for demonstrating a link between genes and proteins.

Beadle and Tatum

Beadle and Tatum

- 33 years later, they worked with bread mold *neurospora crassa &* exposed spores to x- rays to create mutant strains. Through their experiments they concluded:a gene acts by directing the production of **only one** enzyme - called the one gene-one enzyme

- The one gene–one enzyme hypothesis, proposed by George Wells Beadle in the US in 1941, is the theory that each gene directly produces a single enzyme, which consequently affects an individual step in a metabolic pathway.

- In 1941, Beadle demonstrated that one gene in a fruit fly controlled a single, specific chemical reaction in the fruit fly, which one enzyme controlled. In the 1950s, the theory that genes produce enzymes that control a single metabolic step was dubbed the one gene–one enzyme hypothesis by Norman Horowitz, a professor at the California Institute of Technology (Caltech) and an associate of Beadle's.

- This concept helped researchers characterize genes as chemical molecules, and it helped them identify the functions of those molecules.

- In 1941

- They used the bread mold *Neurospora crassa* to investigate whether one gene controlled the production of one enzyme or multiple enzymes.

- Normal, wild-type *N. crassa* can grow on minimal medium.

- Beadle and Tatum first created *Neurospora* mutants by irradiating *Neurospora* with x-rays. They subsequently germinated sexual spores in tubes of a complete medium, or physical environment, which contained amino acids, vitamins, and other organic substances.

- They then transferred *Neurospora* to tubes of a minimal medium, which lacked some of the nutrients that the *Neurospora* needed to survive.

- Beadle and Tatum reexamined any *Neurospora* mutants that failed to grow in the second, minimal medium to determine whether or not any new growth factor requirements had been induced.

- In almost all cases in which a mutant was unable to survive in the minimal medium, Beadle and Tatum remedied the failure to grow by adding a particular chemical—either a vitamin or a specific amino acid—to the medium.

- The results suggested that these chemicals, which were products of genes, were necessary for the genes to encode a required enzyme in a biochemical pathway. In 1941 Beadle and Tatum published their results in "Genetic control of biochemical reactions in *Neurospora*," in which Beadle proposed the one gene–one enzyme hypothesis.

- The information obtained from the experiments on *Neurospora* confirmed what Beadle had witnessed in *Drosophila* when he worked with Ephrussi.

- It confirmed that a gene specified the action of a single biochemical pathway, or one step in an overall set of reactions, and this was done through the production of a specific enzyme.

- Beadle and Tatum received the Nobel Prize in Physiology or Medicine in 1958 for their work on the *Neurospora* and for demonstrating that genes regulated chemical processes.

- The hypothesis was modified after various studies, including that of Vernon Ingram who worked at the Massachusetts Institute of Technology in Cambridge, Massachusetts.

- In 1957, Ingram showed that some genes accounted for single polypeptide chains of a protein comprised of multiple chains.

- Subsequently, the idea was dubbed the one gene–one polypeptide hypothesis, after further investigation into the phenomena led scientists to conclude that genes actually specify protein products.

One-Gene/One-Polypeptide Hypothesis

Beadle and Tatum concluded that one gene codes for one enzyme. This relationship was updated to the **one-gene/one-polypeptide hypothesis**, since not all proteins are enzymes.

one gene-one polypeptide hypothesis

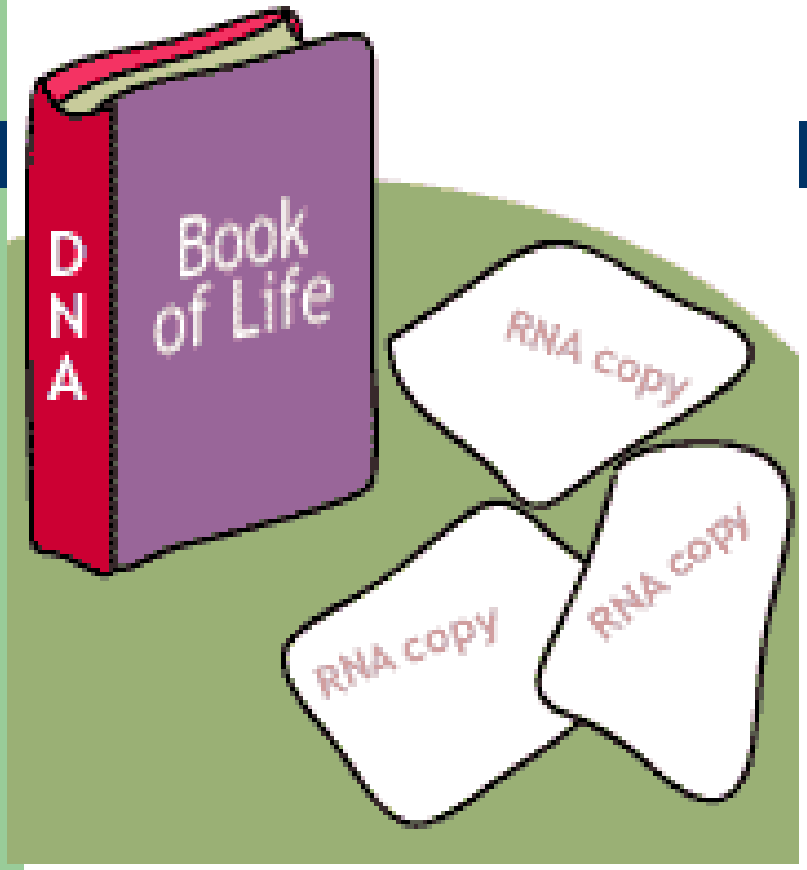
- The theory that each gene is responsible for the synthesis of a single polypeptide.

- It was originally stated as the **one gene-one enzyme hypothesis** by the US geneticist George Beadle in 1945 but later modified when it was realized that genes also encoded nonenzyme proteins and individual polypeptide chains.

- It is now known that some genes code for various types of RNA involved in protein synthesis.

one gene-one polypeptide hypothesis

- The hypothesis that a large class of structural genes exists in which each gene encodes a single polypeptide, which may function either independently or as a subunit of a more complex protein.
- Originally it was thought that each gene encoded the whole of a single enzyme, but it has since been found that some enzymes and other proteins derive from more than one polypeptide and hence from more than one gene.
- The “one gene—one enzyme” **hypothesis** was altered because genes code for proteins, and not all proteins are enzymes. ... Translation refers to the conversion of mRNA to a specific amino acid chain(polypeptide).



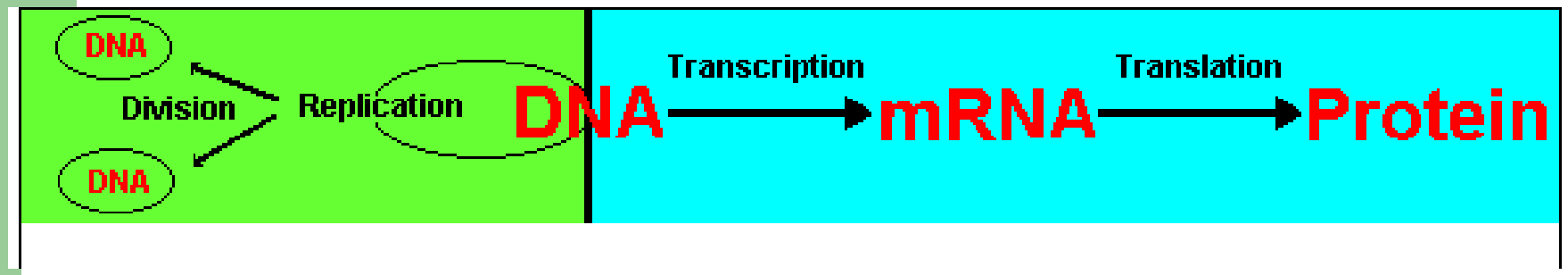
Protein Synthesis

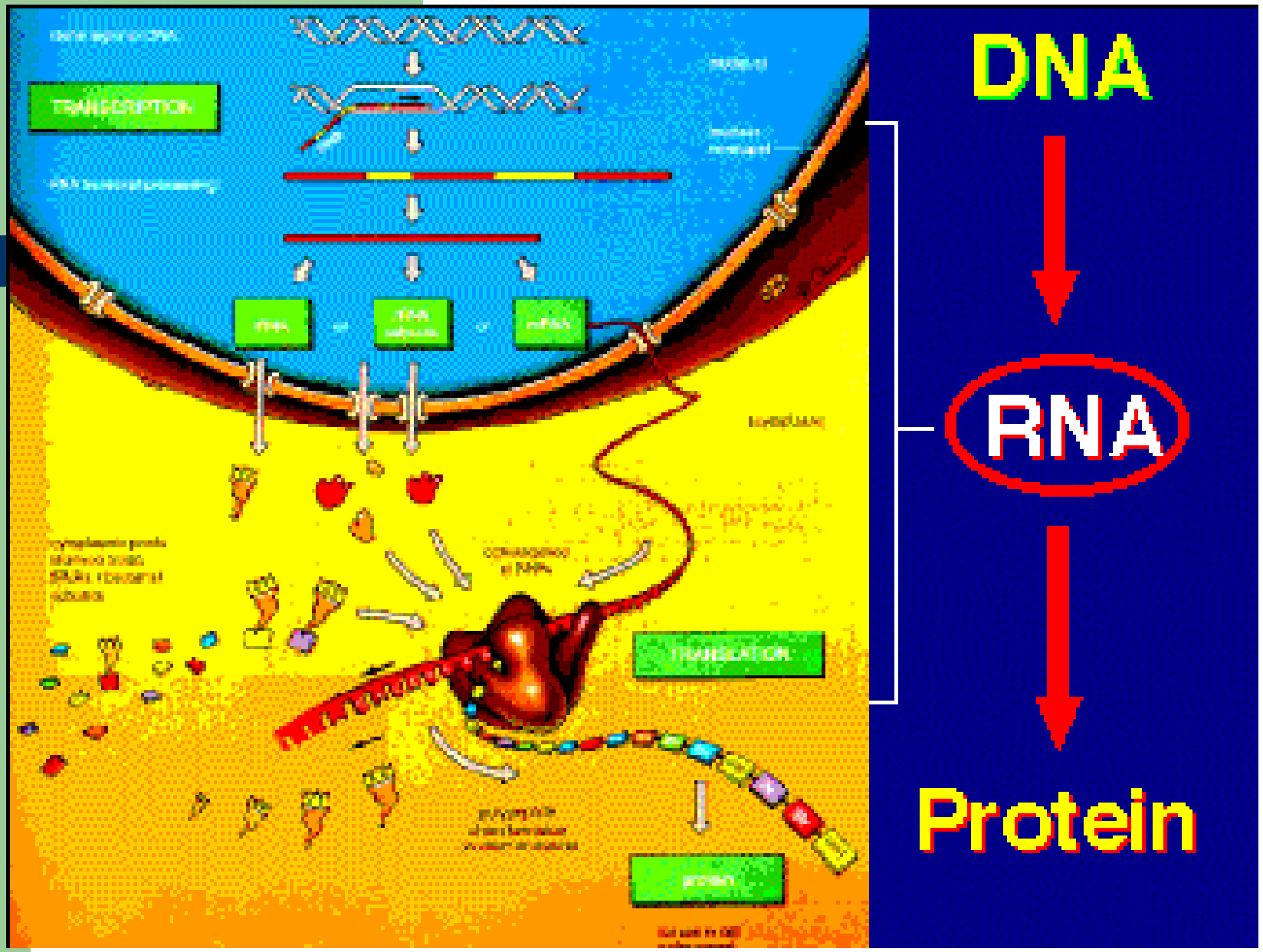
Dr.K.Kalimuthu

Protein synthesis pg 72-73

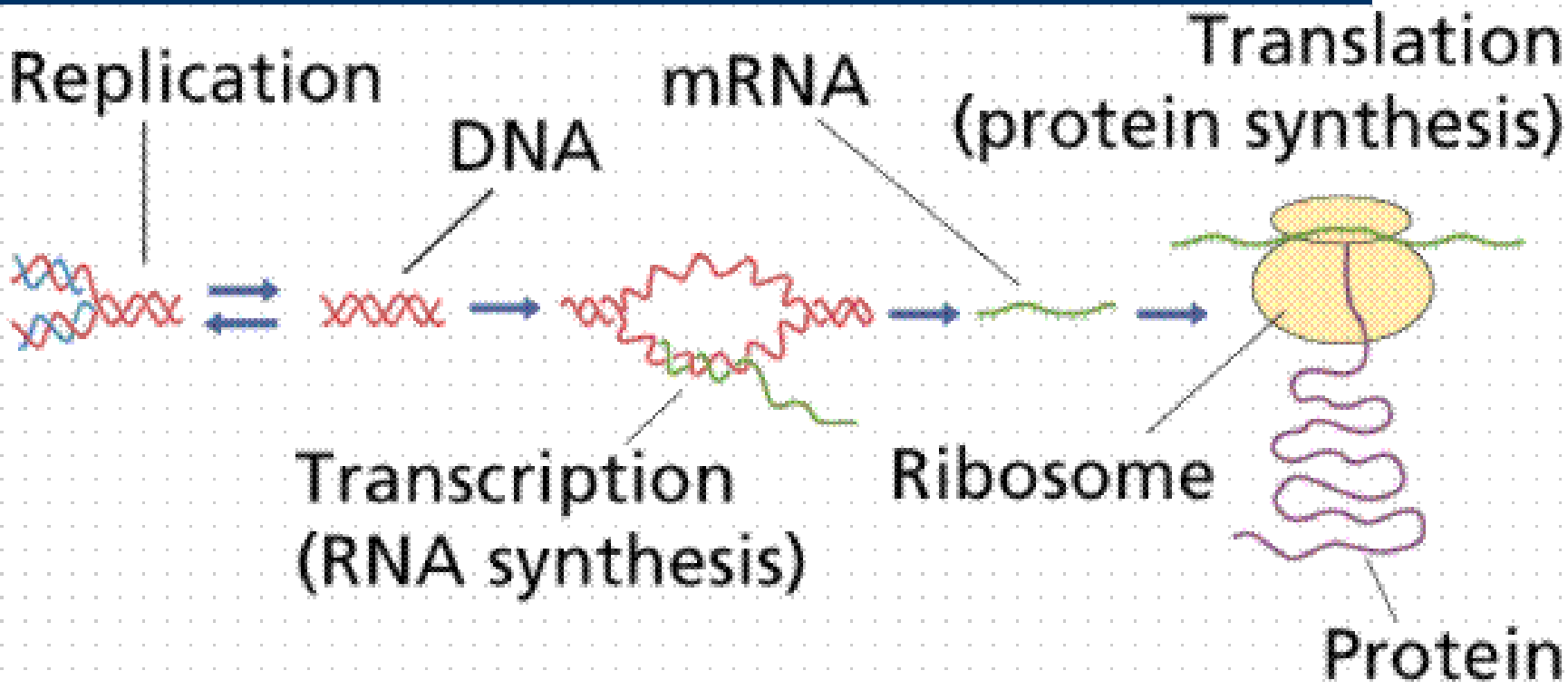
1. DNA unwinds
2. mRNA copy is made of one of the DNA strands.
3. mRNA copy moves out of nucleus into cytoplasm.
4. tRNA molecules are activated as their complementary amino acids are attached to them.
5. mRNA copy attaches to the small subunit of the ribosomes in cytoplasm. 6 of the bases in the mRNA are exposed in the ribosome.
6. A tRNA bonds complementarily with the mRNA via its anticodon.
7. A second tRNA bonds with the next three bases of the mRNA, the amino acid joins onto the amino acid of the first tRNA via a peptide bond.
8. The ribosome moves along. The first tRNA leaves the ribosome.
9. A third tRNA brings a third amino acid
10. Eventually a stop codon is reached on the mRNA. The newly synthesised polypeptide leaves the ribosome.

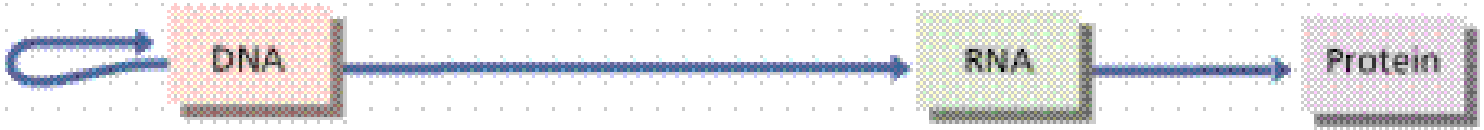
Overview


DNA
Division
Replication
DNA
DNA
Transcription
mRNA
Translation
Protein

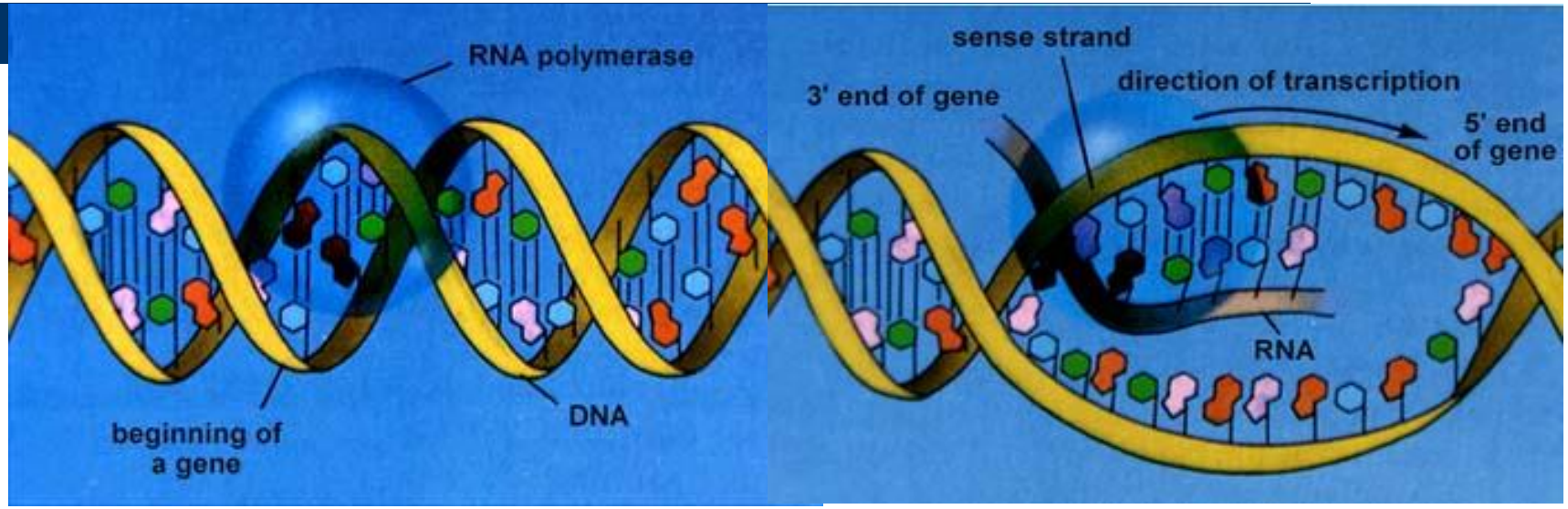

TRANSCRIPTION
TRANSLATION
protein
DNA
RNA
Protein

Summary


Replication
DNA
mRNA
Translation
(protein synthesis)
Transcription
(RNA synthesis)
Ribosome
Protein

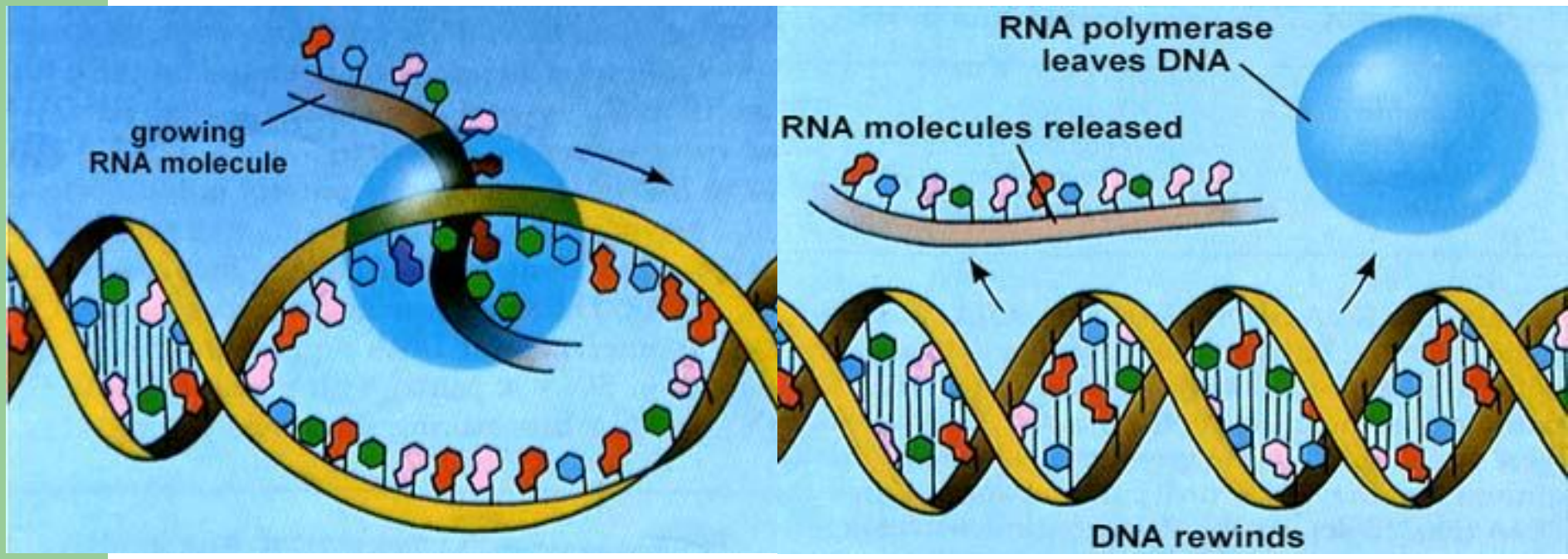

DNA
RNA
Protein

Transcription 1 (making a mRNA copy of DNA)



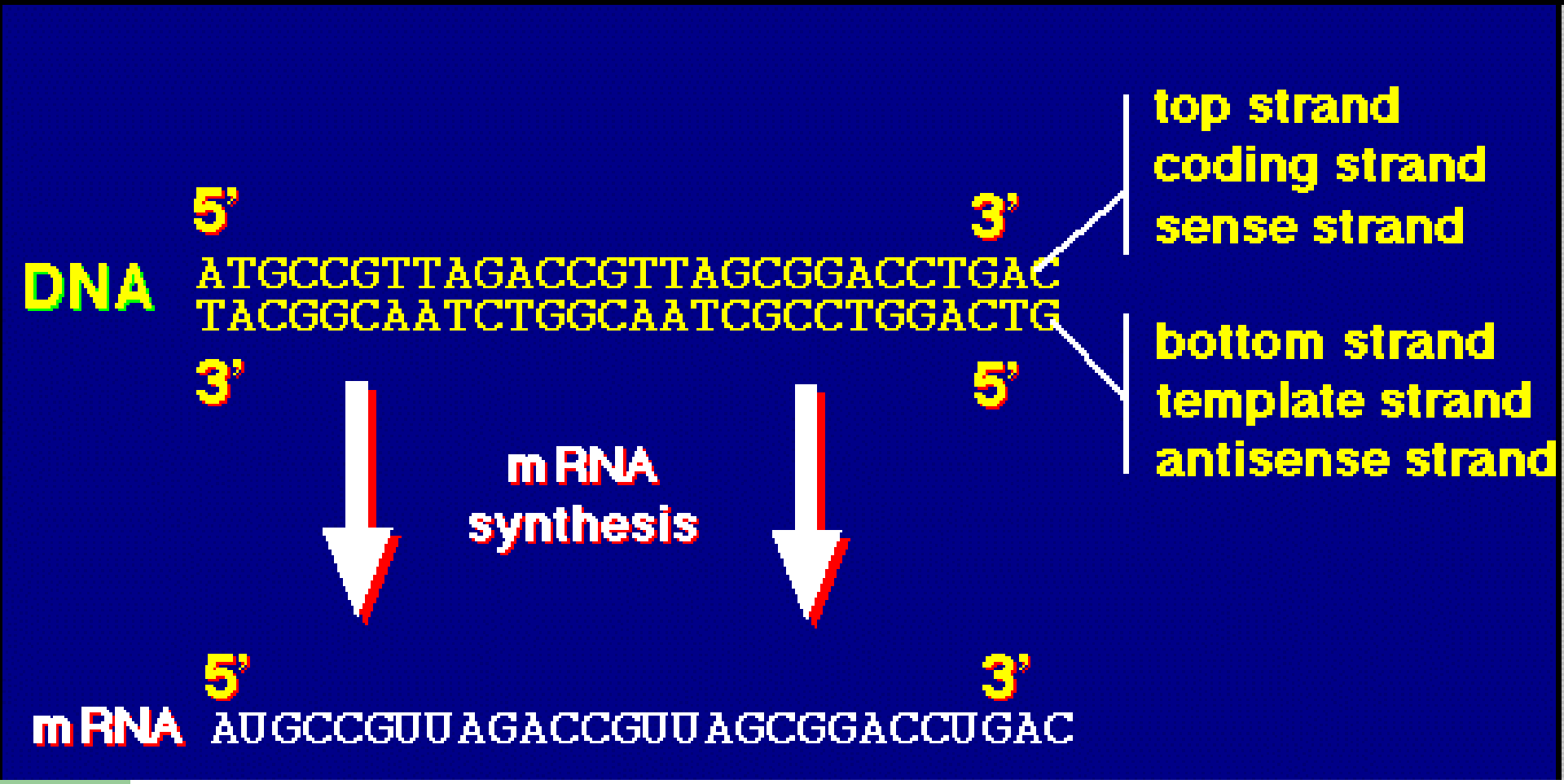
- The part of the DNA molecule (the gene) that the cell wants the information from to make a protein unwinds to expose the bases.
- Free mRNA nucleotides in the nucleus base pair with one strand of the unwound DNA molecule.

Transcription 2

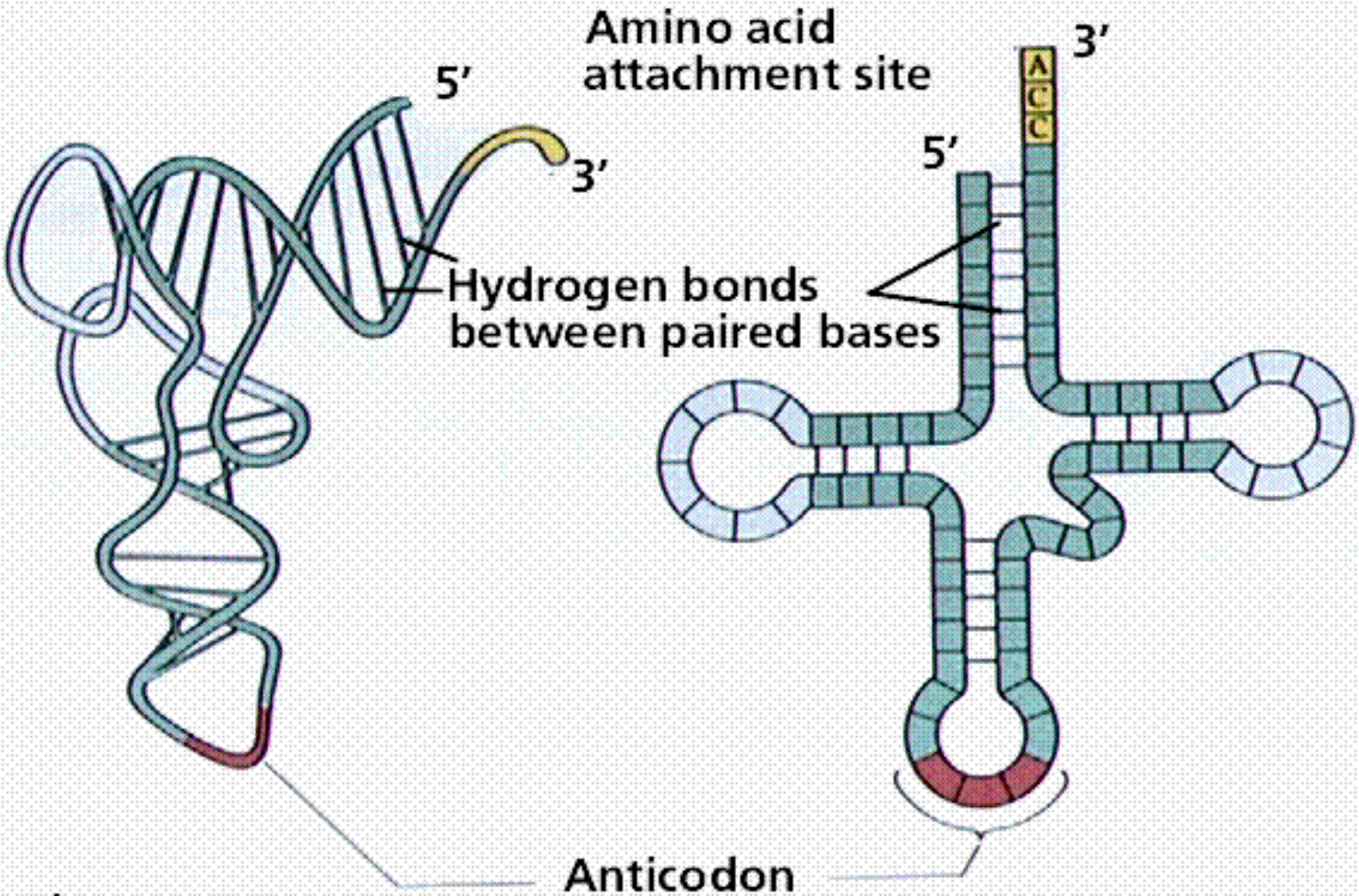


- The mRNA copy is made with the help of RNA polymerase. This enzyme joins up the mRNA nucleotides to make a mRNA strand.
- This mRNA strand is a complementary copy of the DNA (gene)
- The mRNA molecule leaves the nucleus via a nuclear pore into the cytoplasm

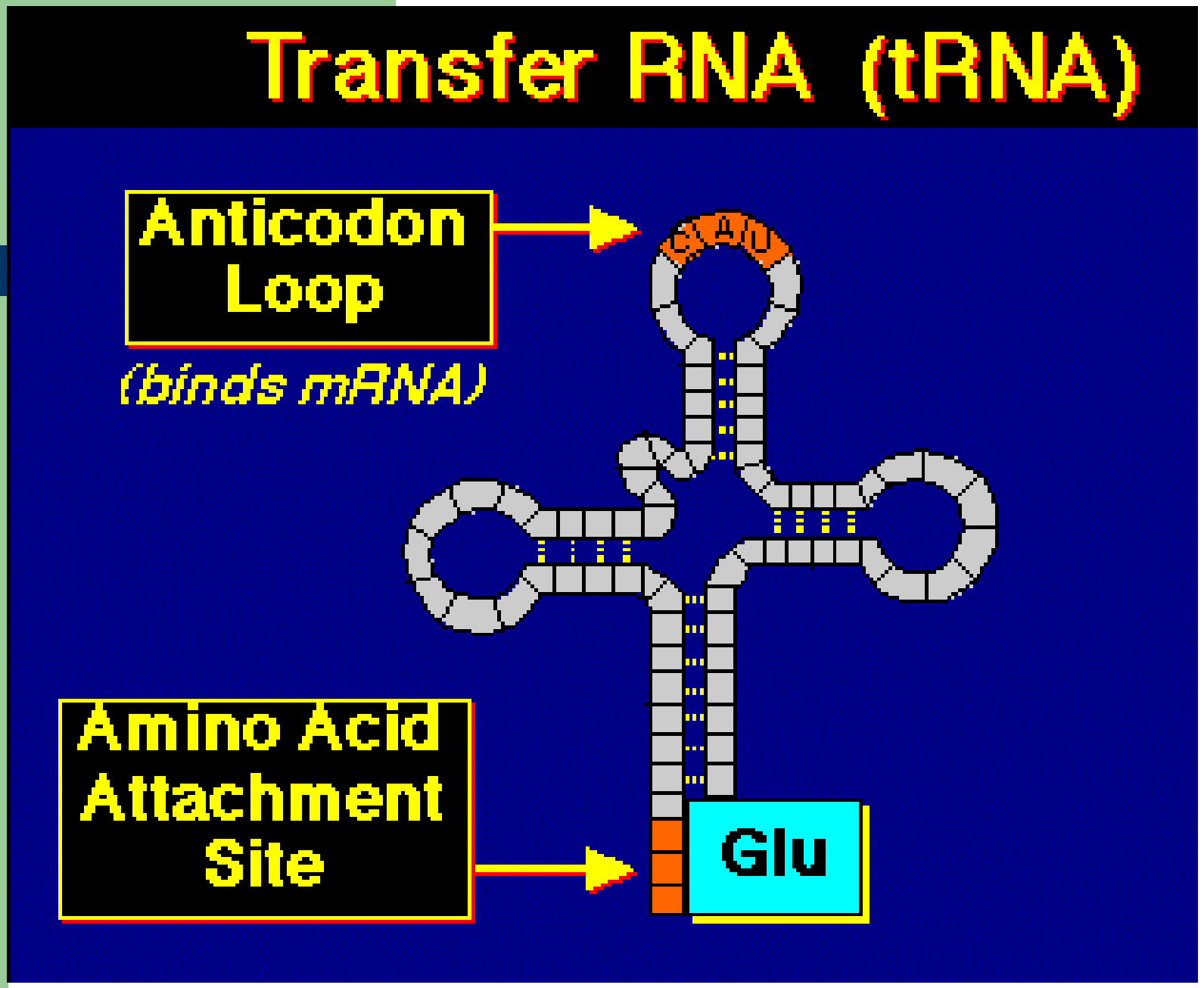
TRANSCRIPTION



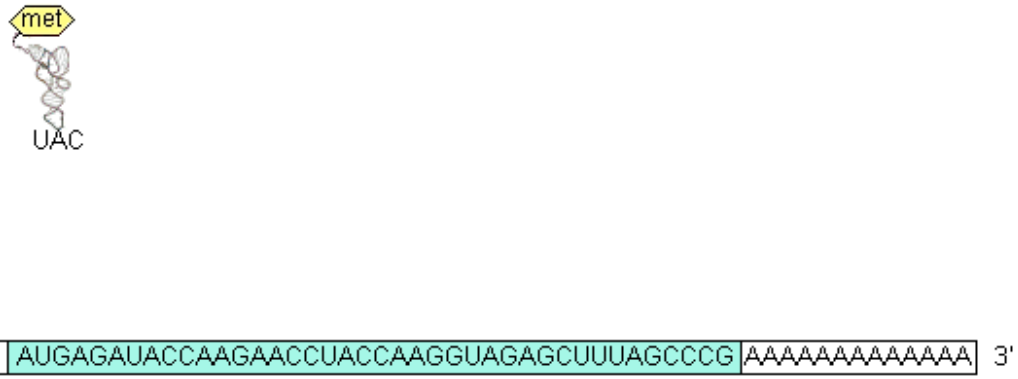
tRNA –
pick up their specific amino acids from the cytoplasm



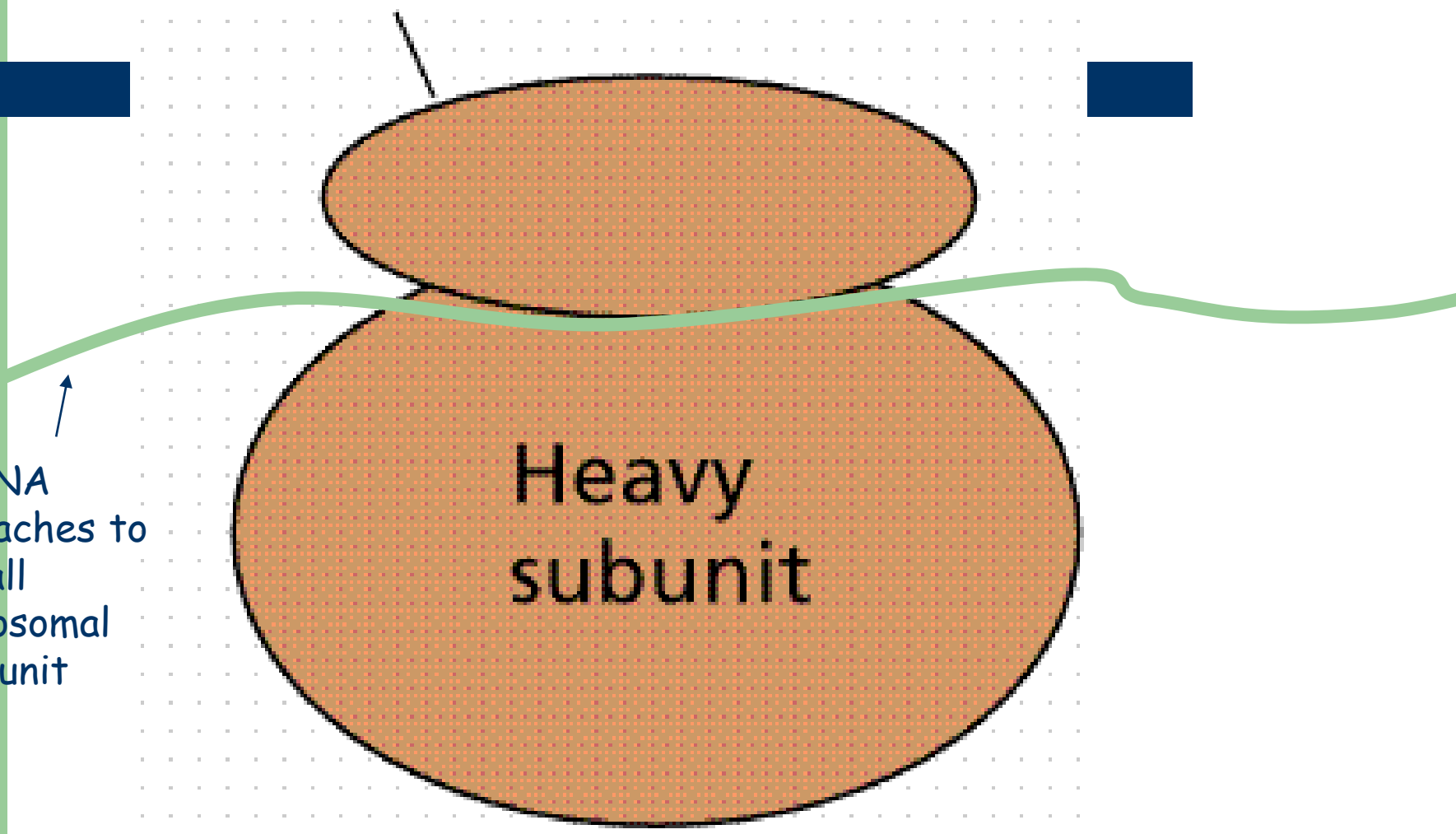
Transfer RNA (tRNA)



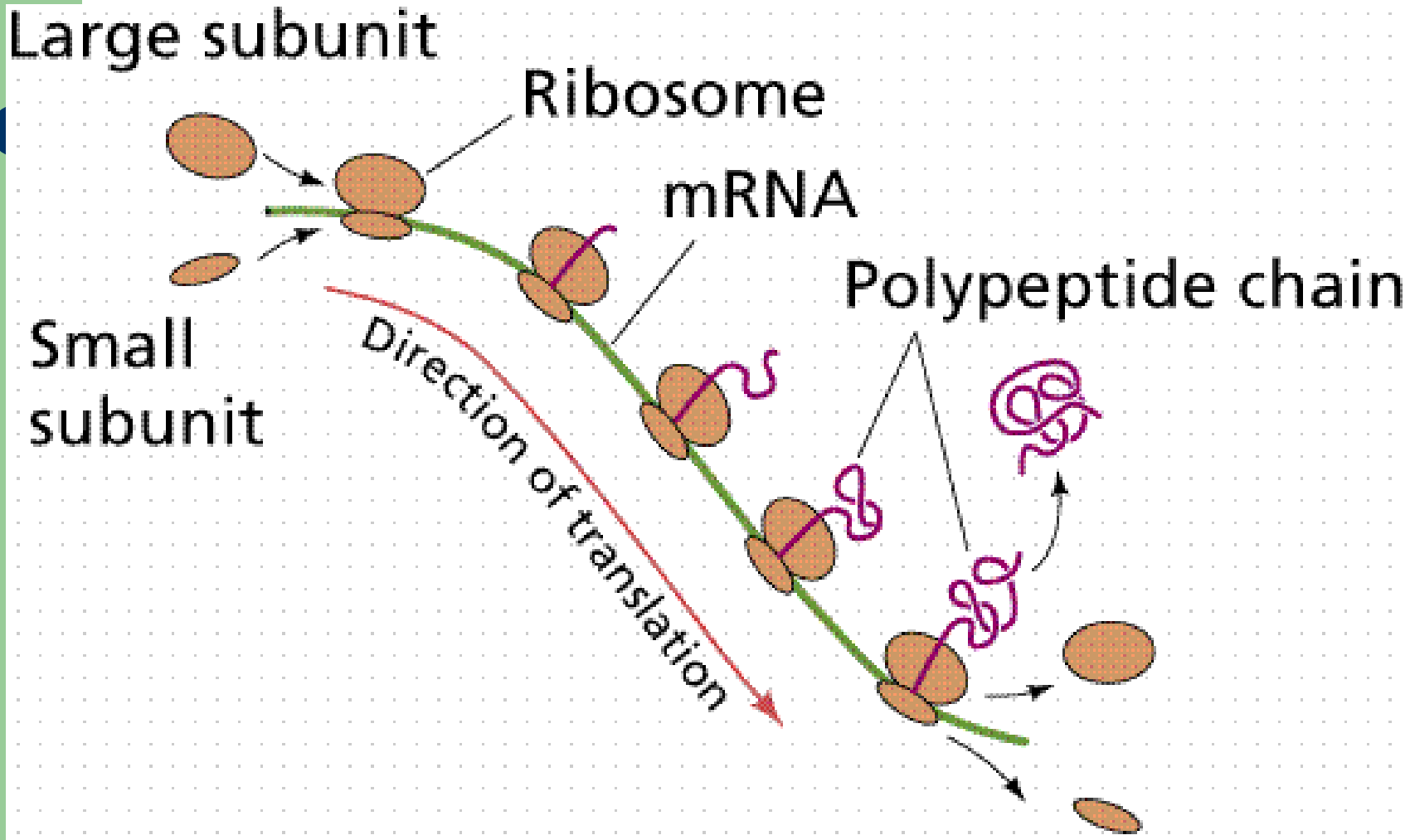
Translation - animation



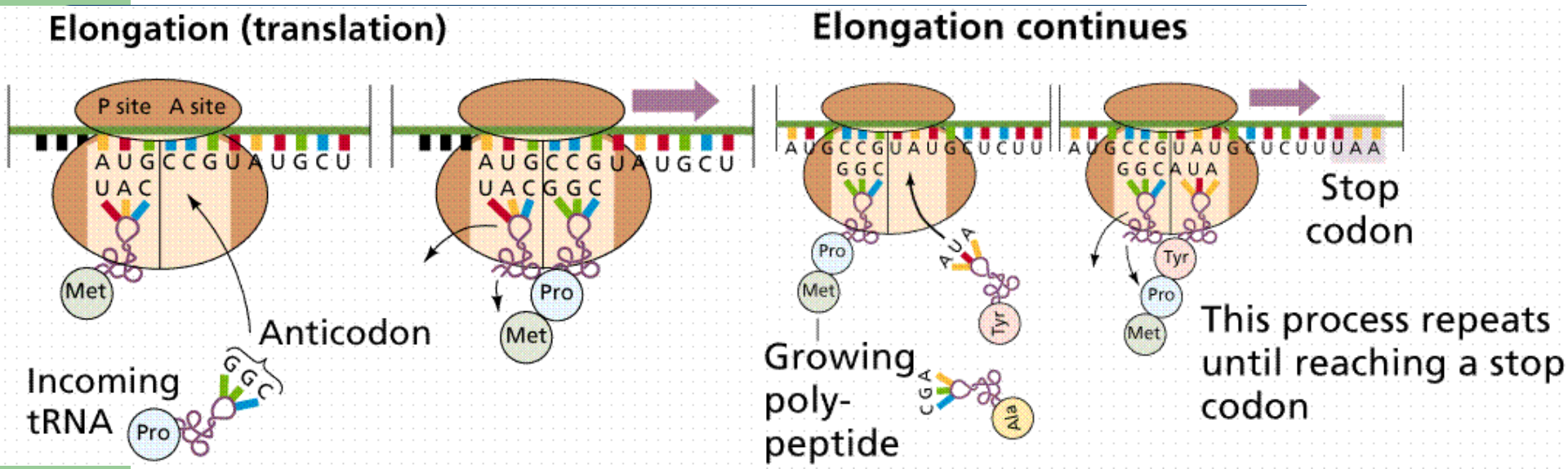
Ribosome


Light subunit
Heavy subunit
mRNA attaches to small ribosomal subunit

Translation - outline

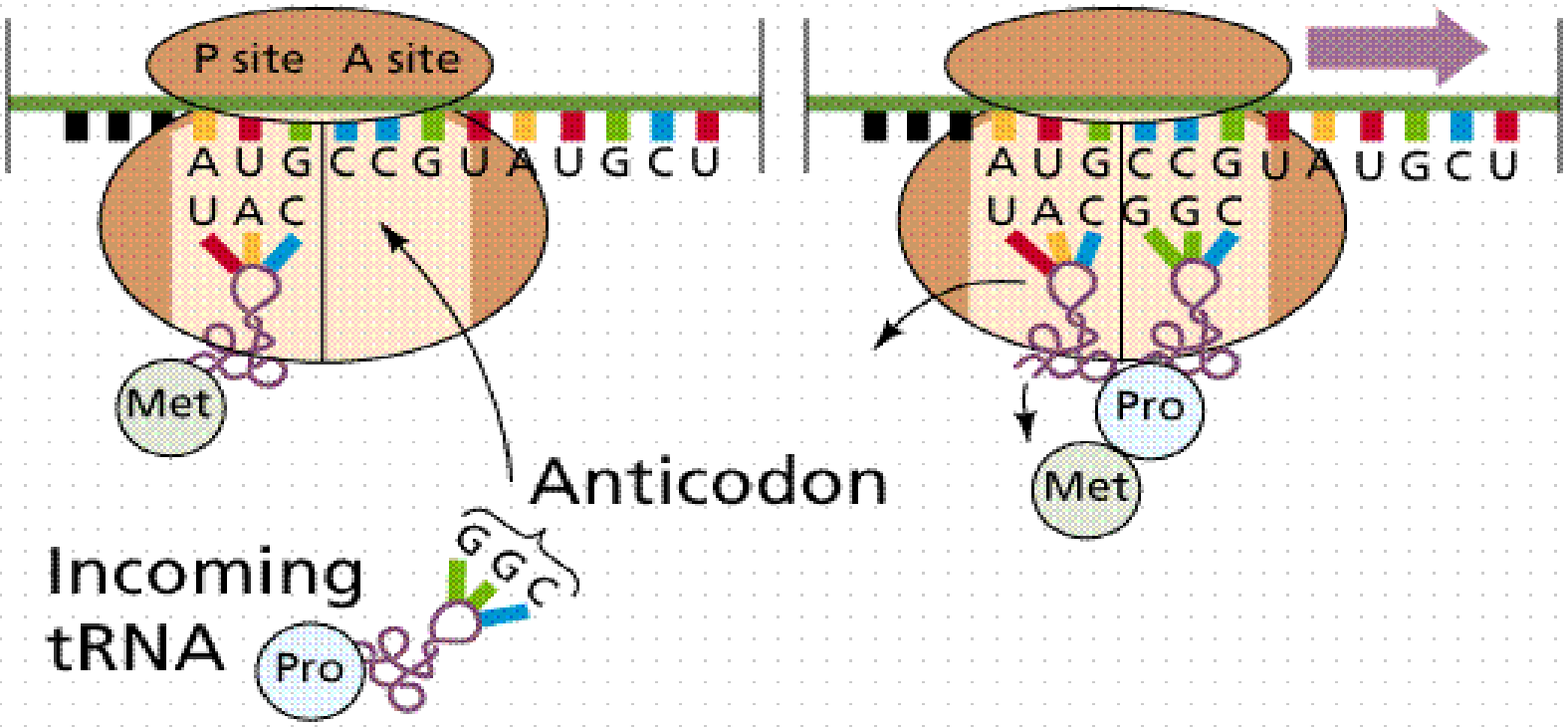


Translation. mRNA used to make polypeptide chain (protein)



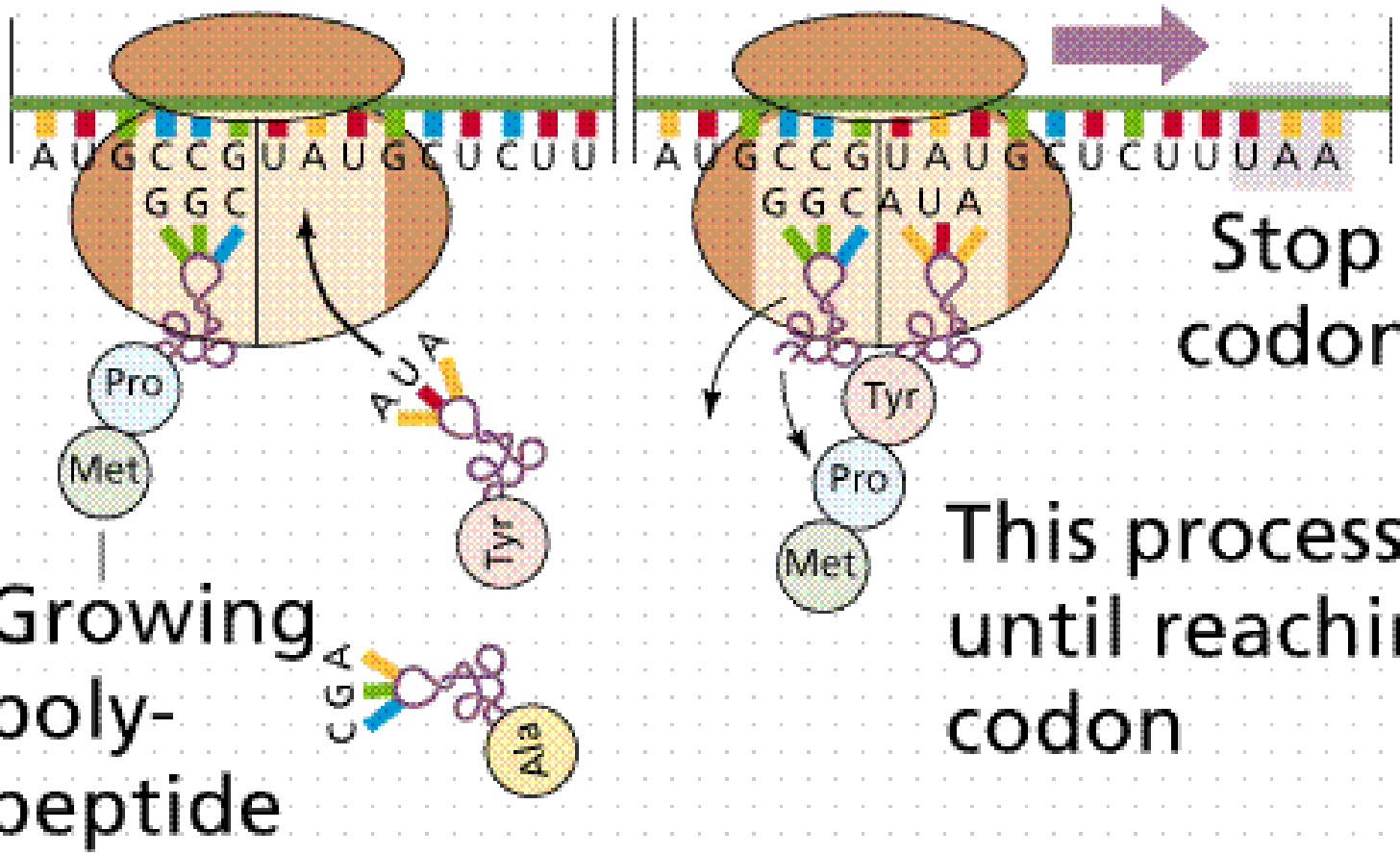
1.

Elongation (translation)



- First the mRNA attaches itself to a ribosome (to the small subunit).
- Six bases of the mRNA are exposed.
- A complementary tRNA molecule with its attached amino acid (methionine) base pairs via its anticodon UAC with the AUG on the mRNA in the first position P.
- Another tRNA base pairs with the other three mRNA bases in the ribosome at position A.
- The enzyme peptidyl transferase forms a peptide bond between the two amino acids.
- The first tRNA (without its amino acid) leaves the ribosome.

Elongation continues



Growing poly-peptide

This process repeats until reaching a stop codon

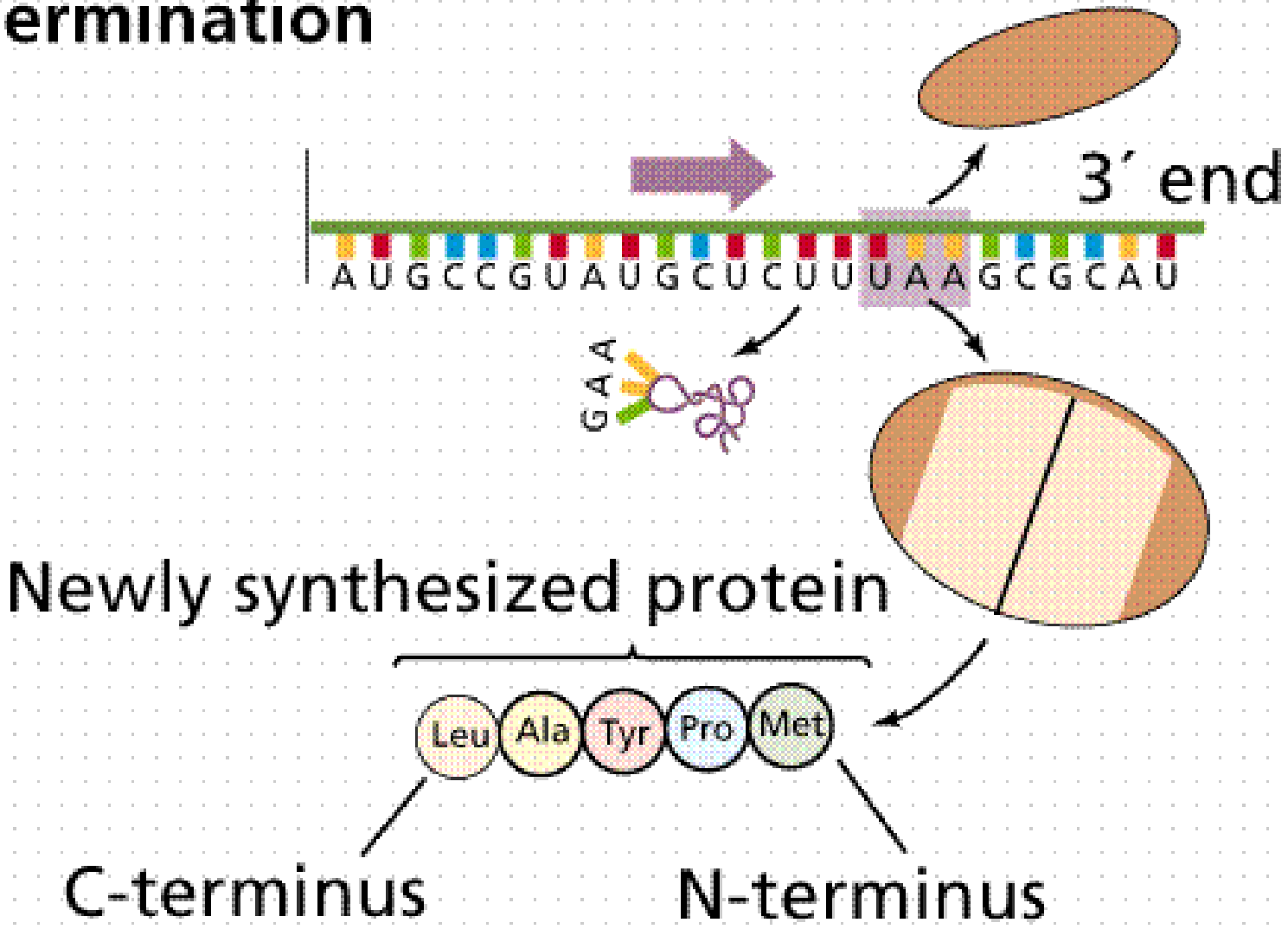
The ribosome moves along the mRNA to the next codon (three bases).

The second tRNA molecule moves into position P.

Another tRNA molecule pairs with the mRNA in position A bringing its amino acid.

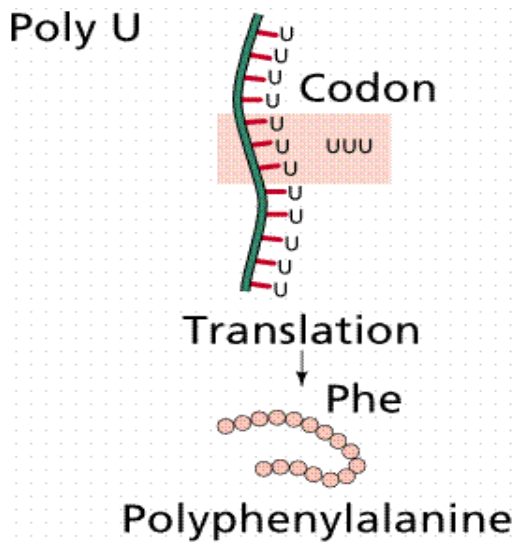
A growing polypeptide is formed in this way until a stop codon is reached.

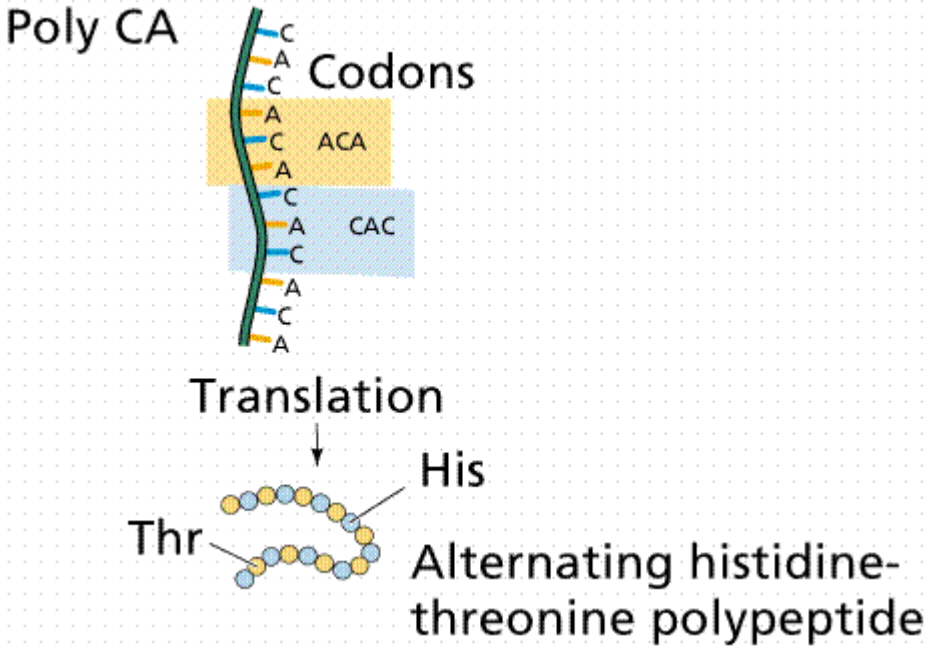
Termination



A stop codon on the mRNA is reached and this signals the ribosome to leave the mRNA. A newly synthesised protein is now complete!

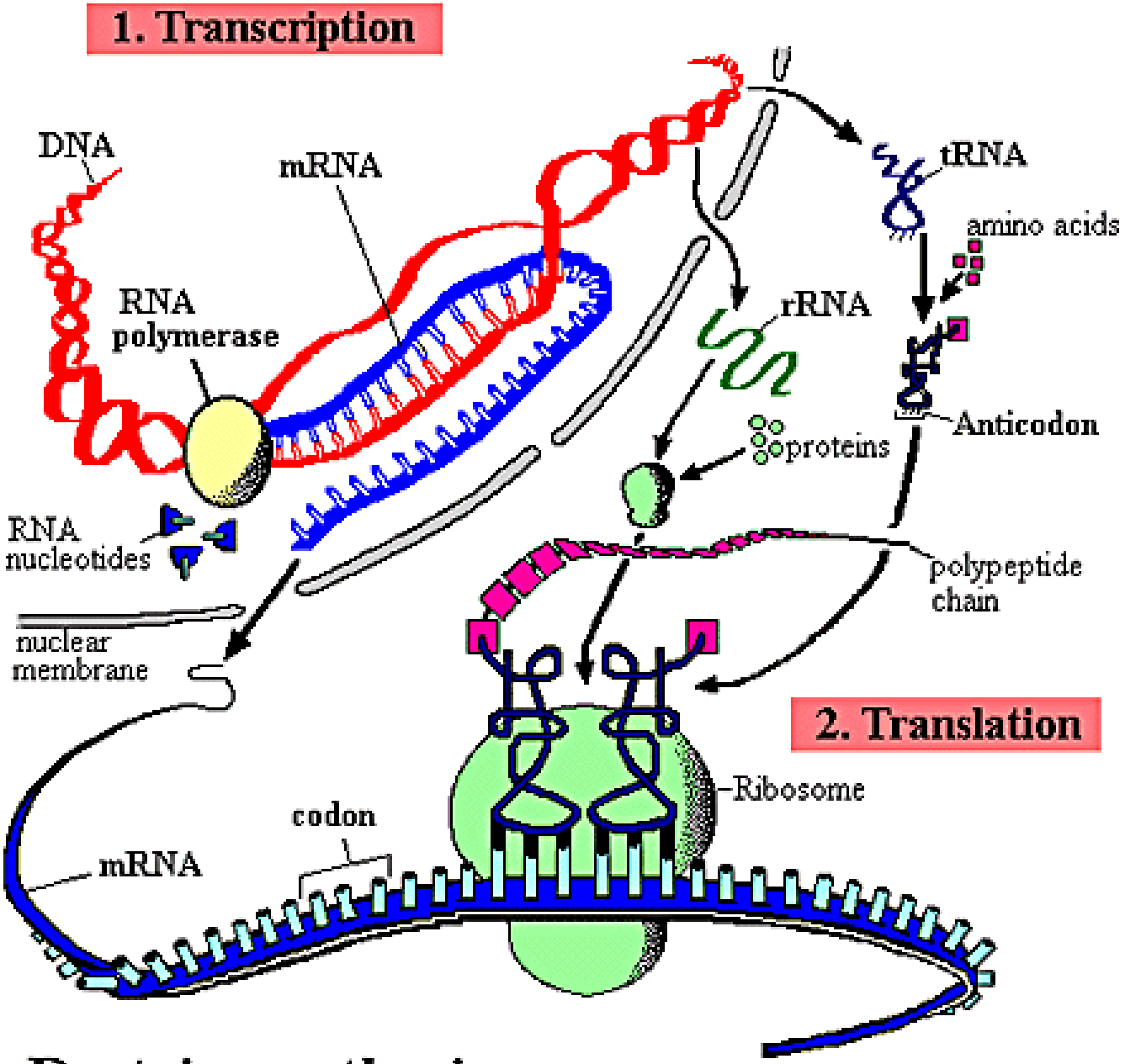
Translation
mRNA to Polypeptide





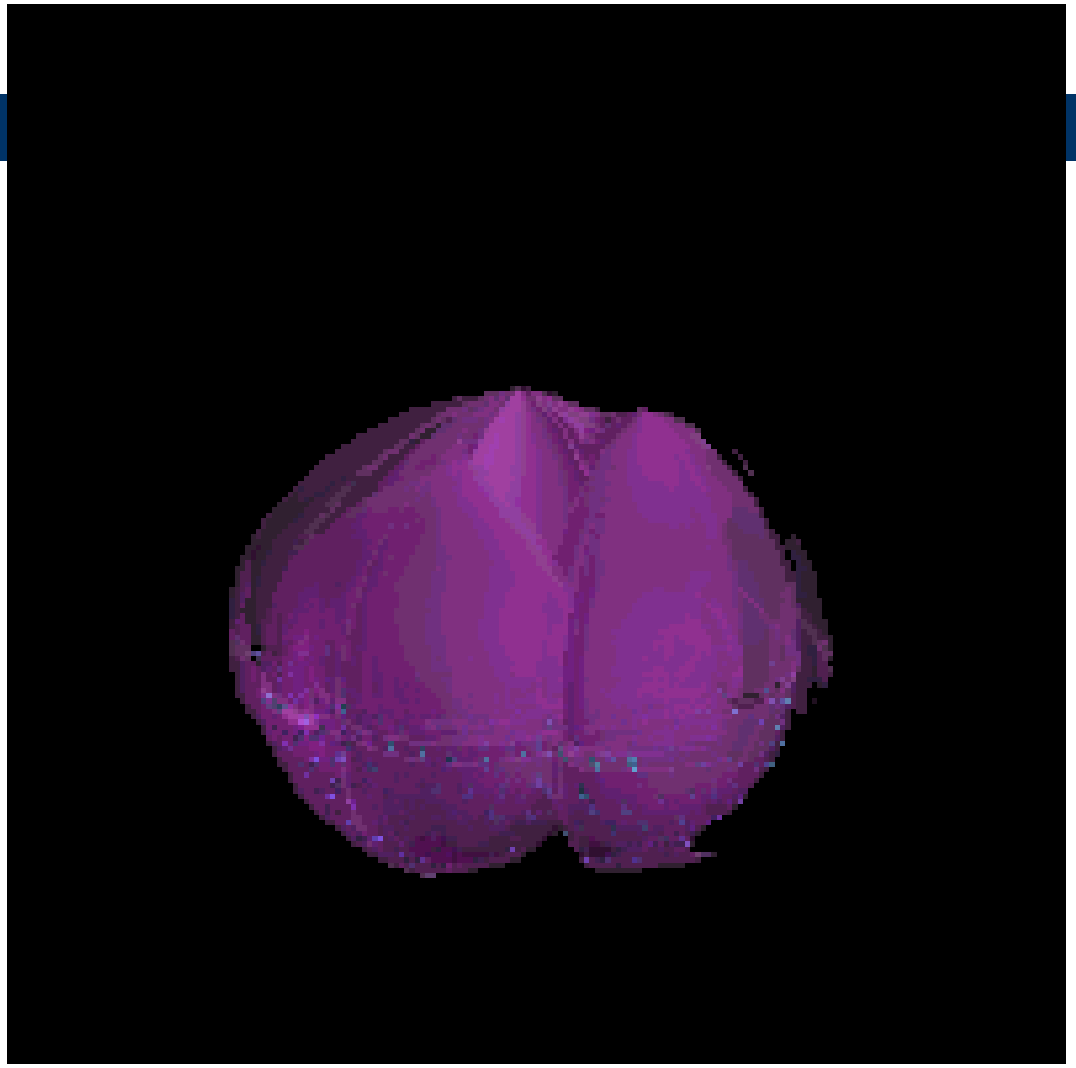
Second letter

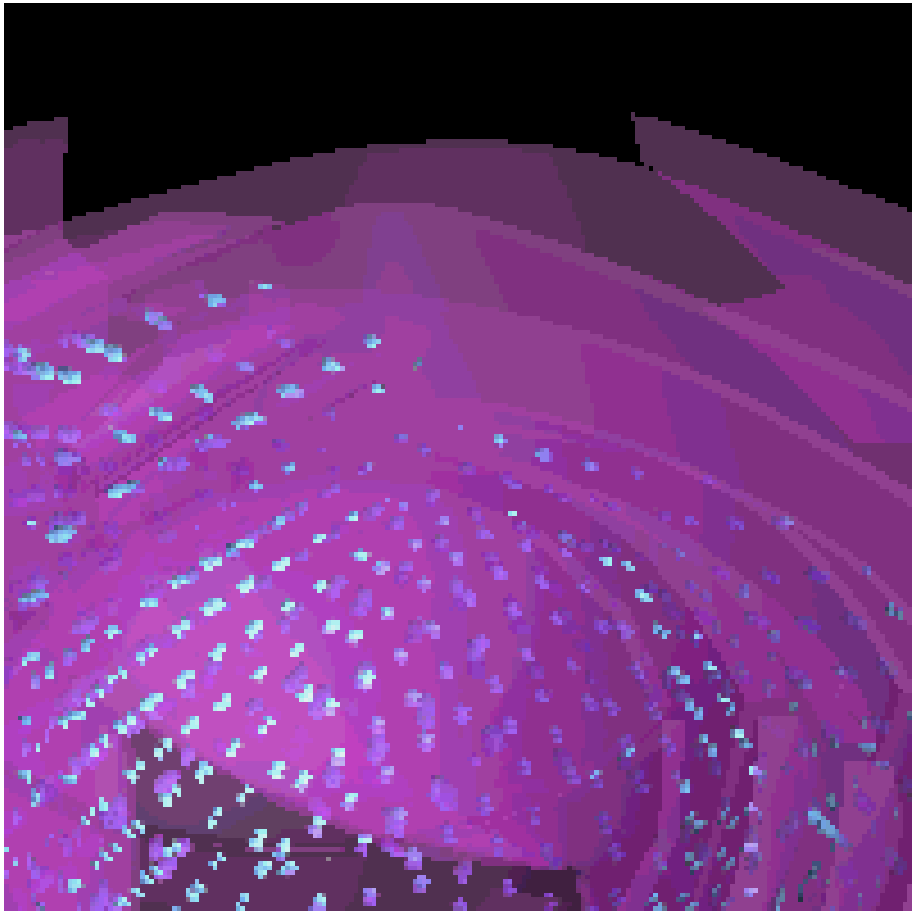
First letter	U	C	A	G	
U	UUU UUC Phenyl-alanine UUA UUG Leucine	UCU UCC UCA UCG Serine	UAU UAC Tyrosine UAA Stop codon UAG Stop codon	UGU UGC Cysteine UGA Stop codon UGG Tryptophan	U C A G
C	CUU CUC CUA CUG Leucine	CCU CCC CCA CCG Proline	CAU CAC Histidine CAA CAG Glutamine	CGU CGC CGA CGG Arginine	U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



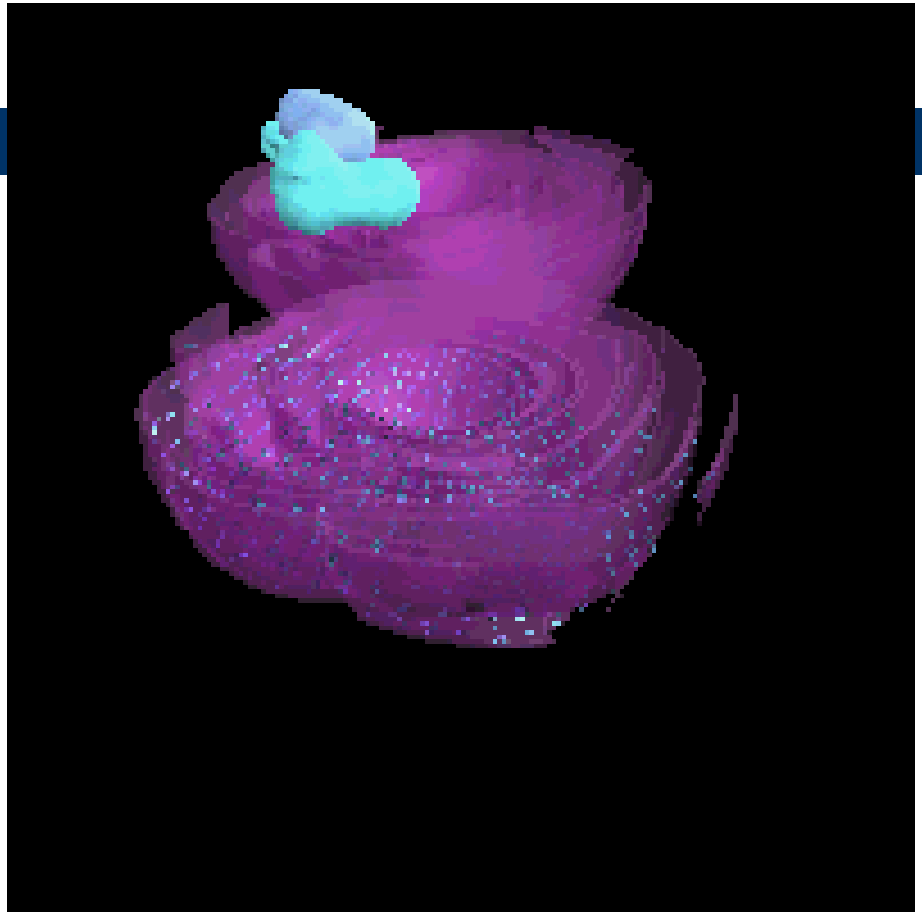
Protein synthesis

Rough endoplasmic reticulum

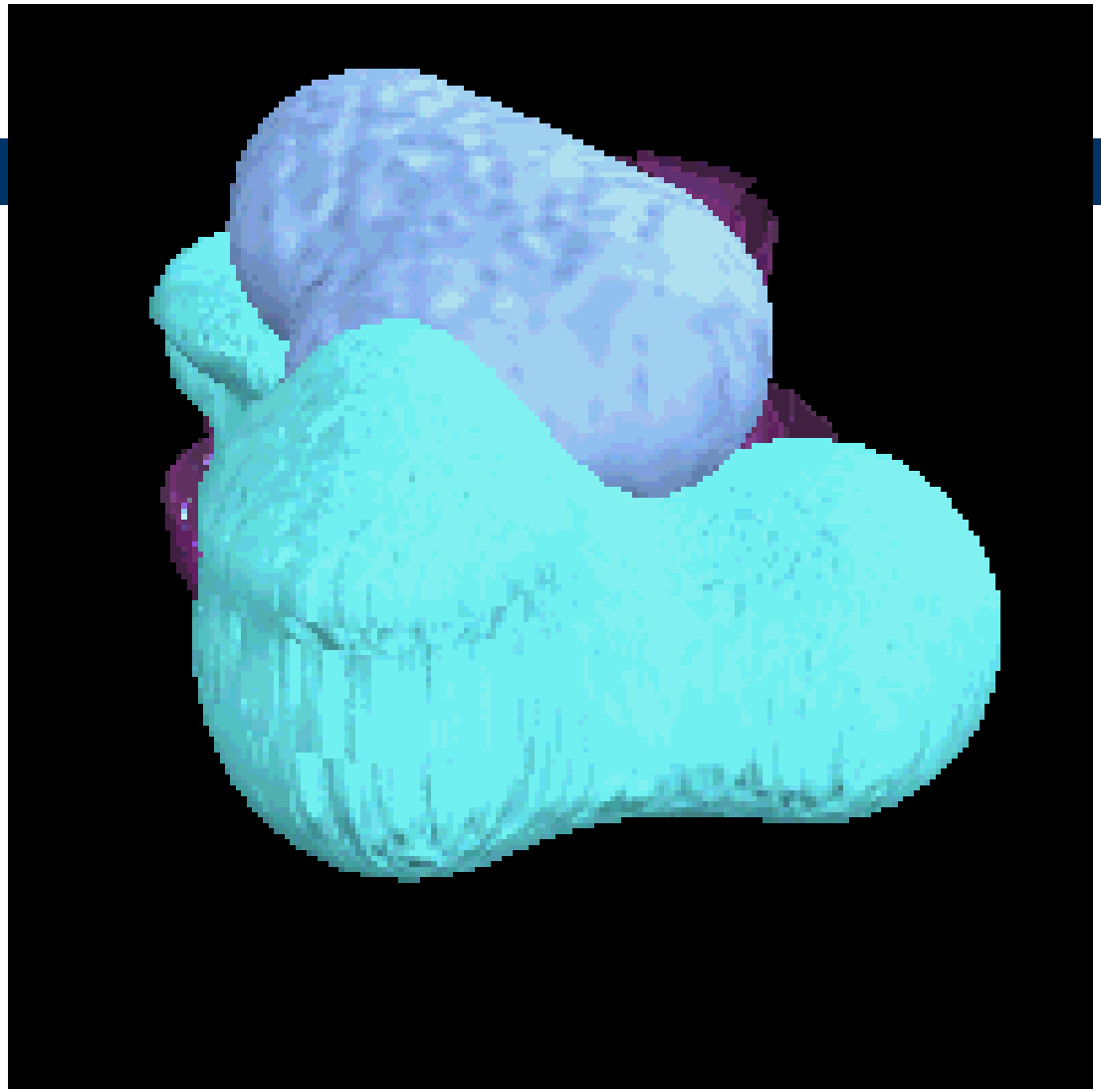




One ribosome from the RER



A ribosome



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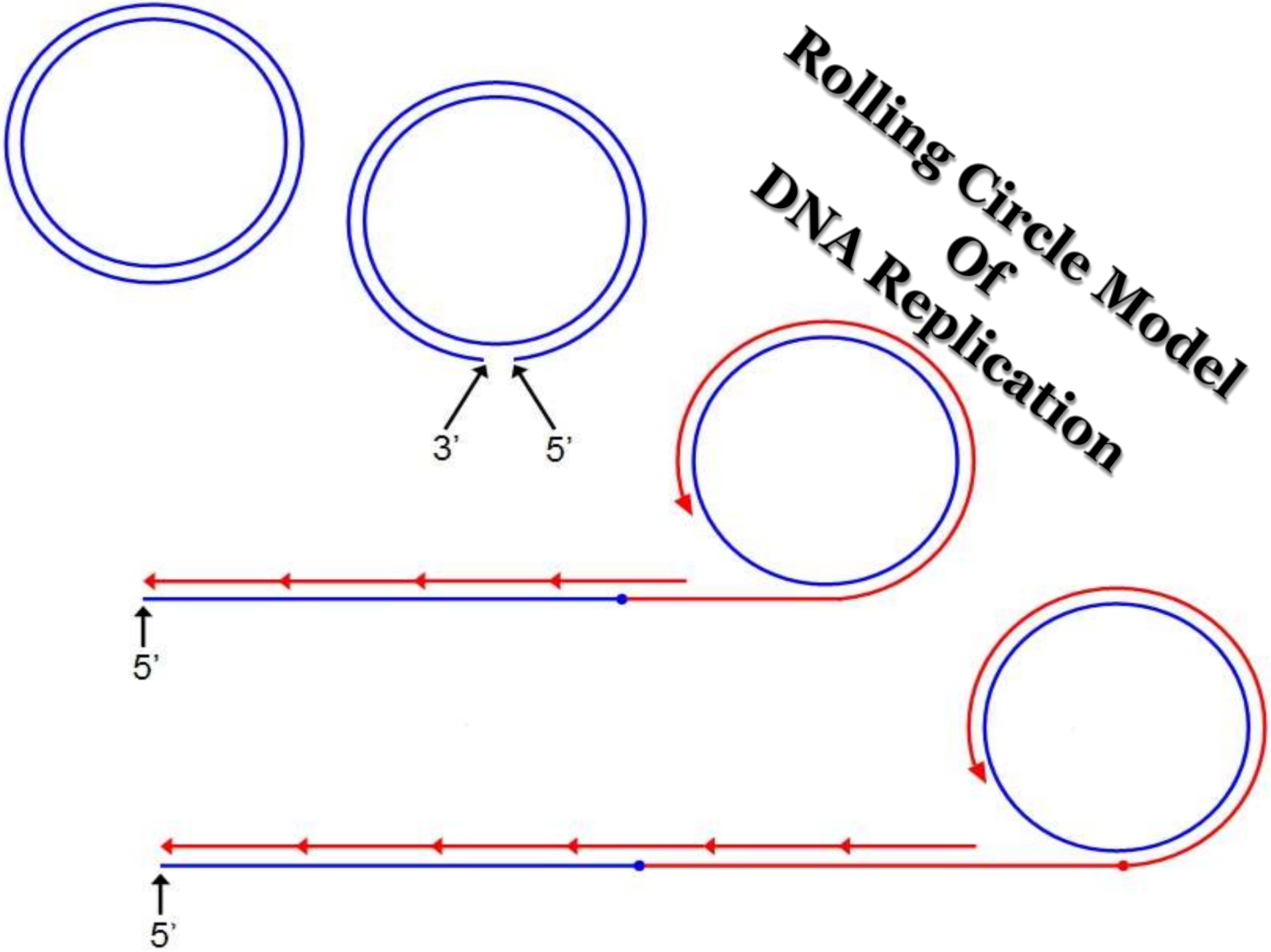
Rolling Circle Model Of DNA Replication



DNA Replication
A general Account

A process of producing two identical copies from one original DNA molecule

Three basic steps:

i) Initiation

ii) Elongation

iii) Termination

i) Initiation:

During initiation, some enzymes like helicase, cut the hydrogen bonds or produce the nick in the strands of DNA to make it available for the enzymes to carry out further process of replication. Single strand binding proteins restrict the rebinding of hydrogen bonds. Enzymes & proteins reach to the nick; make the complex and replication starts.

Real difference is present at the step of elongation.

ii) Elongation:

Polymerase proceeds on the DNA and formation or elongation starts.

In Eukaryotes, the DNA is much larger so the replication forms a linear structure often. But in some **Prokaryotes,** specially in bacteria who possess the plasmid, a unique type of replication occurs known as **"Rolling circle Replication".**

Rolling Circle Model of DNA Replication

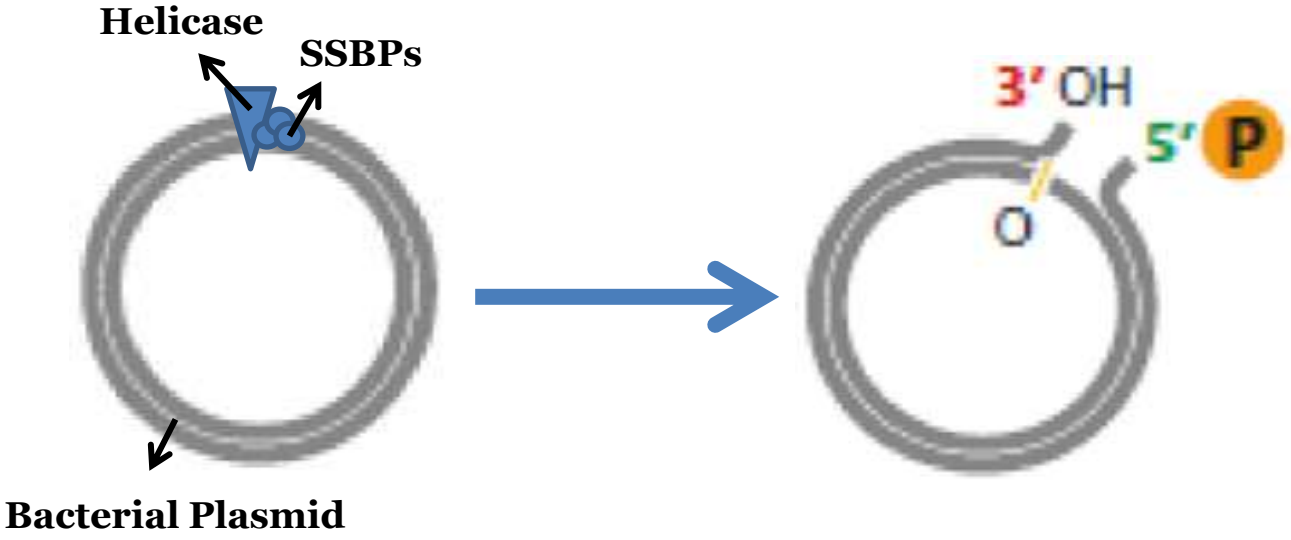
- Replication in eukaryotes is bidirectional, this type is **unidirectional.**
- Ideal example of this type is the circular plasmid of bacteria, as it happens only in circular genomes.

Initiation

- **Initiates**

  - phosphate ends, by the action of:

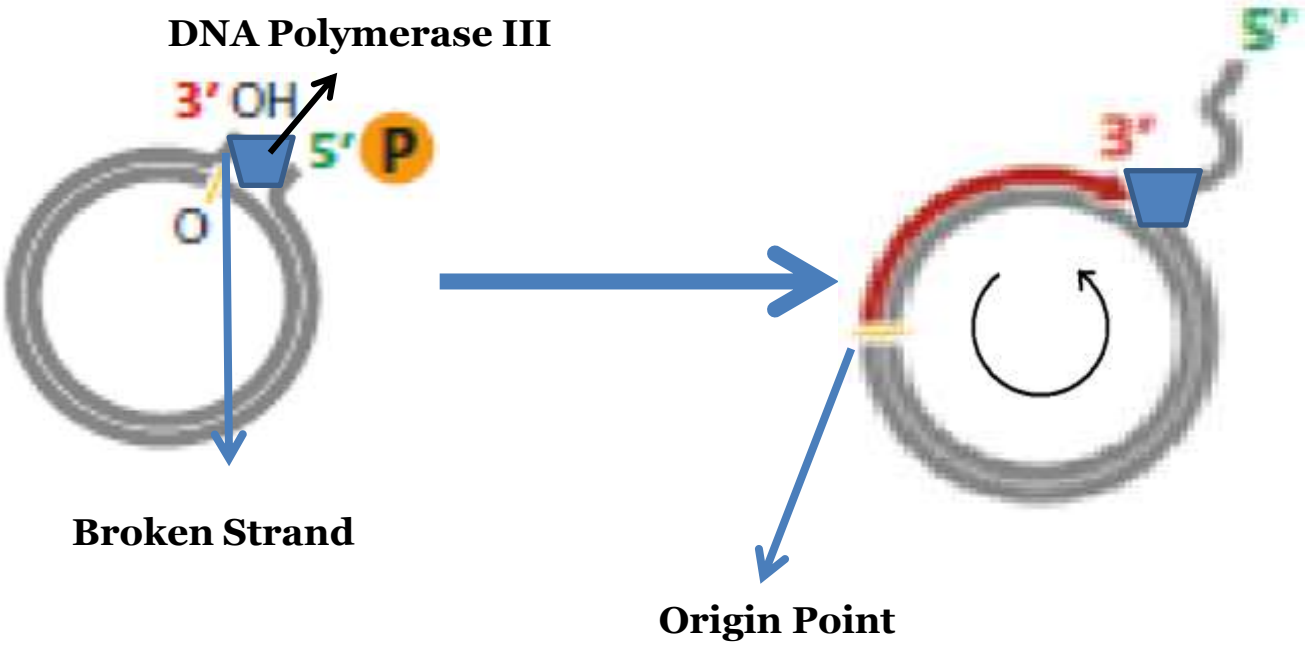
  a) Helicase
  b) Topoisomerases
  c) Single stranded binding proteins (SSBPs).



Elongation

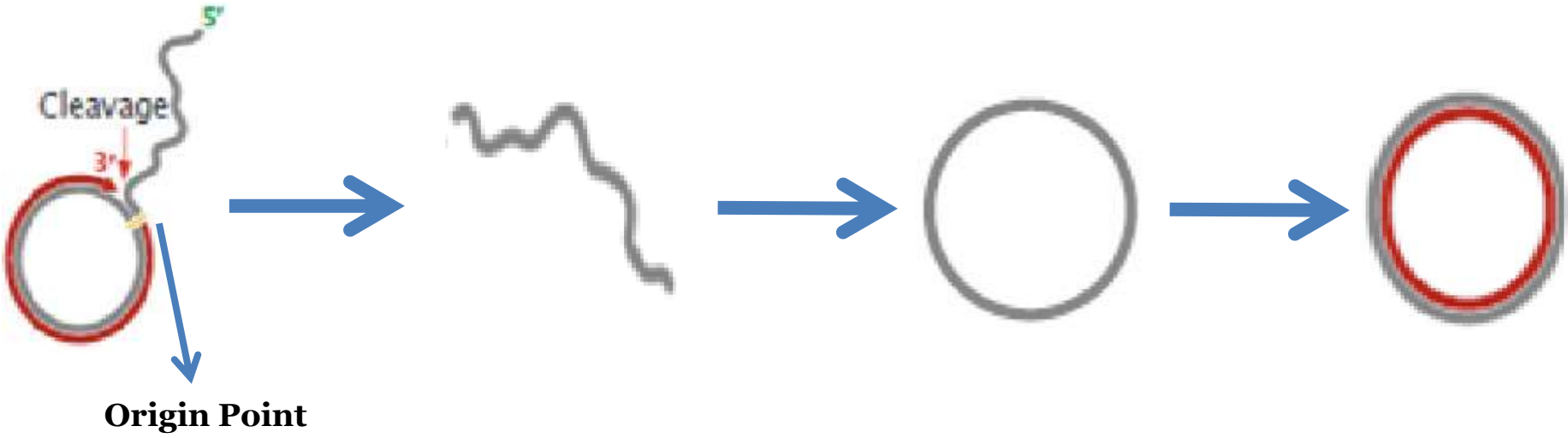
- For **Elongation,** -OH group of broken strand, using the unbroken strand as a template. The polymerase will start to move in a circle for elongation, due to which it is named as **Rolling circle model**

  end will be displaced and will grow out like a waving thread.

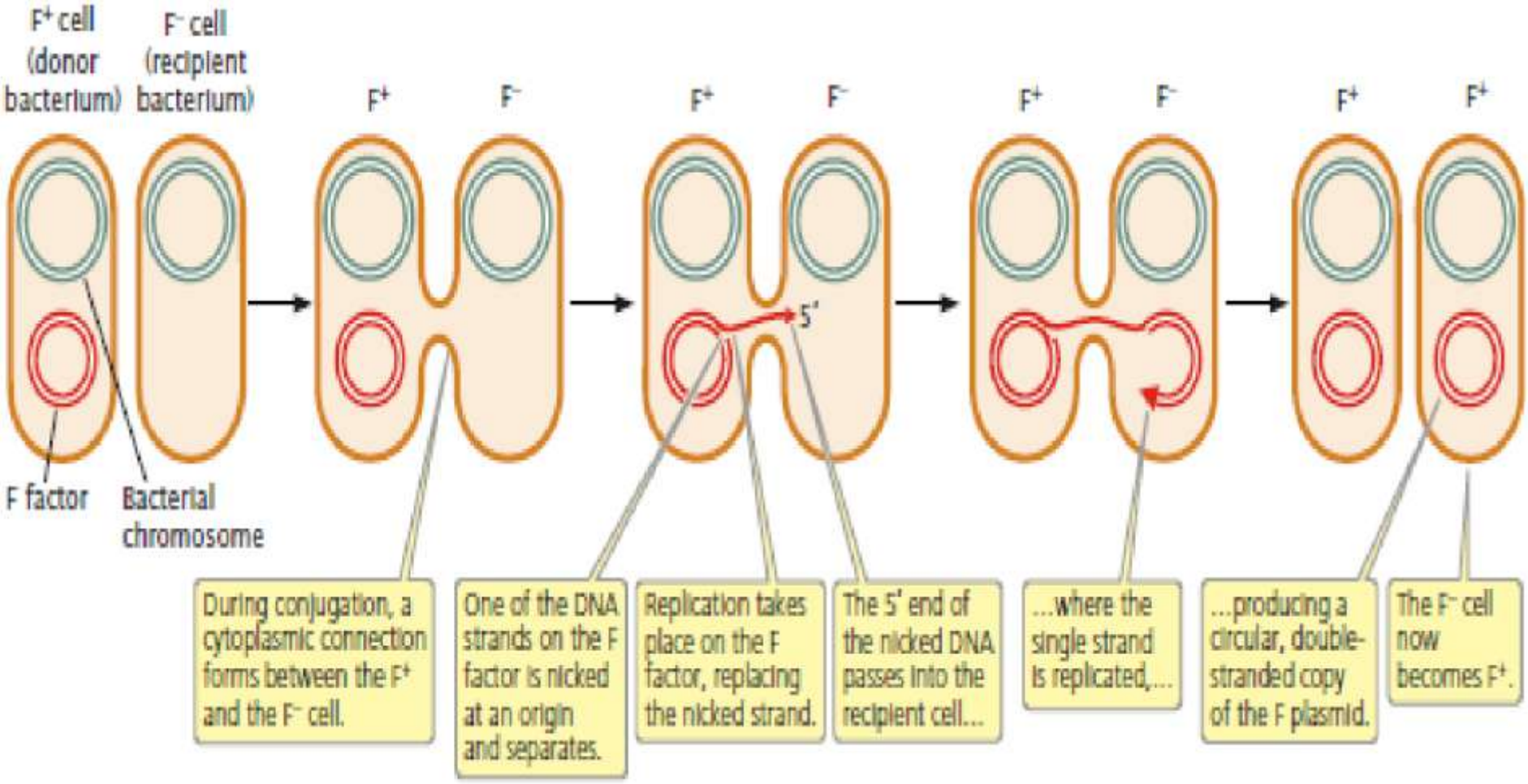


Termination

- At the point of termination, the linear DNA molecule is cleaved from the circle, resulting in a double stranded circular DNA molecule and a single-stranded linear DNA molecule.
- The linear single stranded molecule is circularized by the action of ligase and then replication to double stranded circular plasmid molecule.

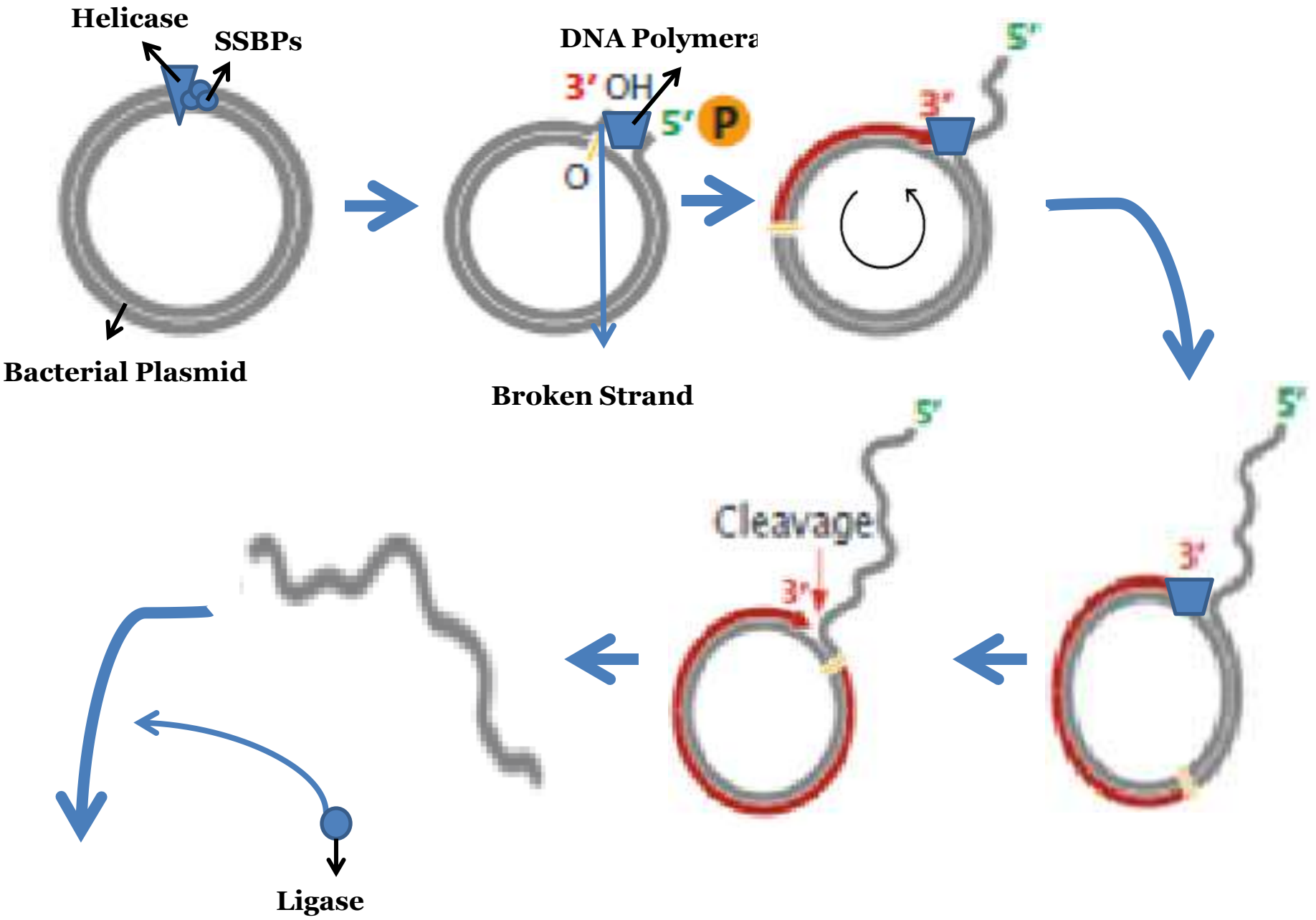


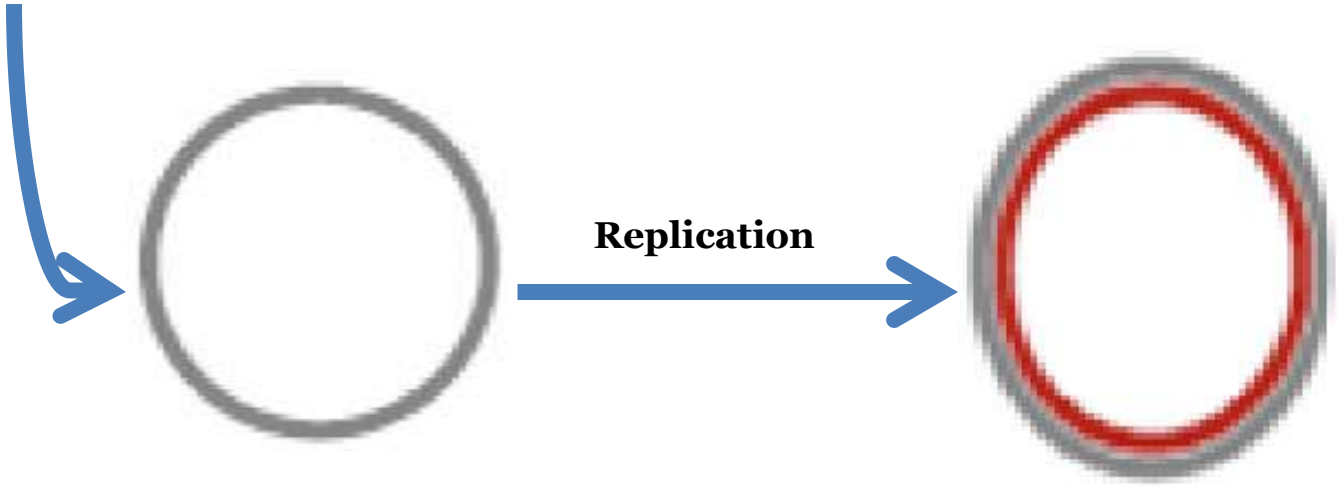
A brilliant Example of Rolling Circle Model: The conjugation between F+ and F- Bacteria



The F factor is transferred during conjugation between an F+ and F− cell.

Schematic Diagram of Rolling Circle Model of DNA Replication


Helicase
SSBPs
Bacterial Plasmid
DNA Polymera
3′ OH
5′
P
O
Broken Strand
5′
3′
5′
3′
Cleavage
3′
5′
3′
Ligase


Replication

Questions & Answers

Thank you for listening