Transcription and Translation and the Genetic Code

CIE Biology Jones
pp 111-122

Videos
DNA to Protein 2.41 https://www.youtube.com/watch?v=gG7uCskJQrA
Professor Dave Explains 6.26m https://www.youtube.com/watch?v=bKIpDTddK8Q&t=293s

G11 Biology 2017-2018

Learning Objective:

1. Specifics of transcription and translation.
2. Explain the properties of the Genetic Code

Success Criteria

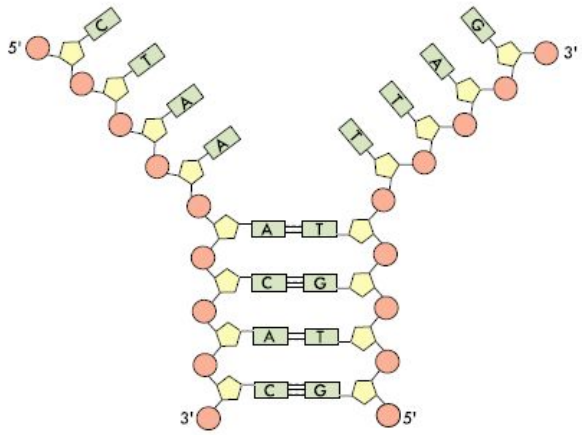
1. Define transcription and translation.
2. Describe how the triplet code and be transferred to a protein using at least four given terms.
3. Explain the properties of the genetic code.

Terminology

English	Google Russian ☺
Transcription	транскрипция
Translation	Перевод
Codon - triplet	Кодон - триплет
Anticodon – anti-triplet	Антикодон - антитриплет
Genetic code, codon chart	Генетический код, кодонная диаграмма
Messenger RNA (mRNA)	Мессина РНК (мРНК)
Ribosomal RNA (rRNA)	Рибосомная РНК (рРНК)
Transfer RNA (tRNA)	Передача РНК (тРНК)
Nuclear pore	Ядерная пора
Template (antisense)	Шаблон (антисмысловой)
5’ to 3’Sense, coding, non-template	5 'to 3'Sense, кодирование, не шаблон
3’ to 5’ Antisense, non-coding, template	3 'to 5' Антисмысловое, некодирующее, шаблонное
Degenerate, Degenerative – Redundant	Вырожденный, дегенеративный - избыточный
Deoxyribonucleic acid (DNA)	Дезоксирибонуклеиновая кислота (ДНК)
Ribonucleic acid (RNA)	Рибонуклеиновая кислота (РНК)
RNA polymerase	РНК-полимераза

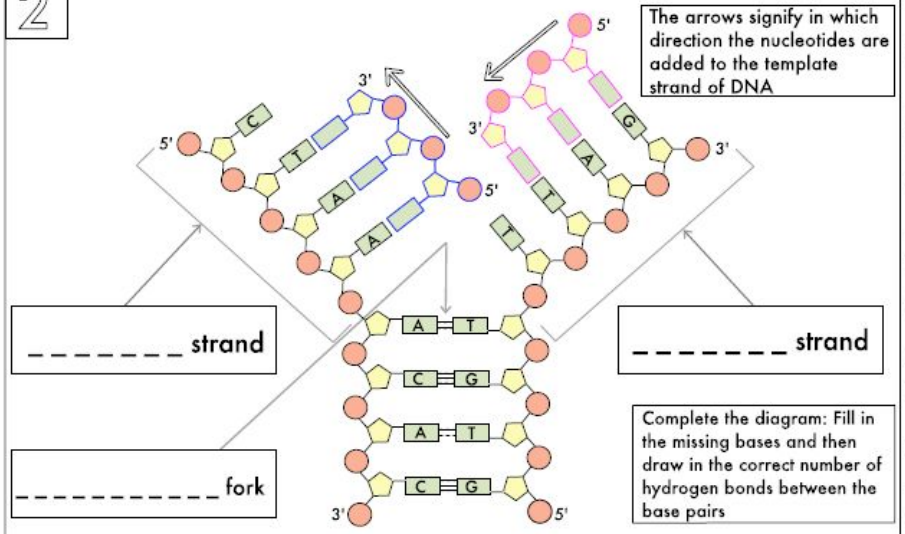
DNA Replication DNA □ DNA

1



Before replication of DNA can start, the molecule has to unwind from its _ _ _ _ _ _ _ shape, a section at a time. DNA _ _ _ _ _ _ is the enzyme responsible for this unwinding of the DNA molecule. Also, the two strands have to be separated. DNA _ _ _ _ _ _ _ _ is the enzyme responsible for breaking the _ _ _ _ _ _ _ _ bonds between the bases on either strands, causing it to unzip. This exposes the bases on both strands so that DNA _ _ _ _ _ _ _ _ _ _ _ _ can occur. Where the two strands separate, a Y-shape is formed, this is known as a _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _.

2



The enzyme DNA _ _ _ _ _ _ _ _ _ _ _ is responsible for joining free nucleotides to the two exposed template strands using _ _ _ _ _ _ _ _ _ _ _ _ _ _ base pairing. _ _ _ _ _ _ _ _ , made from a short strand of RNA, act as starting points for the DNA nucleotides to bind to in the process of DNA _ _ _ _ _ _ _ _ _ _ _ _. One stand is known as the _ _ _ _ _ _ _ strand. This strand is oriented in the 3′ to _′ direction, towards the replication fork. On the leading strand the nucleotides are added _ _ _ _ _ _ _ _ _ _ _ _ _ _. Whereas with the _ _ _ _ _ _ _ strand the process has to be done _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _, using Okazaki _ _ _ _ _ _ _ _ _ _ . The fragments are then later joined to one another by the enzyme _ _ _ _ _ _.

☆ DNA replication is known as _ _ _ _ - _ _ _ _ _ _ _ _ _ _ _ _. This is because both identical copies of the DNA molecule made consist of an original strand and a _ _ _ strand. If errors occur when the DNA is replicated the _ _ _ _ sequence may change, this could lead to a _ _ _ _ _ _ _ _.

Central Dogma of Biology

DNA □ DNA
(DNA polymerase)

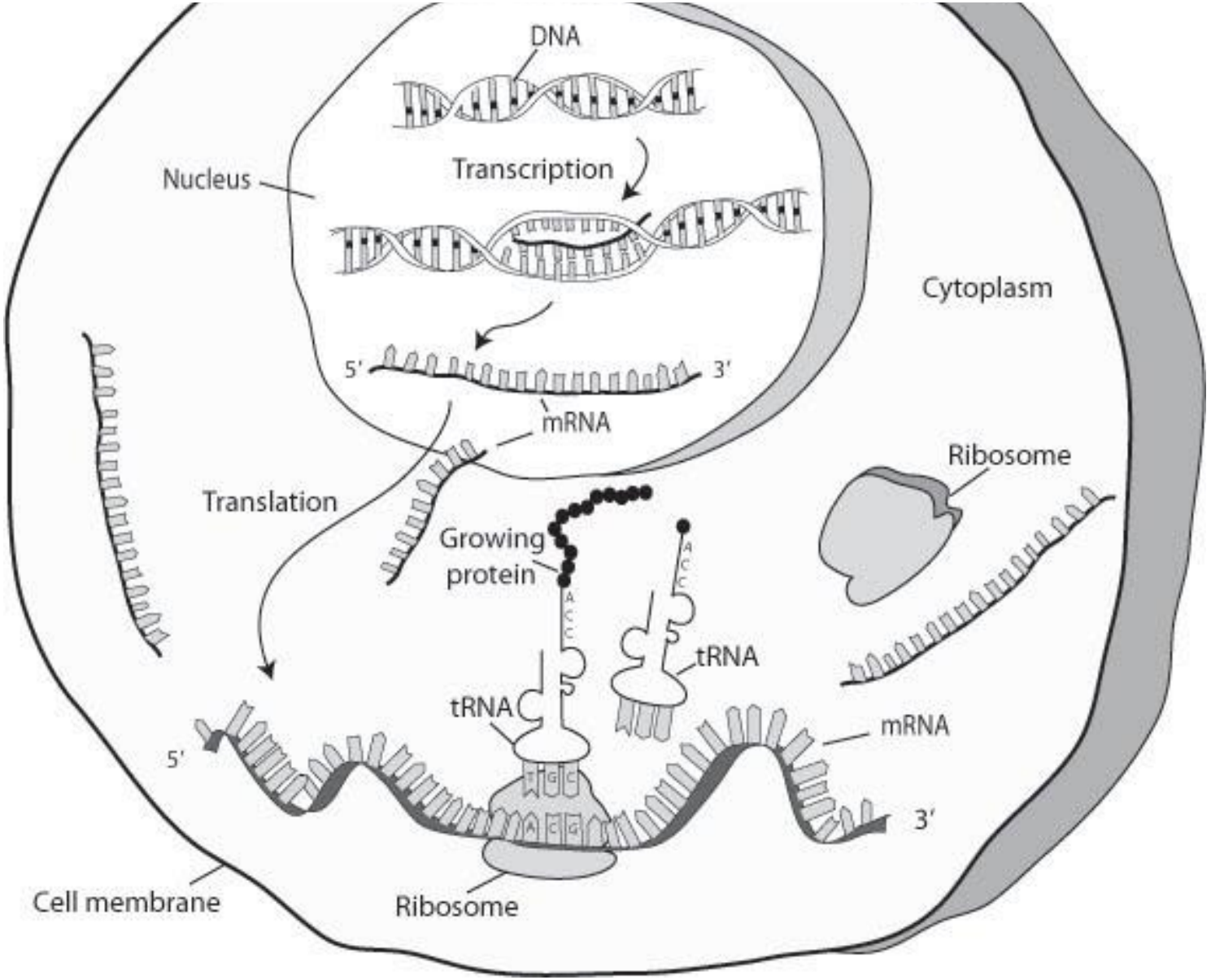
DNA □ RNA
(RNA polymerase)

RNA □ protein
(Ribosome)

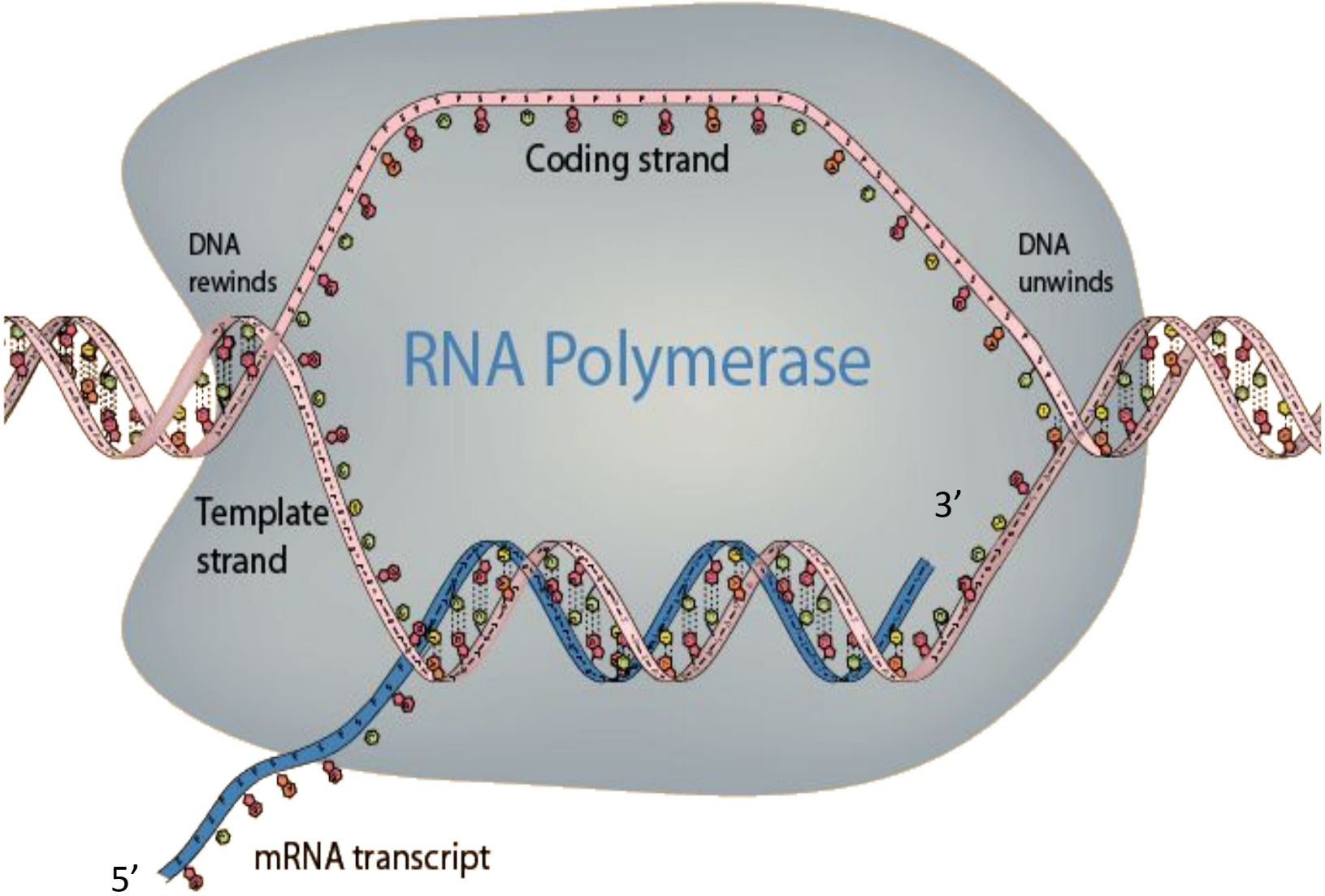
Where in the cell do these processes occur?

Protein Synthesis – DNA mRNA mRNA protein

Professor Dave Explains 6.26m
https://www.youtube.com/watch?v=bKIpDtJdR8Q&t=293s

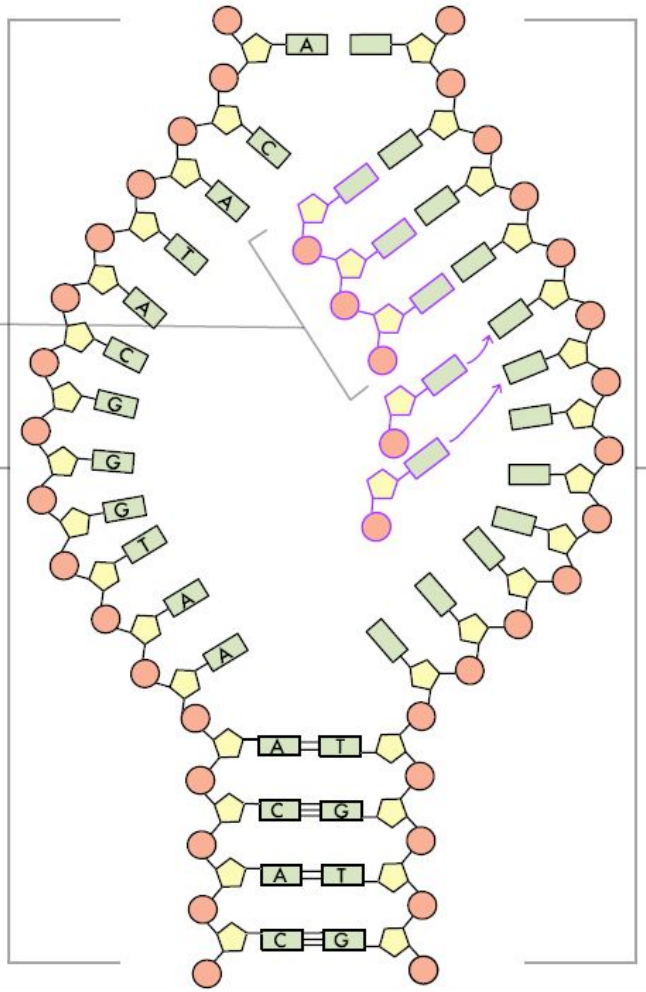


TransCription - DNA to mRNA



DNA to Protein 2.41 https://www.youtube.com/watch?v=gG7uCskUOrA

1 TRANSCRIPTION



1

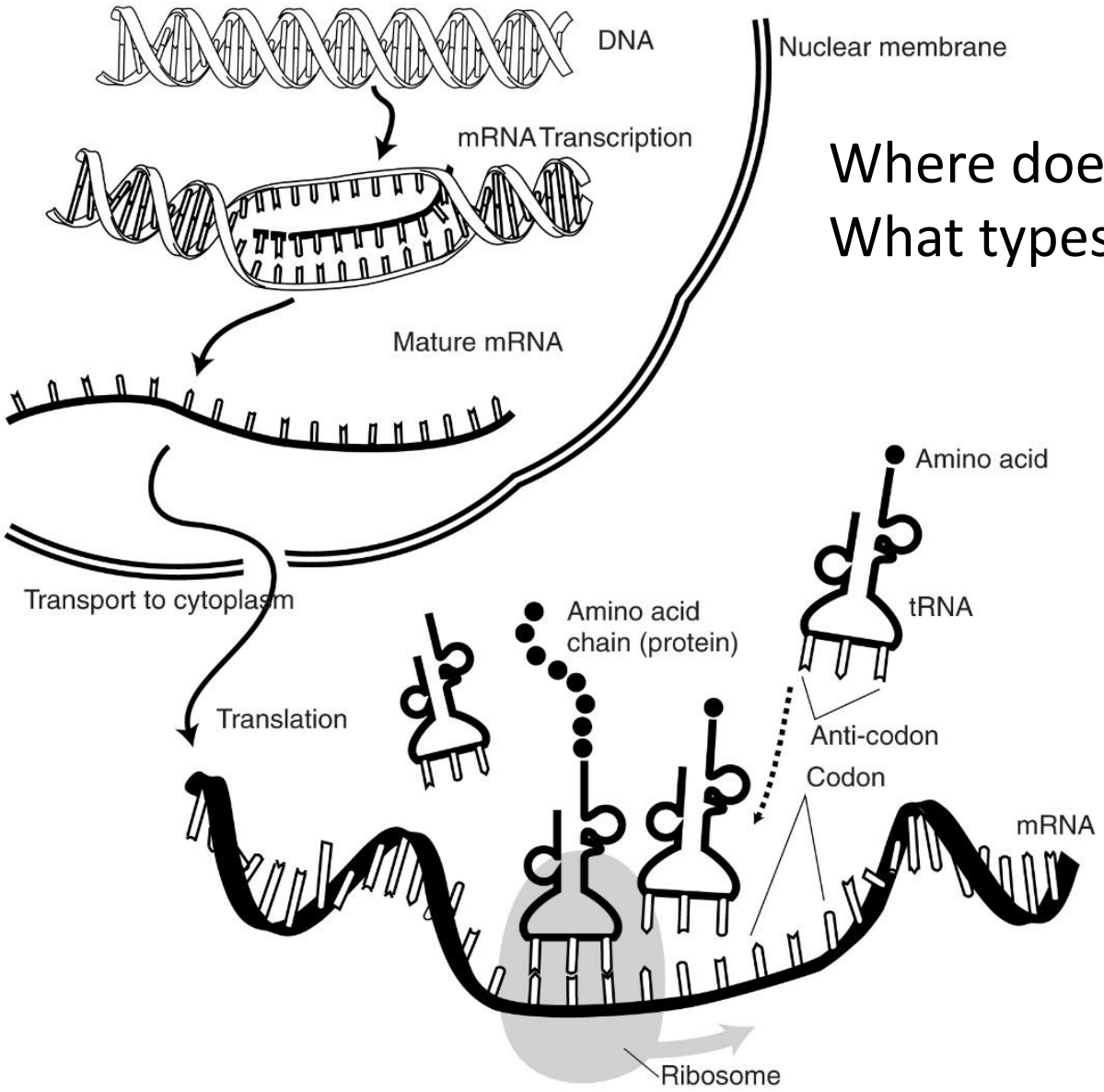
2

3

Complete the diagram: Fill in all of the missing bases and then write in the correct names of the strands in the three boxes

Transcription occurs in the _ _ _ _ _ _ _ of a cell. A section of DNA called a _ _ _ _ unwinds and unzips. Each gene codes for one _ _ _ _ _ _ _ _ _ _ _ _. One strand acts as the _ _ _ _ _ _ _ _ strand. The free RNA _ _ _ _ _ _ _ _ _ _ _ _ complementary base pair with the exposed DNA bases on this template strand. A length of RNA is created which is a copy of the other DNA strand, so this DNA strand is called the _ _ _ _ _ _ strand. The strand of _ _ _ _ _ _ _ _ _ RNA once created, leaves the nucleus through a nuclear _ _ _ _.

TransLation – mRNA to Protein

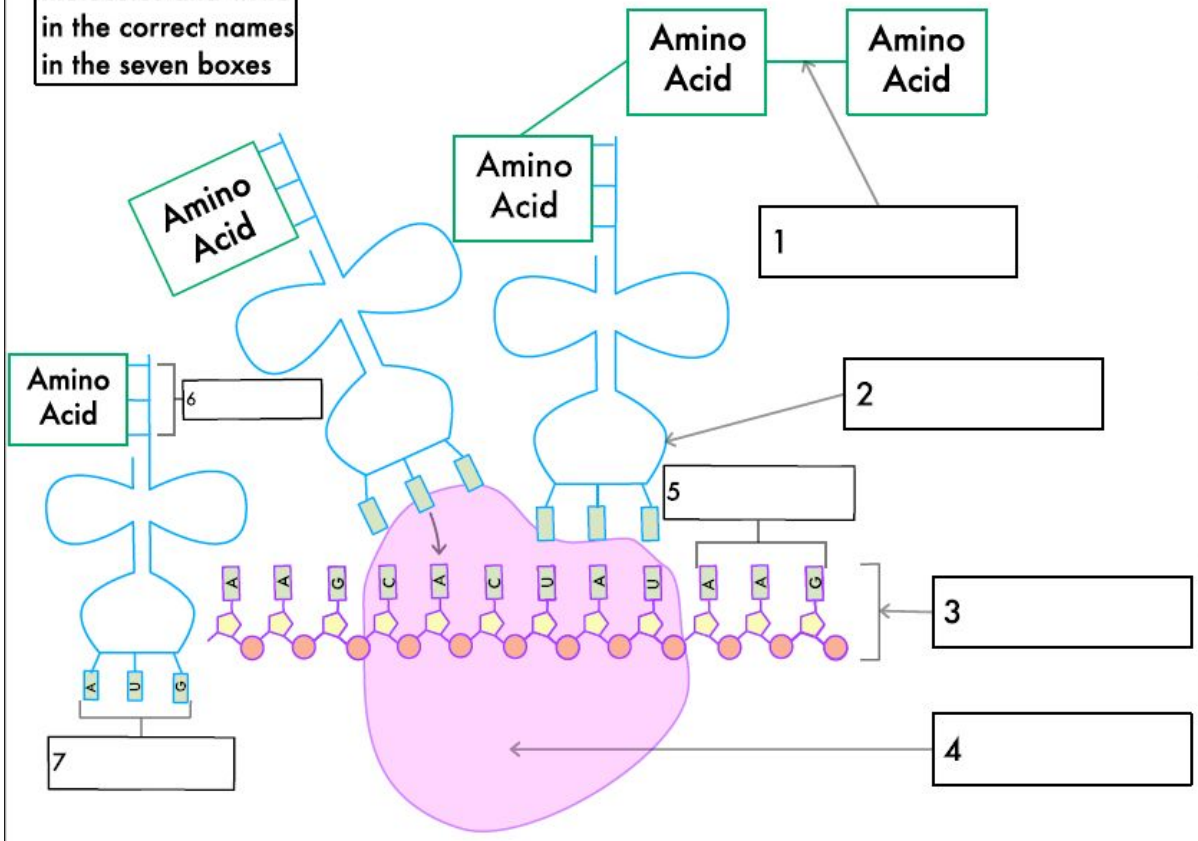


Where does it occur?

What types of RNA are used?

2 TRANSLATION

Complete the diagram: Fill in the missing bases on the two tRNA molecules and write in the correct names in the seven boxes



Translation occurs on the _ _ _ _ _ _ _ _ _ of the cell. Two _ _ _ _ _ _ on the mRNA strand are exposed by the ribosome at a time. _ _ _ _ _ _ _ _ RNA brings amino acids to the ribosome. The tRNA molecule has a binding site made up of three bases which are _ _ _ _ _ _ _ _ to a particular amino acid. The tRNA molecule also has three exposed bases called an _ _ _ _ _ _ _ _ _ _, this is complementary to the codon on the mRNA strand. Temporary _ _ _ _ _ _ _ _ bonds form between the codon and the anticodon. As two _ _ _ _ _ _ _ _ _ _ are brought close to one another by adjacent tRNA molecules a _ _ _ _ _ _ _ bond forms between them. Energy in the form of _ _ _ is required for this process. Eventually a _ _ _ _ codon is reached on the mRNA strand which signals the end of the polypeptide, which is then released. The polypeptide can then fold into its 3D shape with the help of _ _ _ _ _ _ _ _ _ proteins. tRNA molecules are released as the ribosome moves along the mRNA strand and are then free to pick up another amino acid from the _ _ _ _ _ _ _ _ _.

Define TransCription and TransLation

Transcription:

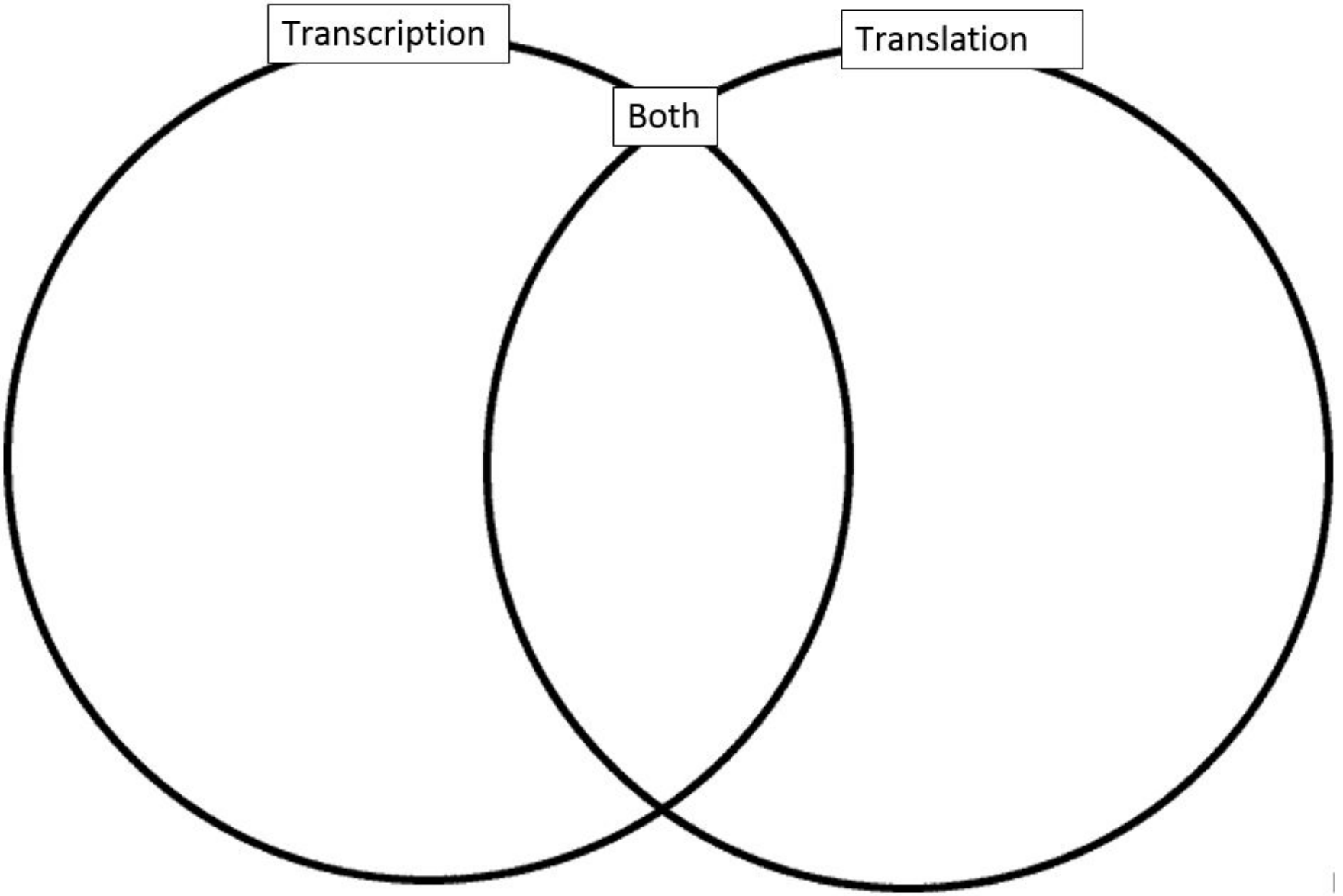
Transcription is the process by which the DNA molecule (genetic material and hereditary information) is copied to form a single stranded molecule messenger RNA (mRNA). Transcription takes place in the nucleus of eukaryotic cells, then after modification, the mature mRNA leaves the nucleus and enters the cytoplasm through the nuclear pore.

Translation:

The mRNA molecule is now in the cytoplasm. Transfer RNA (tRNA) (anticodon) carries a specific, amino acid complementary to the mRNA (codon) at the ribosome (rRNA). At the ribosome amino acids are synthesized by dehydration reaction to form a polypeptide (protein). Remember amino acids have a peptide bond.

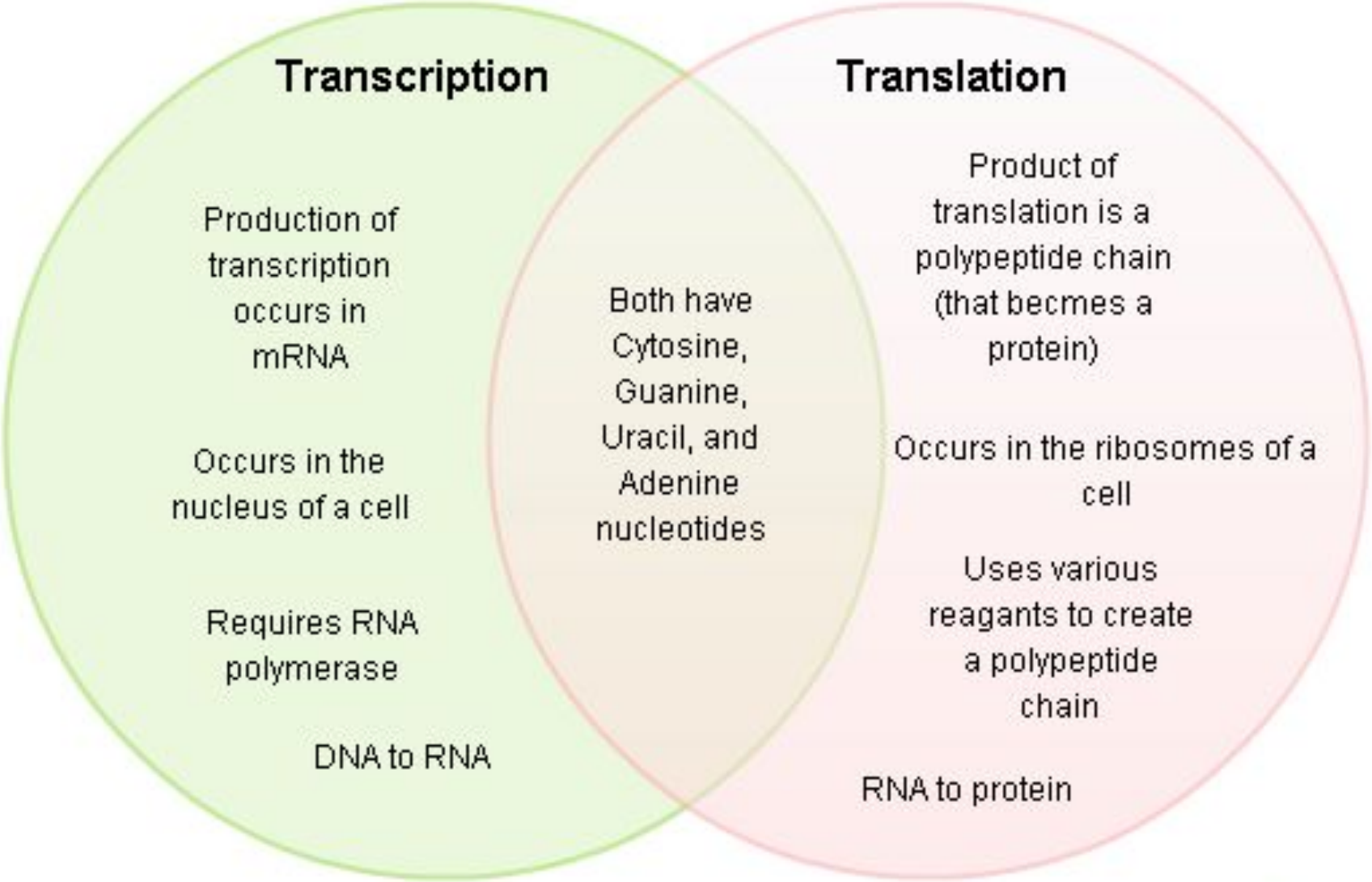
1. An mRNA strand has 76 codons. How many amino acids will be in the polypeptide? _____
2. A polypeptide contains 103 amino acids. What is the length of the gene (unit = base pairs)? _____

Compare TransCription with TransLation

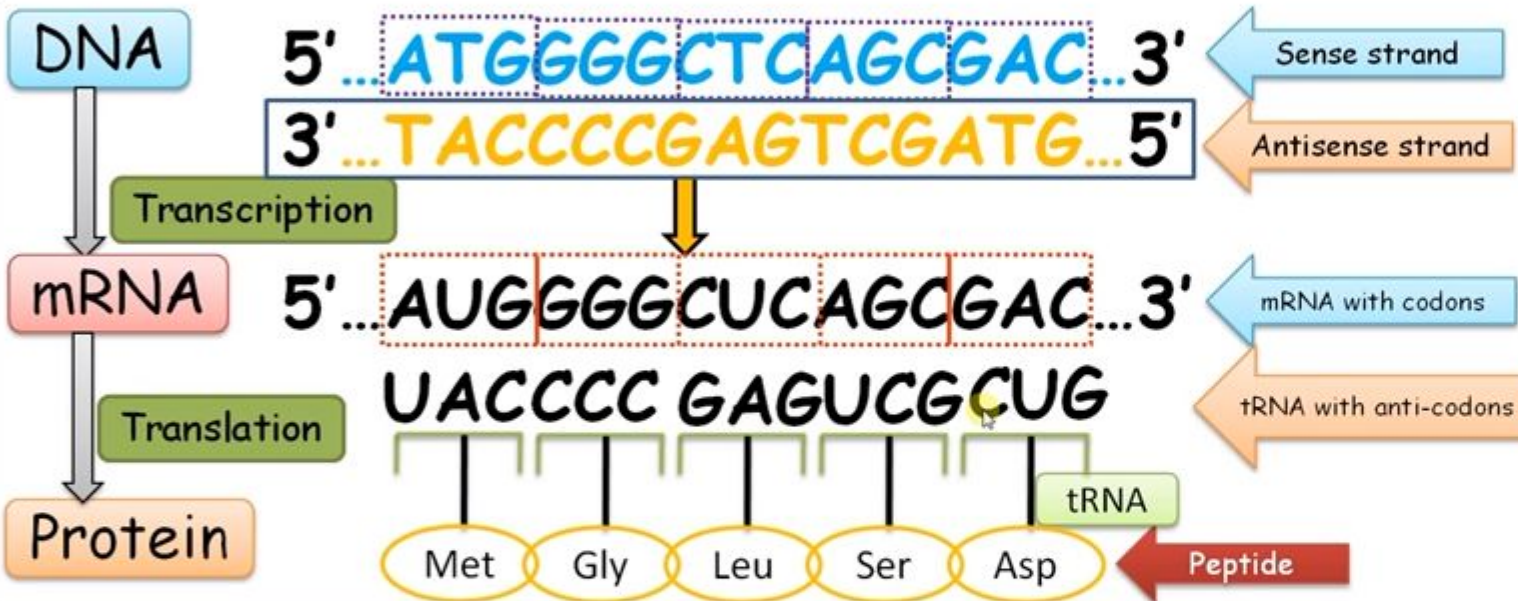


Sort

Product is mRNA	Product is a polypeptide / protein	Occurs on ribosome
Nucleotides Adenine, Guanine, Cytosine Uracil	Occurs in the nucleus	Occurs in the cytoplasm
Uses a template	mRNA, tRNA, rRNA	Requires RNA polymerase



5’ to 3’Sense, coding, non-template - 3’ to 5’ Antisense, non-coding, template



Sense Strand 5’ □ 3’

1. Is also called the coding strand or non-template strand.
2. Is the same as mRNA except that thymine in DNA is replaced by Uracil in RNA.
3. The sense strand contains the information for codons via mRNA.

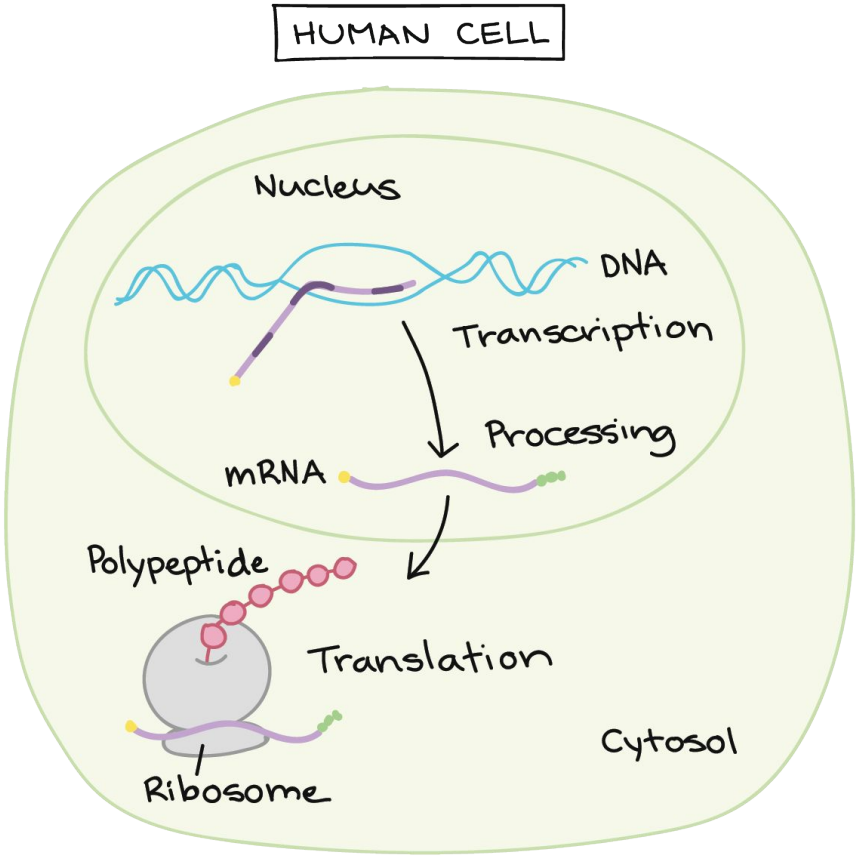
Antisense 3’ □ 5’

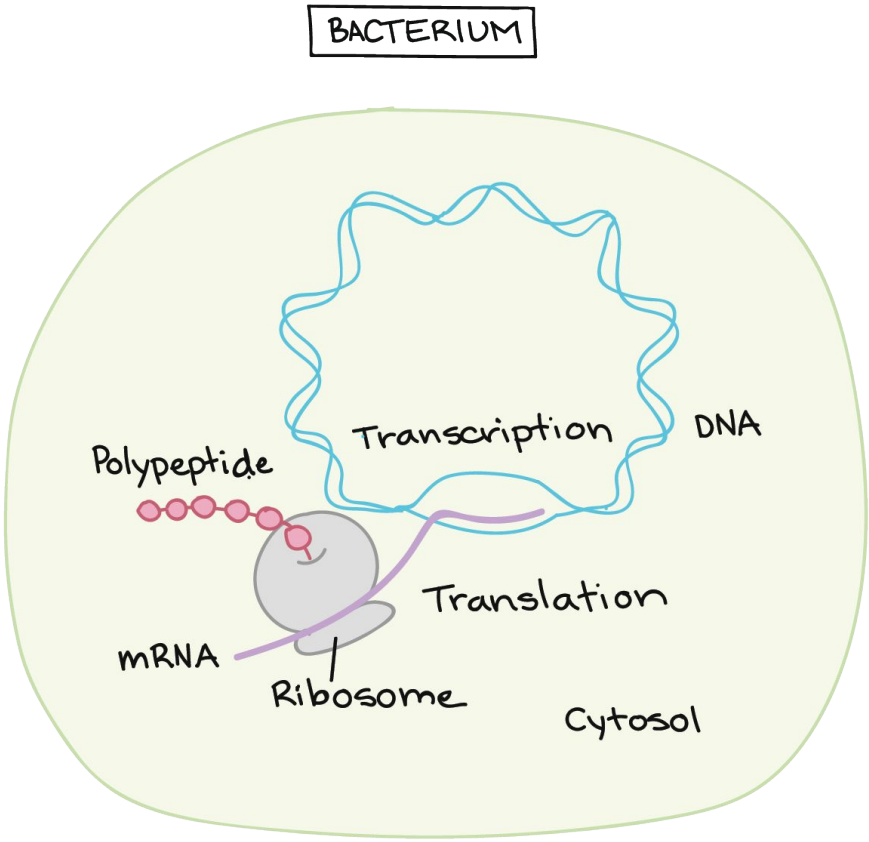
1. Is also called the non-coding strand or template strand.
2. Is a template for the synthesis of mRNA – antisense is complementary to sense strand.
3. Antisense contains the code for anticodons – except T in DNA is U in RNA

Compare eukaryote to prokaryote

Remember all living things use the same process of transcription and translation.

What is different? What is the same?





Genetic code

Properties of the Genetic Code

Degenerate: Having one or more base triplet to code for one amino acid. 64 combinations of GCAU, but only 20 amino acids. Stop codons are not amino acids.

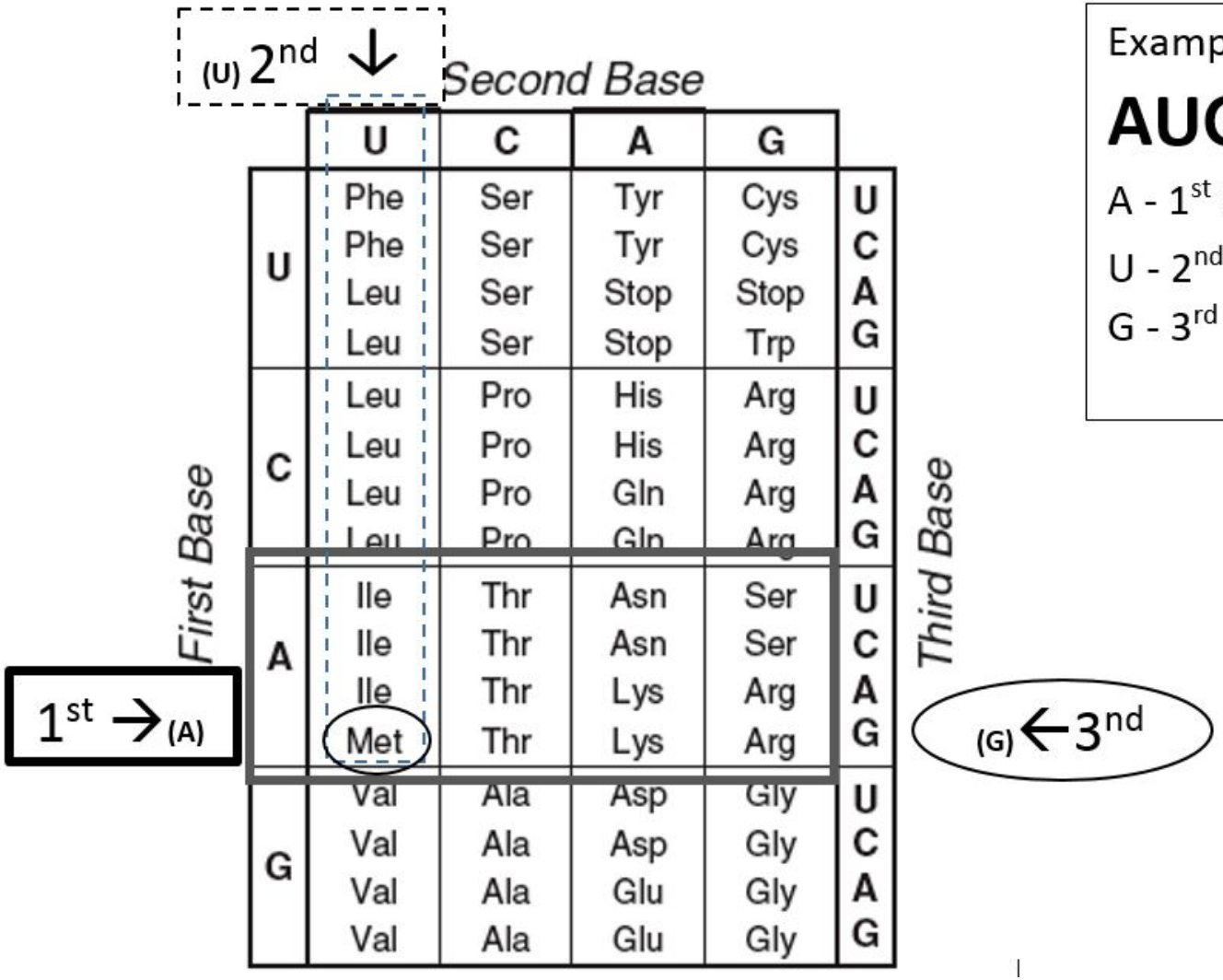
Universal: Most living organisms use the same 64 combinations of the 20 amino acids. All living organisms use the codon AUG, amino acid methionine, making it the universal START codon.

Practice

TRANSCRIPTION # 1						
Given DNA base sequence:	T A C	G C T	T G G	T G A	C C G	A C T
Complimentary DNA strand:	__ __ __	__ __ __	__ __ __	__ __ __	__ __ __	__ __ __
mRNA base sequence:	__ __ __	__ __ __	__ __ __	__ __ __	__ __ __	__ __ __
TRANSLATION						
tRNA's anticodon base sequences:	__ __ __	__ __ __	__ __ __	__ __ __	__ __ __	__ __ __
Amino Acid translation:	_____	_____	_____	_____	_____	_____

TRANSCRIPTION # 2						
Given DNA base sequence:	T A C	T G C	G G G	A A G	C G T	A C T
Complimentary DNA strand:	__ __ __	__ __ __	__ __ __	__ __ __	__ __ __	__ __ __
mRNA base sequence:	__ __ __	__ __ __	__ __ __	__ __ __	__ __ __	__ __ __
TRANSLATION	Codon 1	Codon 2	Codon 3	Codon 4	Codon 5	Codon 6
mRNA base sequence:	__ __ __	__ __ __	__ __ __	__ __ __	__ __ __	__ __ __
tRNA's anticodon base sequences:	__ __ __	__ __ __	__ __ __	__ __ __	__ __ __	__ __ __
Amino Acid translation:	_____	_____	_____	_____	_____	_____

The genetic code – mRNA codon chart



First Base	U	C	A	G	Third Base
U	Phe	Ser	Tyr	Cys	U
	Phe	Ser	Tyr	Cys	C
	Leu	Ser	Stop	Stop	A
	Leu	Ser	Stop	Trp	G
C	Leu	Pro	His	Arg	U
	Leu	Pro	His	Arg	C
	Leu	Pro	Gln	Arg	A
	Leu	Pro	Gln	Arg	G
A	Ile	Thr	Asn	Ser	U
	Ile	Thr	Asn	Ser	C
	Ile	Thr	Lys	Arg	A
	Met	Thr	Lys	Arg	G
G	Val	Ala	Asp	Gly	U
	Val	Ala	Asp	Gly	C
	Val	Ala	Glu	Gly	A
	Val	Ala	Glu	Gly	G

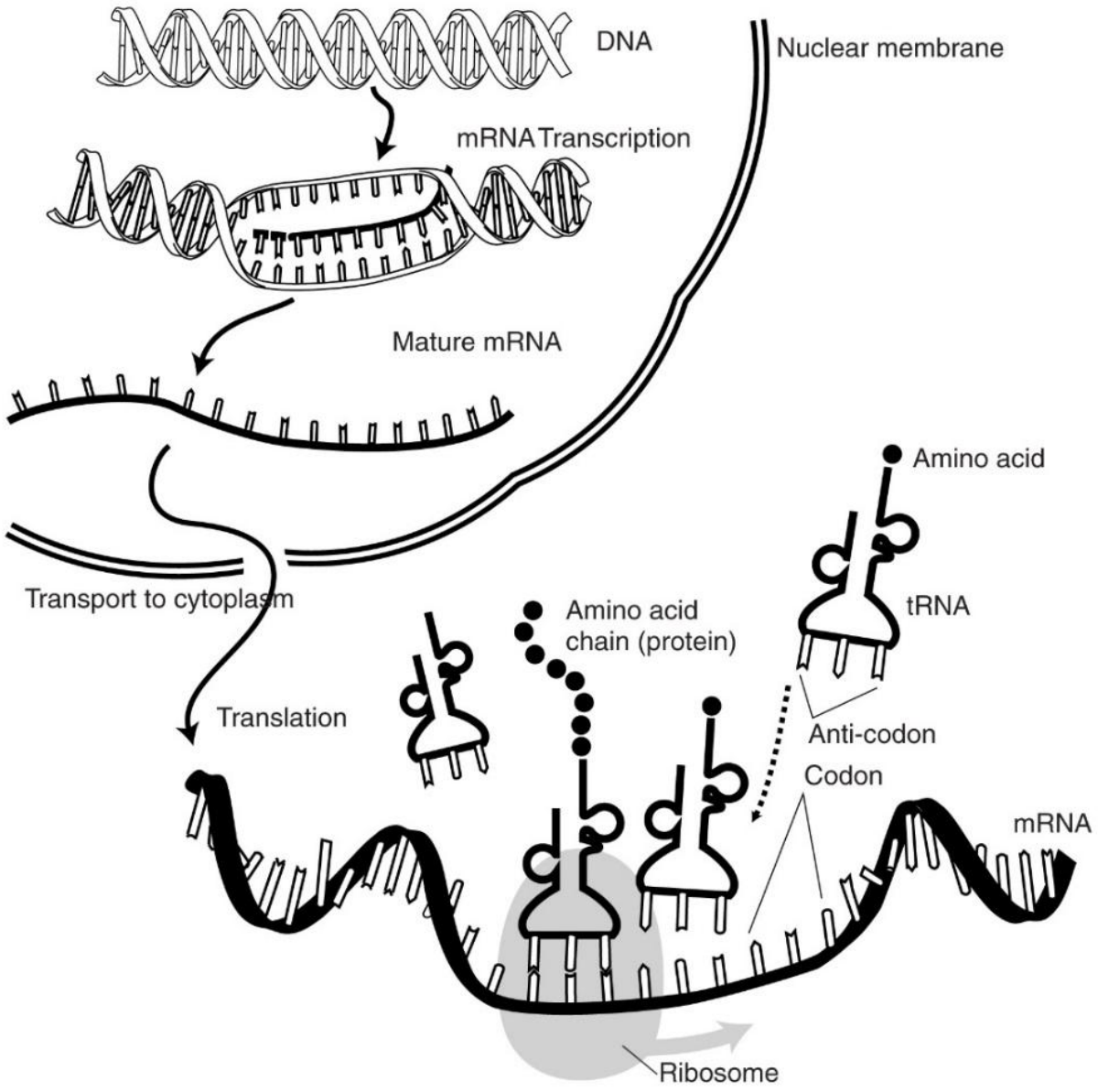
Example:

AUG

A - 1st Base (→Row)

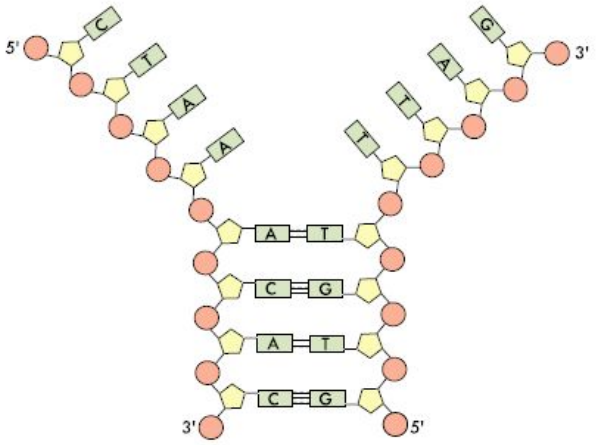
U - 2nd Base (↓ Square)

G - 3rd Base (← a. acid)


DNA
Nuclear membrane
mRNA Transcription
Mature mRNA
Amino acid
tRNA
Transport to cytoplasm
Amino acid
chain (protein)
Translation
Anti-codon
Codon
mRNA
Ribosome

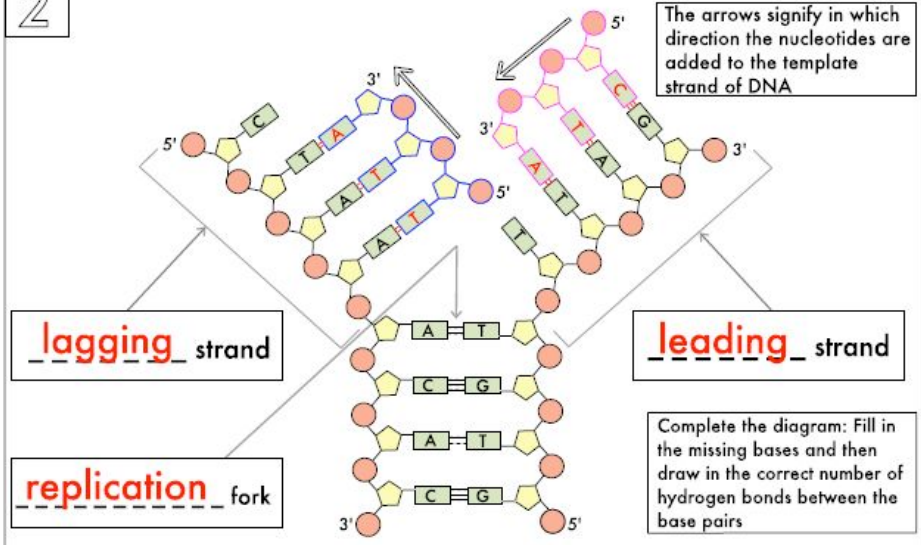
Replication Key

1



Before replication of DNA can start, the molecule has to unwind from its _ _helical_ _ shape, a section at a time. DNA _gyrase_ _ is the enzyme responsible for this unwinding of the DNA molecule. Also, the two strands have to be separated. DNA _ _helicase_ _ is the enzyme responsible for breaking the _hydrogen_ bonds between the bases on either strands, causing it to unzip. This exposes the bases on both strands so that DNA _ _replication_ _ _ can occur. Where the two strands separate, a Y-shape is formed, this is known as a _ _replication_ _ _fork_.

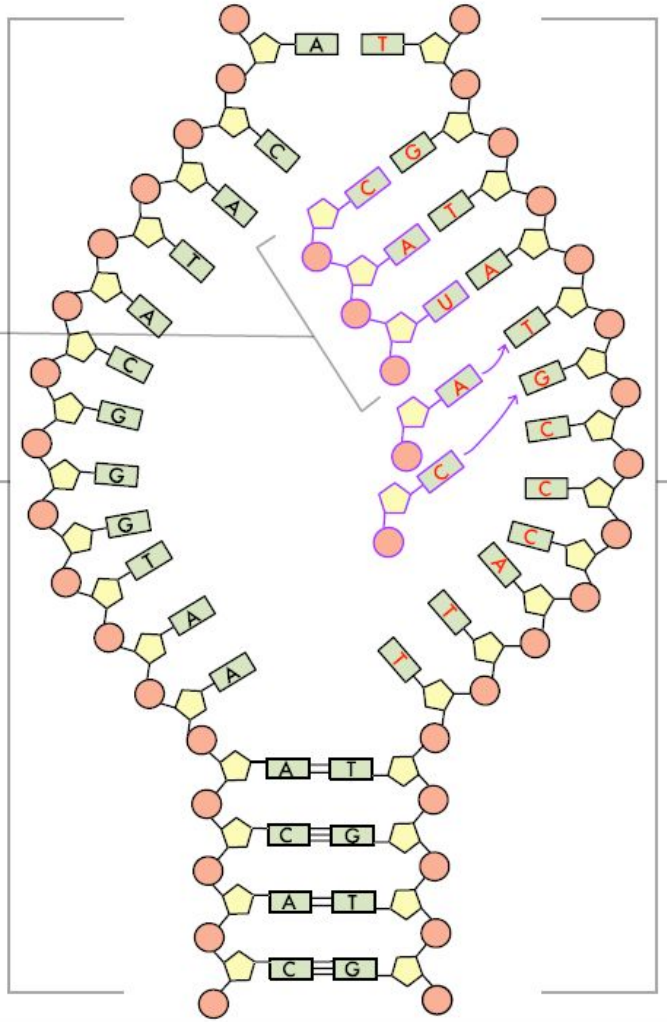
2



The enzyme DNA _ _polymerase_ _ is responsible for joining free nucleotides to the two exposed template strands using _complementary_ _ _ base pairing. _primers_ _ , made from a short strand of RNA, act as starting points for the DNA nucleotides to bind to in the process of DNA _ _replication_ _ _. One stand is known as the _ _leading_ _ strand. This strand is oriented in the 3′ to 5′ direction, towards the replication fork. On the leading strand the nucleotides are added _ _continuously_ _ _. Whereas with the _ _lagging_ _ strand the process has to be done _ _ _discontinuously_ _ _, using Okazaki _ _fragments_ _ . The fragments are then later joined to one another by the enzyme _ _ligase_ _.

☆ DNA replication is known as _semi_ - _ _conservative_ _. This is because both identical copies of the DNA molecule made consist of an original strand and a _new_ strand. If errors occur when the DNA is replicated the _base_ sequence may change, this could lead to a _mutation_.

1 TRANSCRIPTION



1 mRNA strand

2 coding strand

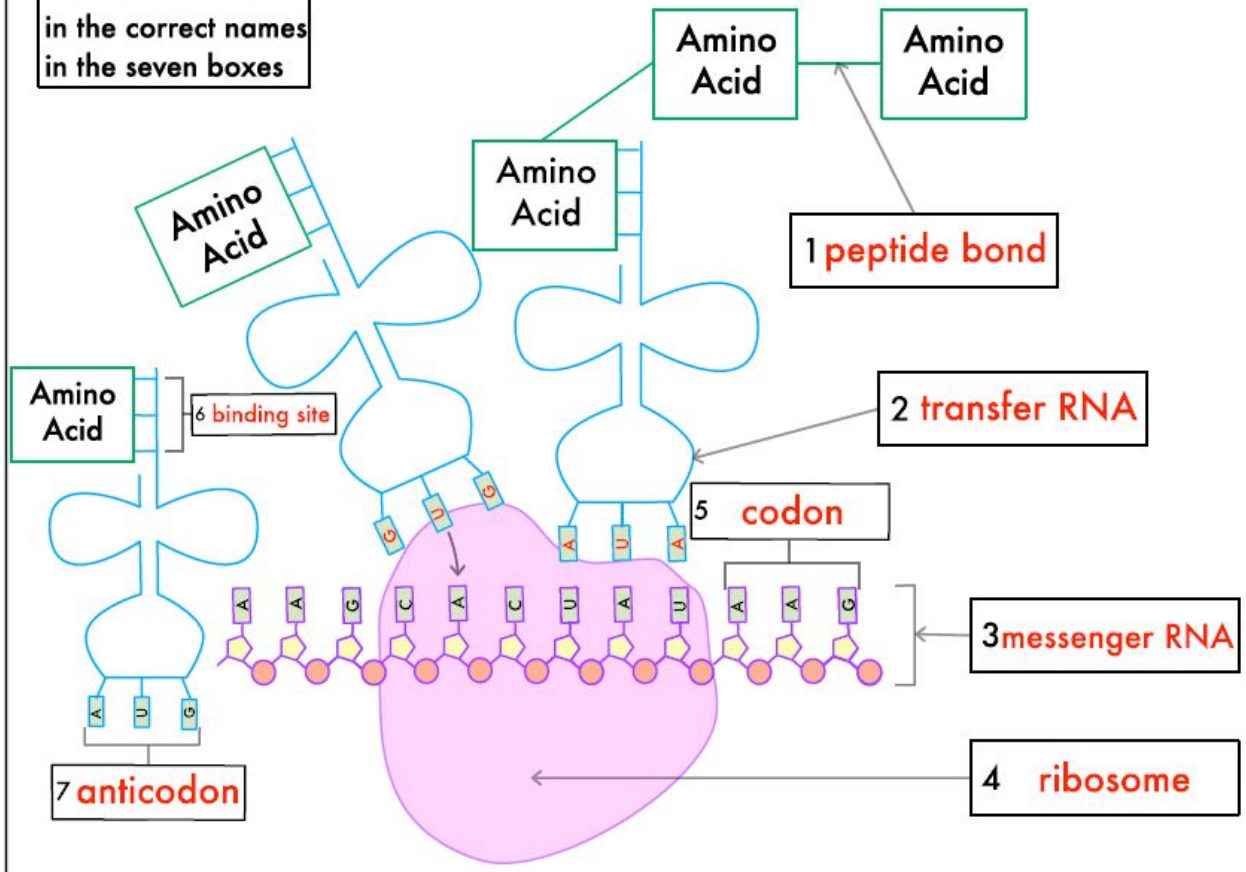
3 template strand

Complete the diagram: Fill in all of the missing bases and then write in the correct names of the strands in the three boxes

Transcription occurs in the _ nucleus _ of a cell. A section of DNA called a _gene_ unwinds and unzips. Each gene codes for one _ _polypeptide_ _ _. One strand acts as the _ _template_ _ strand. The free RNA _ _nucleotides_ _ _ complementary base pair with the exposed DNA bases on this template strand. A length of RNA is created which is a copy of the other DNA strand, so this DNA strand is called the _coding _ strand. The strand of _ messenger_ _ RNA once created, leaves the nucleus through a nuclear _pore_.

2 TRANSLATION

Complete the diagram: Fill in the missing bases on the two tRNA molecules and write in the correct names in the seven boxes



Translation occurs on the _ ribosomes _ _ of the cell. Two _ codons _ on the mRNA strand are exposed by the ribosome at a time. _ transfer _ _ RNA brings amino acids to the ribosome. The tRNA molecule has a binding site made up of three bases which are _ _ specific _ _ to a particular amino acid. The tRNA molecule also has three exposed bases called an _ anticodons _ , this is complementary to the codon on the mRNA strand. Temporary _ hydrogen _ _ bonds form between the codon and the anticodon. As two _ amino _ _ acids _ _ are brought close to one another by adjacent tRNA molecules a _ peptide _ bond forms between them. Energy in the form of _ ATP _ is required for this process. Eventually a _ stop _ codon is reached on the mRNA strand which signals the end of the polypeptide, which is then released. The polypeptide can then fold into its 3D shape with the help of _ chaperone _ _ proteins. tRNA molecules are released as the ribosome moves along the mRNA strand and are then free to pick up another amino acid from the _ cytoplasm _ _.