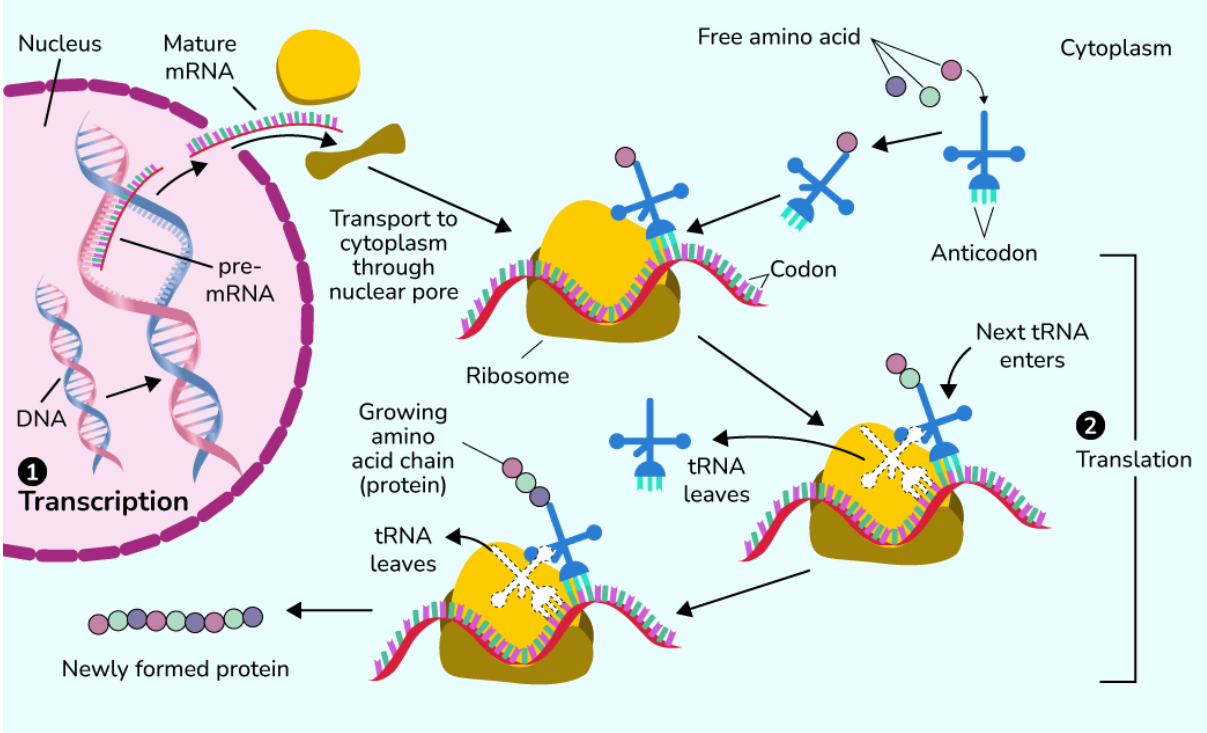
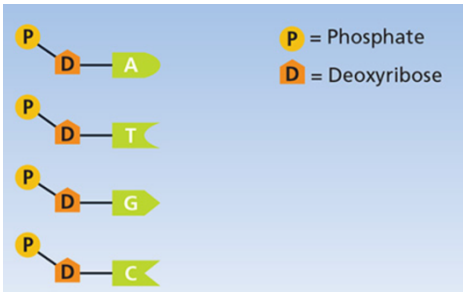
Topic Notes

DNA, RNA & Protein Synthesis



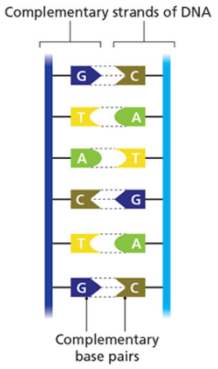
3 Main Structures of DNA



1. **Nucleotides**
   Nucleotides consist of 3 parts;
   1) Phosphate
   2) Sugar (Deoxyribose)
   3) Nitrogen Base

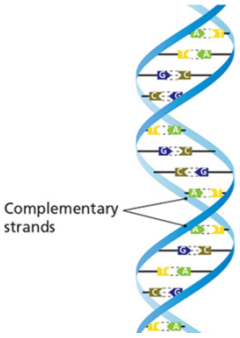
2. **Base Pairs**
   4 Base Pairs of
   1) Adenine
   2) Thymine
   3) Cytosine
   4) Guanine

   Apples in Trees
   Cars in the Garage



3. **Double Helix**
   Outer parts of the double helix are made up of the phosphate and deoxyribose

   Inner parts (or rungs of the ladder) made up of the base pairs



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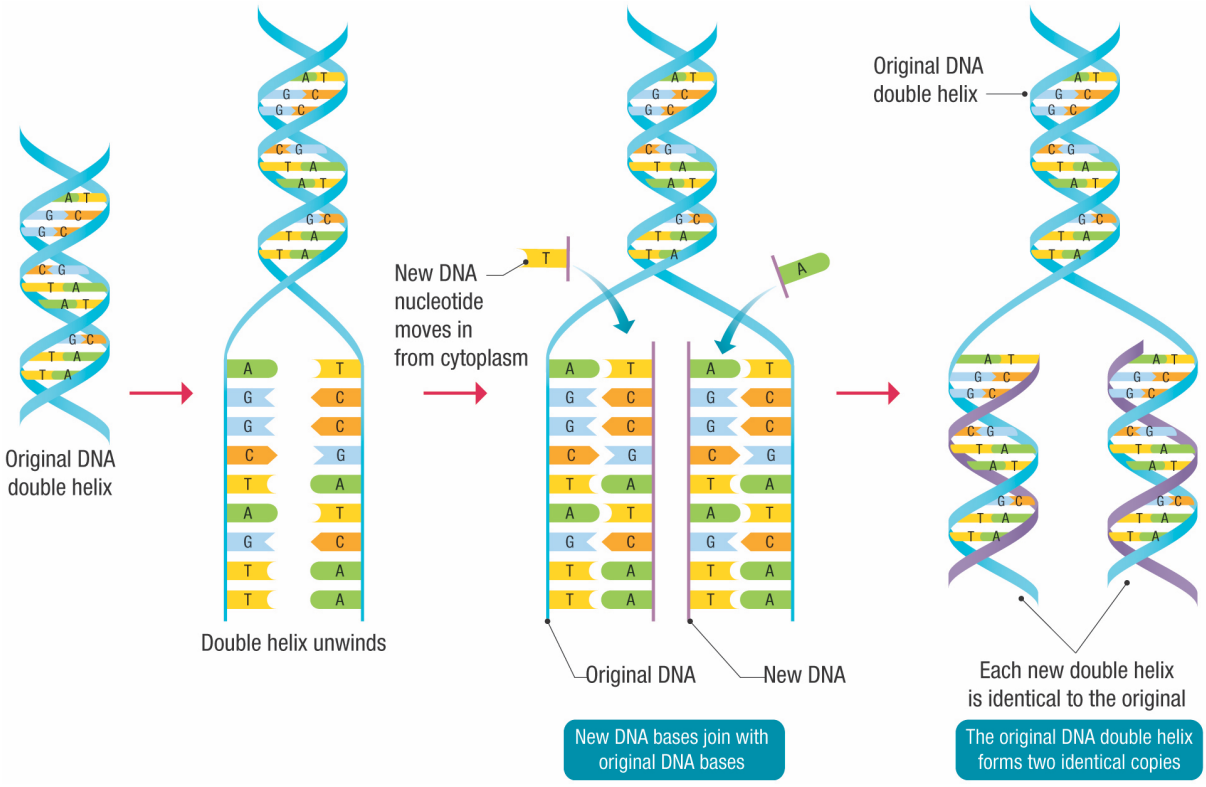
DNA Replication

- Enzymes unwind the double helix and 'unzip' the two strands of DNA. (DNA Helicase)
- The exposed bases pair with their complementary base pairs from a pool of free nucleotides.
- Two identical strands of DNA are produced from the original strand.
- Each now twists to form a helix.
- One side of each new DNA molecule comes from the original and one is new.
- The genes on each chromosome are the same.



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2024 (Deferred) Q4

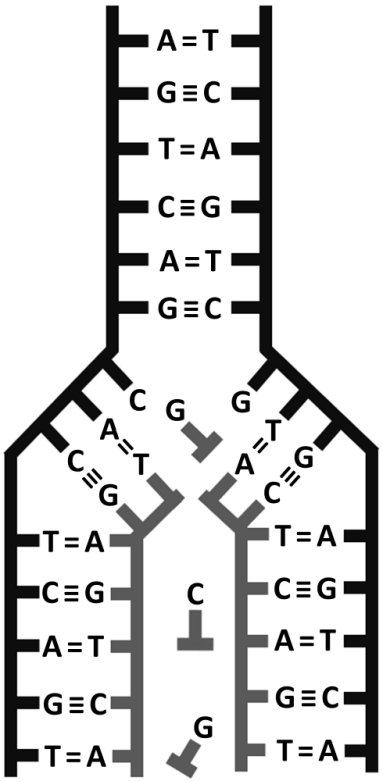
4. The diagram shows a piece of DNA undergoing replication.

(a) What name is given to the shape of a DNA molecule?

(b) Most DNA in a eukaryotic cell is found in the nucleus.
Name another cell organelle in which DNA is found.

(c) DNA is composed of nucleotides with purine and pyrimidine nitrogenous bases.
Name the **two** purine nitrogenous bases present in DNA.

1.
2.



(d) The nitrogenous bases are paired together as complementary base pairs.
Explain how complementary base pairs are held together.

(e) DNA replication is an important biological process.
Briefly describe **two** events shown in the diagram above that show this piece of DNA is undergoing replication.

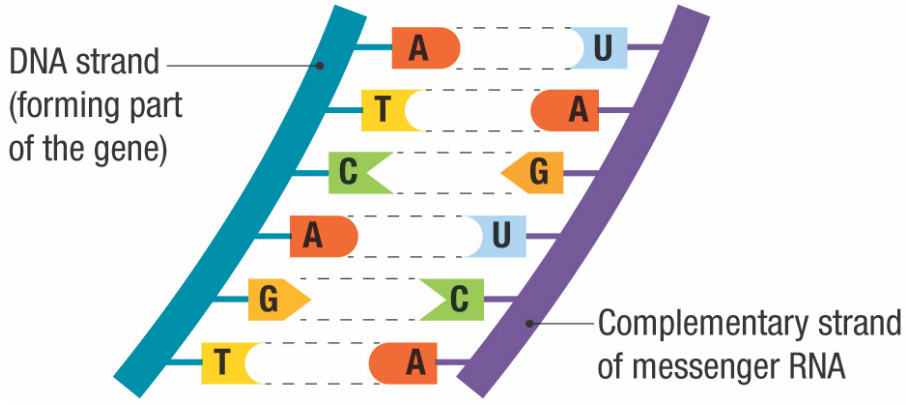
DNA Replication vs Protein Synthesis

- Protein synthesis has to use mRNA to transcribe the DNA and move it out of the nucleus
- Once it has moved it out of the nucleus to a ribosome, the mRNA can then be translated into a protein

RNA vs DNA

RNA is similar to DNA, but it differs in the following ways;

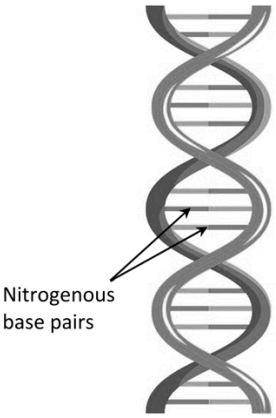
- RNA has the base uracil (U) instead of thymine.
- RNA contains the sugar ribose instead of deoxyribose.
- RNA is a single strand.
- RNA is found in the nucleus, cytoplasm and ribosomes.



Type of RNA	Where it functions	Functions
mRNA	Produced in nucleus Used at ribosome to make protein	Copy of the genetic message Used as a template to make protein
rRNA	A component of the ribosome	'Reads' the message on the mRNA Used to attach tRNA to the mRNA
tRNA	It attaches to mRNA at the ribosome	Places amino acids in the correct sequence to make a protein

Protein Synthesis (Short Q's) -

6. The diagram represents a part of a DNA molecule.
Complete the following in relation to DNA.



(a) How many strands make up a DNA molecule?

(b) Name any **two** nitrogenous bases found in DNA.

1.

2.

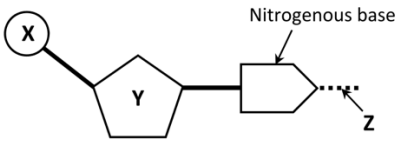
(c) Three bases together are known as a .....

(d) Where in the human cell would you expect to find most DNA?

(e) DNA contains the instructions needed to make protein. This is called the ..... code.

(f) Name a complementary structure to DNA that is involved in protein synthesis.

5. The diagram represents a single nucleotide of a DNA molecule.



(a) Name the parts of the molecule labelled **X** and **Y**.

X:

Y:

(b) State the type of bonding (shown by **Z**) that holds complementary bases together in a DNA molecule.

(c) A short part of one strand of a DNA molecule has the sequence shown in the table below. During transcription, mRNA is made using the code in DNA.
Complete the table to show the complementary mRNA base code.

DNA	**A**	**T**	**G**	**C**	**G**	**A**
mRNA						

(d) An analysis of a different DNA molecule showed it contained 20% thymine (T).
What percentage of the DNA molecule would be guanine (G)?

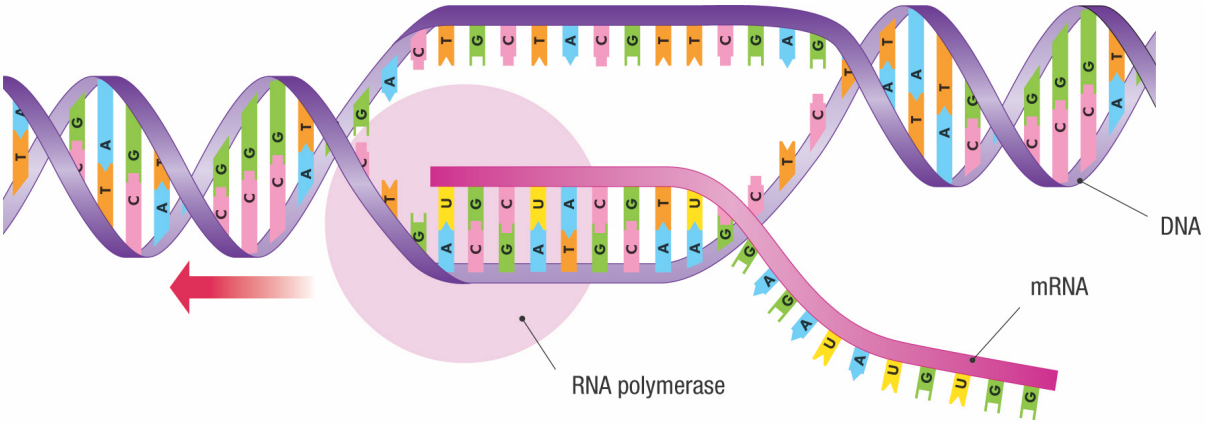
(e) How many nitrogenous bases are in a codon?

(f) Name a base that is a purine.

Protein Synthesis (Part 1) - Transcription

- https://www.youtube.com/watch?v=oefAI2x2CQM&t=8s

- The process is initiated as DNA is 'unzipped' by the RNA Polymerase and one side of the DNA is used as a template to make a complementary copy of mRNA.
- The mRNA has uracil instead of thymine.
- The order of bases in the mRNA is determined by the order of bases in the DNA molecule.
- The DNA code is transcribed onto the complimentary mRna strand. The process of producing mRNA is called transcription.
- The mRNA leave the nucleus, via the nuclear pores, and goes to a ribosome.



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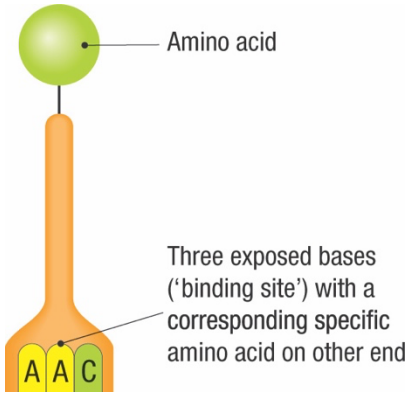
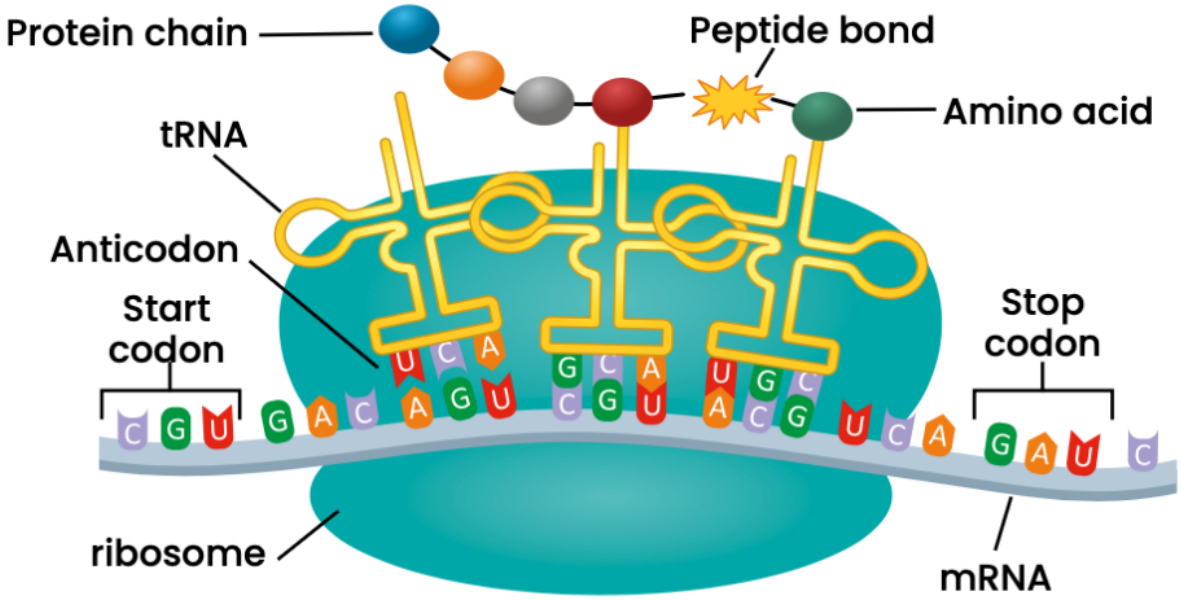
Protein Synthesis (Part 2) - Translation

- Ribosomes are made up of ribosomal RNA (rRNA).
- mRNA, from the nucleus, binds loosely to the rRNA.
- Transfer RNA (tRNA) in the cytoplasm has an amino acid at one end and three specific bases at the other. These bases are known as an anti-codon.
- Each tRNA anti-codon links up with its corresponding mRNA codon in the ribosome, bringing a specific amino acid with it.
- Two tRNA molecules bind to the mRNA at a time. This attaches the amino acids together in the correct sequence, forming a protein.





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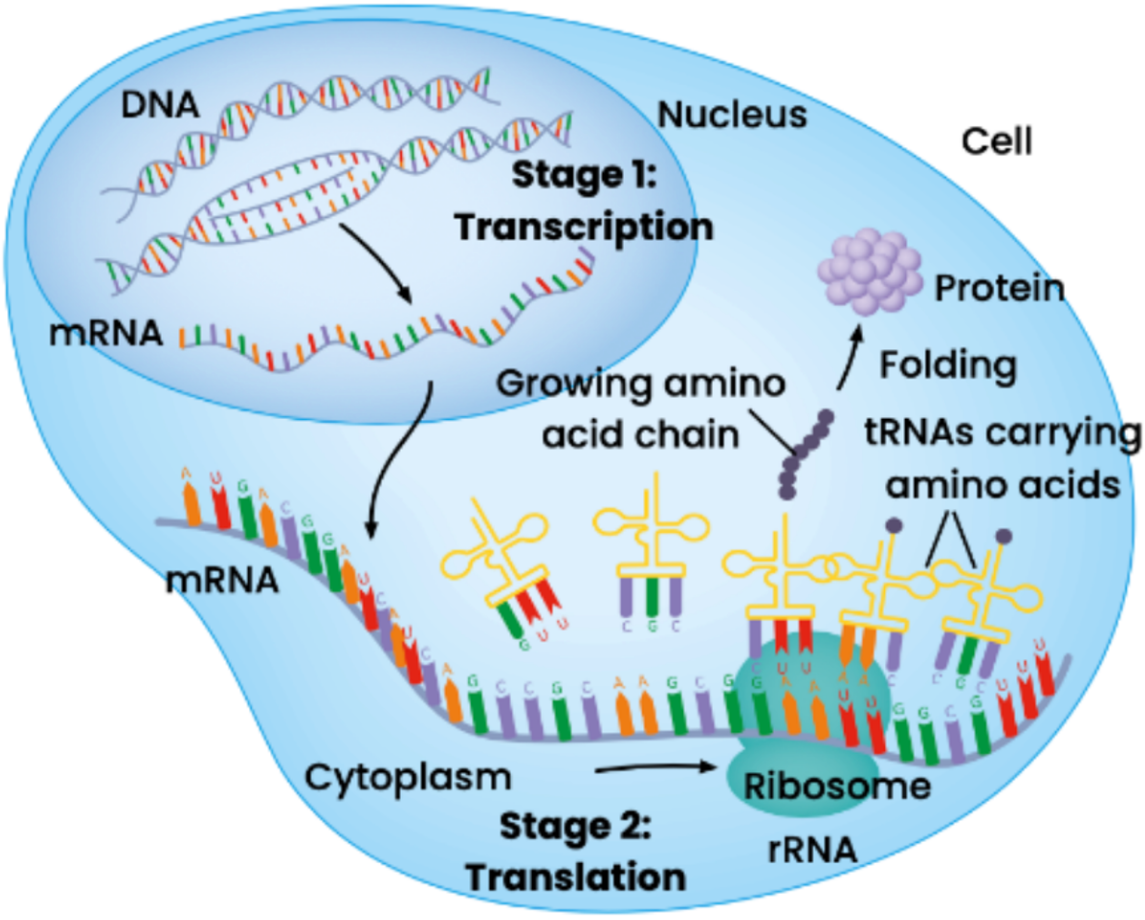
Protein Synthesis Overview



From DNA to Protein

- https://www.youtube.com/watch?v=gG7uCskUOrA

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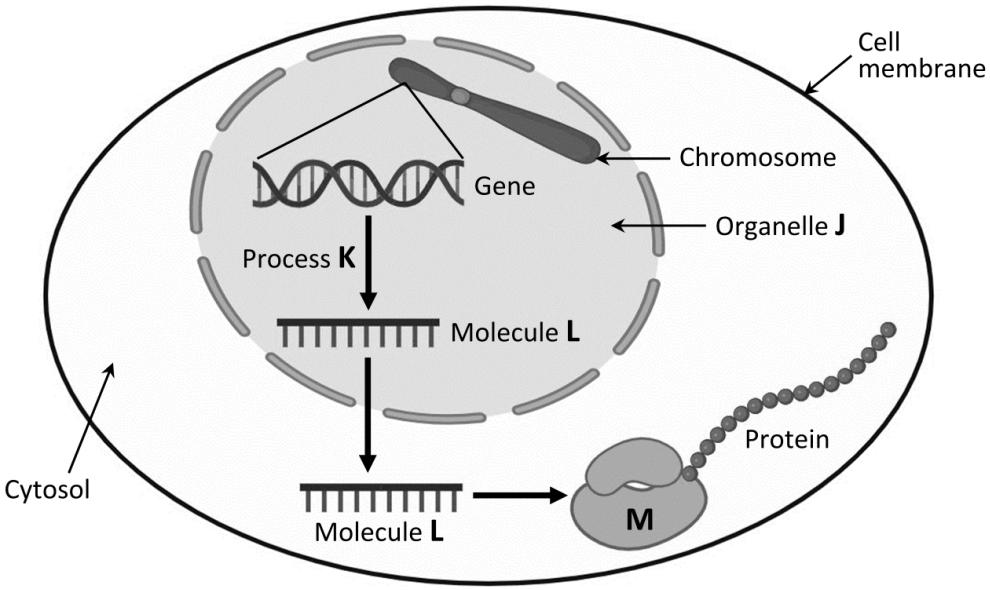
Long Question – 2022 Section C

13. (a) Nucleic acids are composed of subunits called nucleotides.
Draw **and** label the structure of any **one** nucleotide. **(9)**

(b) The diagram illustrates some of the events of protein synthesis.



(i) What is the name of process **K** that results in the formation of molecule **L**?
(ii) Name molecule **L**.
(iii) Part of the sequence of nitrogenous bases in the gene is as follows:

Base sequence: **A C G T G C T G A**

Using this sequence, write out in order the complementary sequence of bases found in molecule **L**.
(iv) Give the name of the opening through which molecule **L** leaves organelle **J**.
(v) Molecule **L** arrives at structure **M** in the cytosol as shown.
1. Identify structure **M**.
2. Name the main molecule from which structure **M** is made.
(vi) Describe the events that occur at structure **M**, which allow the production of a functioning protein. **(27)**

Long Question – 2019 Section C

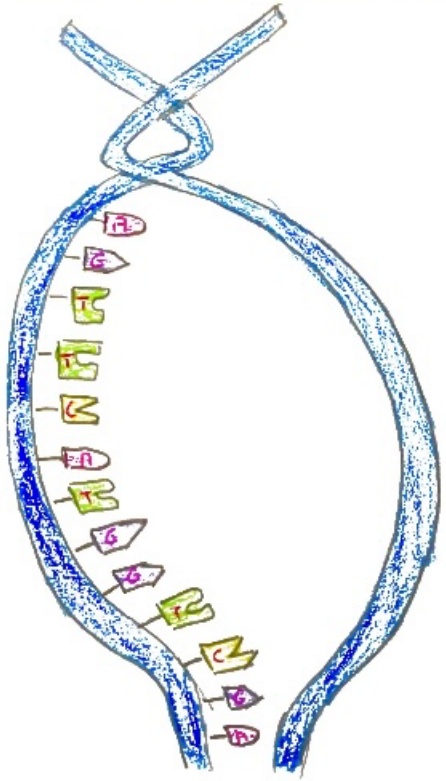
11. (a) (i) Name the sugar present in DNA.
(ii) Other than the sugar, give two structural differences between DNA and RNA.
(9)

(b) Protein synthesis is a complex process, involving both transcription and translation, that occurs in all cells.
(i) Where does transcription occur in animal and plant cells?
(ii) Where precisely in the cell does translation occur?
(iii) Name the **three** types of RNA involved in protein synthesis.
(iv) Describe the events that occur during translation, leading to the formation of a functional protein.
(27)

PROTEIN SYNTHESIS

INITIATION: STARTING PROCESS

1. THE DNA DOUBLE HELIX UNWINDS AT THE SITE OF THE GENE THAT IS GOING TO PRODUCE THE PROTEIN.



TRANSCRIPTION: REWRITING CODE FROM DNA TO RNA

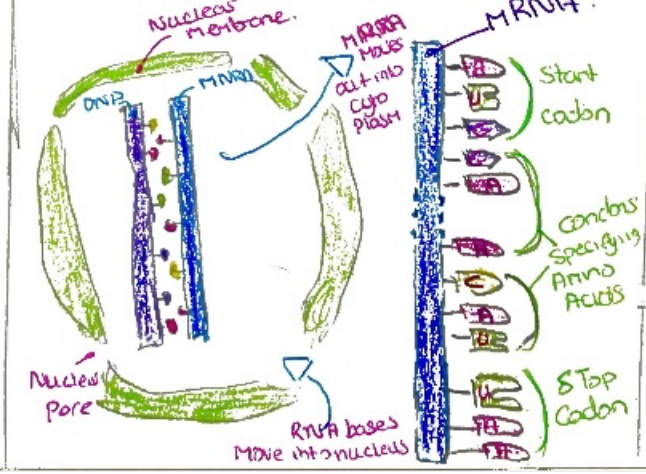
2. RNA bases from cytoplasm move across the nuclear membrane and match up with the complementary bases on the DNA Strand.

3. RNA Polymerase causes the sequence of RNA bases to join and form Messager RNA (MRNA)
   - Each MNRA has C-Bases on DNA Strand it was transcribed From.
   - A sequence of 3 DNA or RNA bases is called a triplet or codon.

START CODONS: Each gene only has one. It indicates the begining of gene. (Not involved in production of protein).

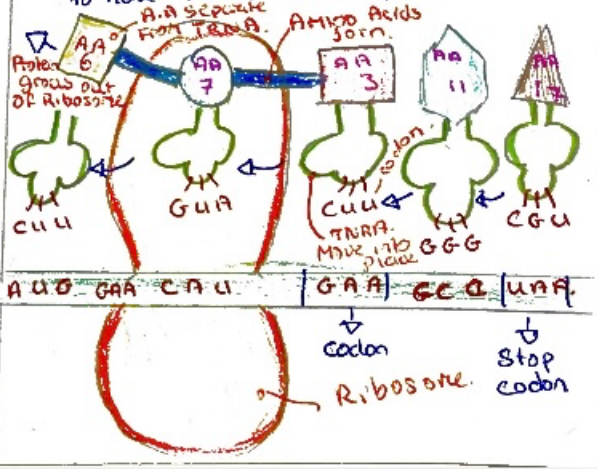
MOST CODONS: Specify the particular amino acid. Located inbetween start + end codon + there are many of them.

STOP CODONS: Each gene only has one. Indicates end of gene (Not involved in Protein production).



TRANSLATION: PRODUCTION OF PROTEIN ACCORDING TO RNA CODE.

5. MRNA moves from nucleus to cytoplasm.
6. Ribosomes are made up of ribosomal RNA + Protens.
7. MRNA forms weak bond with tRNA in ribosome (Site of protein synthesis).
8. TRNA Molecules in cytoplasm carry a special anticodon + particular amino acid Specific to anticodon.
9. TRNA attract to MRNA in Ribosome. Each TRNA Anticodon complentary to codon on MRNA.
10. In the ribosome, amino acids are detached tRNA and bonded together to form a new protein.
11. tRNA Molecules leave Ribosome without any amino acids, pulling the MRNA through.
12. New protein produced and Folds Form to have the correct shape.



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