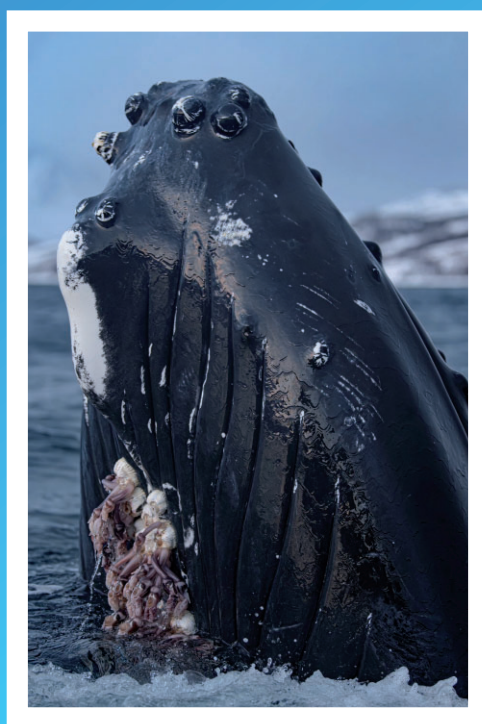


Reference Booklet for Biology

S6-S7 – 4 Periods



EN

Version 3

Notes for inclusion with the Biology reference booklet S6-S7 – 4 Periods

Purpose

This booklet is intended as a memory aid for students, in order to facilitate testing of understanding and application of concepts in light of the competence-based marking system.

It relates to the current S6-S7 4 periods syllabus with reference **2020-12-D-27 – Biology 4 Periods Syllabus – S6-S7**.

This booklet is not intended as a replacement of the former EuroBio. It is an aid during assessment and examinations rather than a basis for in-class teaching.

Permitted use

This booklet is intended for all students in S6 and S7 in the Biology 4 periods course, throughout their 2 years of study.

It is recommended that teachers go through this document in class in order to make the students familiar with the layout and content, pointing out where the notation differs from that used in class.

Students are permitted to use the booklet for all assessments and examinations.

Clean colour copies will be distributed to all students for all Biology examinations in S6 and S7, including the Pre-Bac exams and the European Baccalaureate written and oral exams.

Acknowledgements

Most of the diagrams in this booklet have been adapted from Eurobio (©Schola Europea) and were drawn by Dr Steven Weinberg. Some of the diagrams were drawn by John Watson.

A few of the small images in the Geological Record were adapted from other sources shown below.

Humans (Neogene):

<https://commonslibrary.org/standing-in-solidarity-with-people-of-colour/>

Flower (Cretaceous): Nature Open Access, Creative Commons:

<https://www.nature.com/articles/ncomms16047>

Archaeopteryx (Jurassic):

https://commons.wikimedia.org/wiki/File:Archaeopteryx_lithographica.JPG

Lystrosaurus (Triassic): <https://en.wikipedia.org/wiki/Triassic>

Cycas sp. (Triassic): Cycas https://commons.wikimedia.org/wiki/File:Cycus_tici.jpg

Cone (Permian): <https://commons.wikimedia.org/wiki/File:Gymnospermae.jpg>

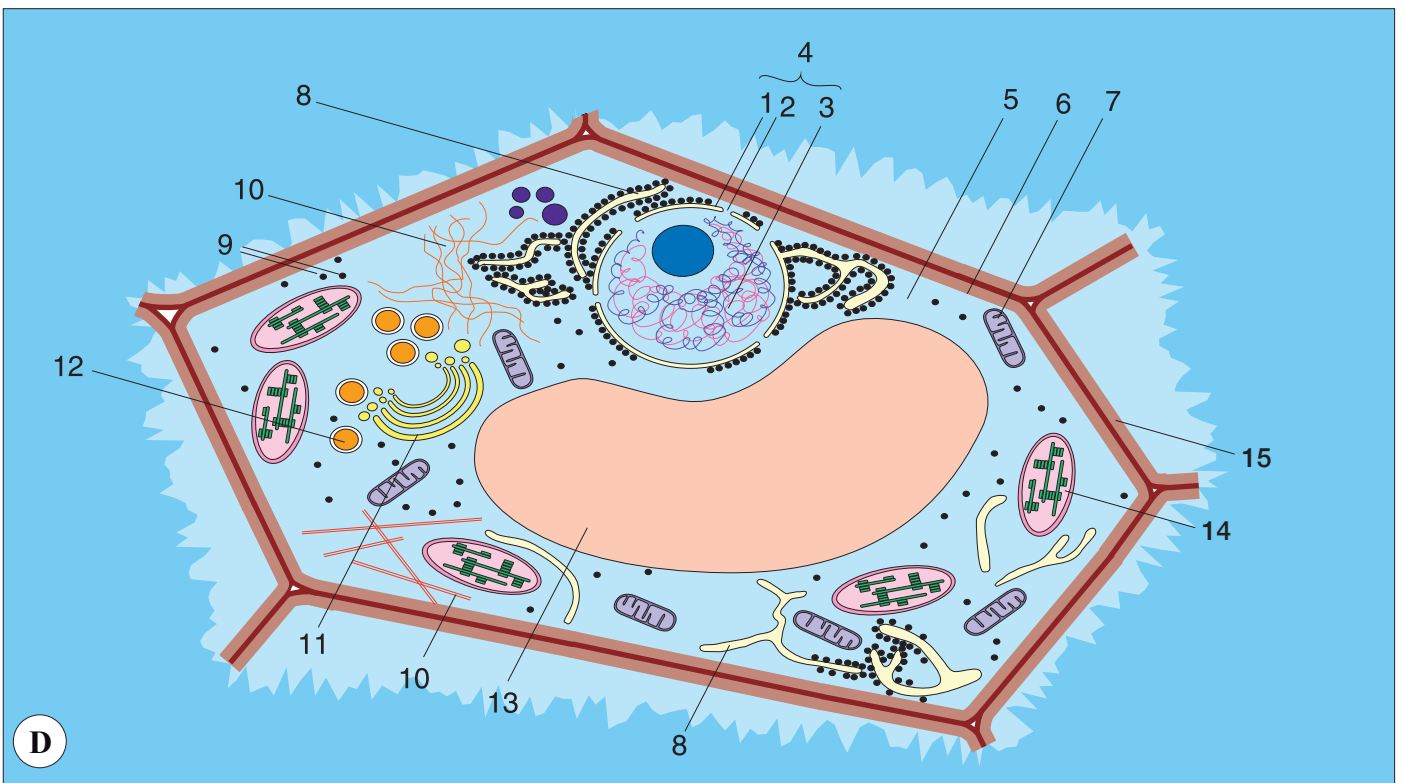
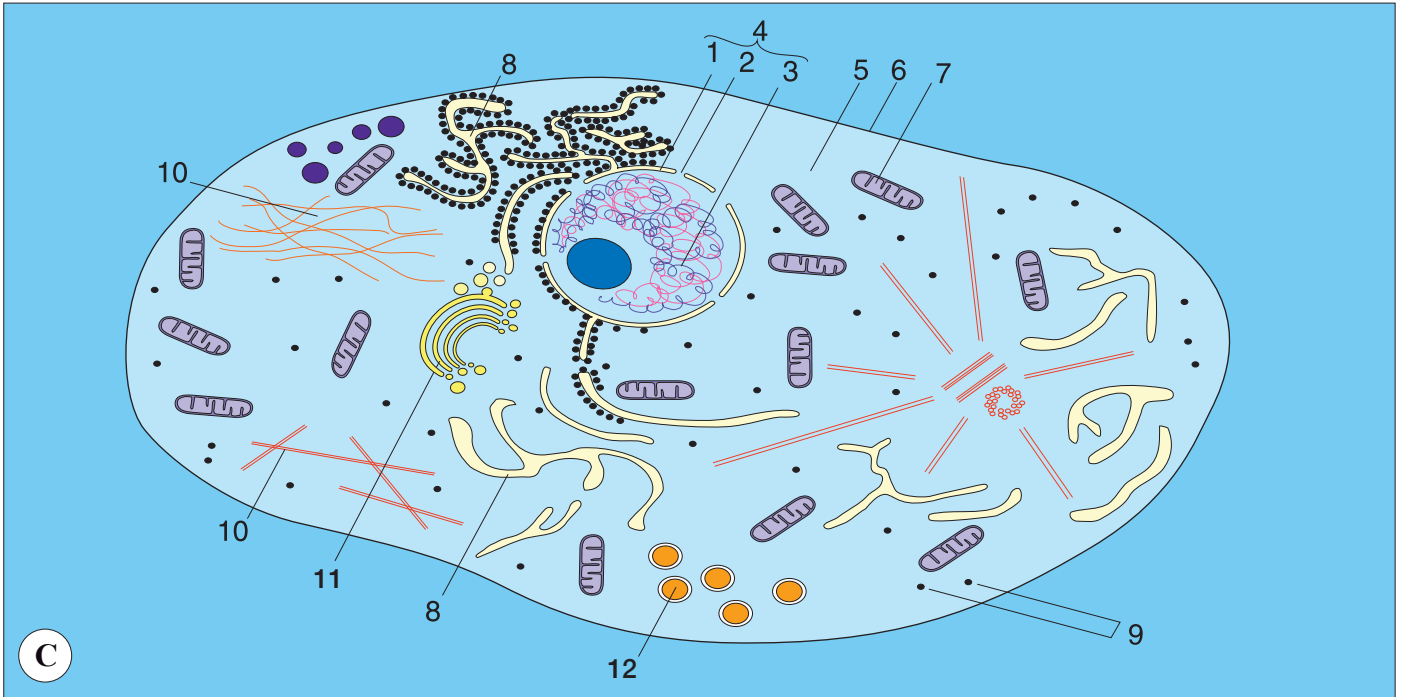
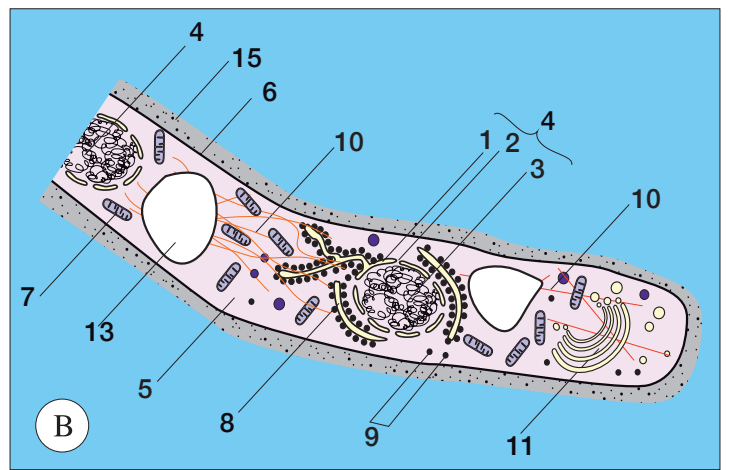
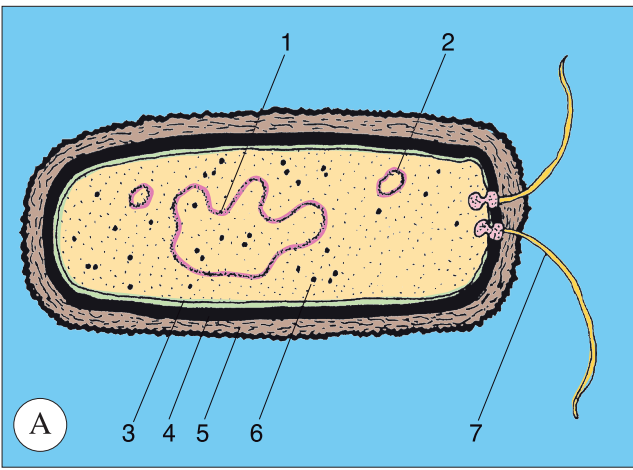
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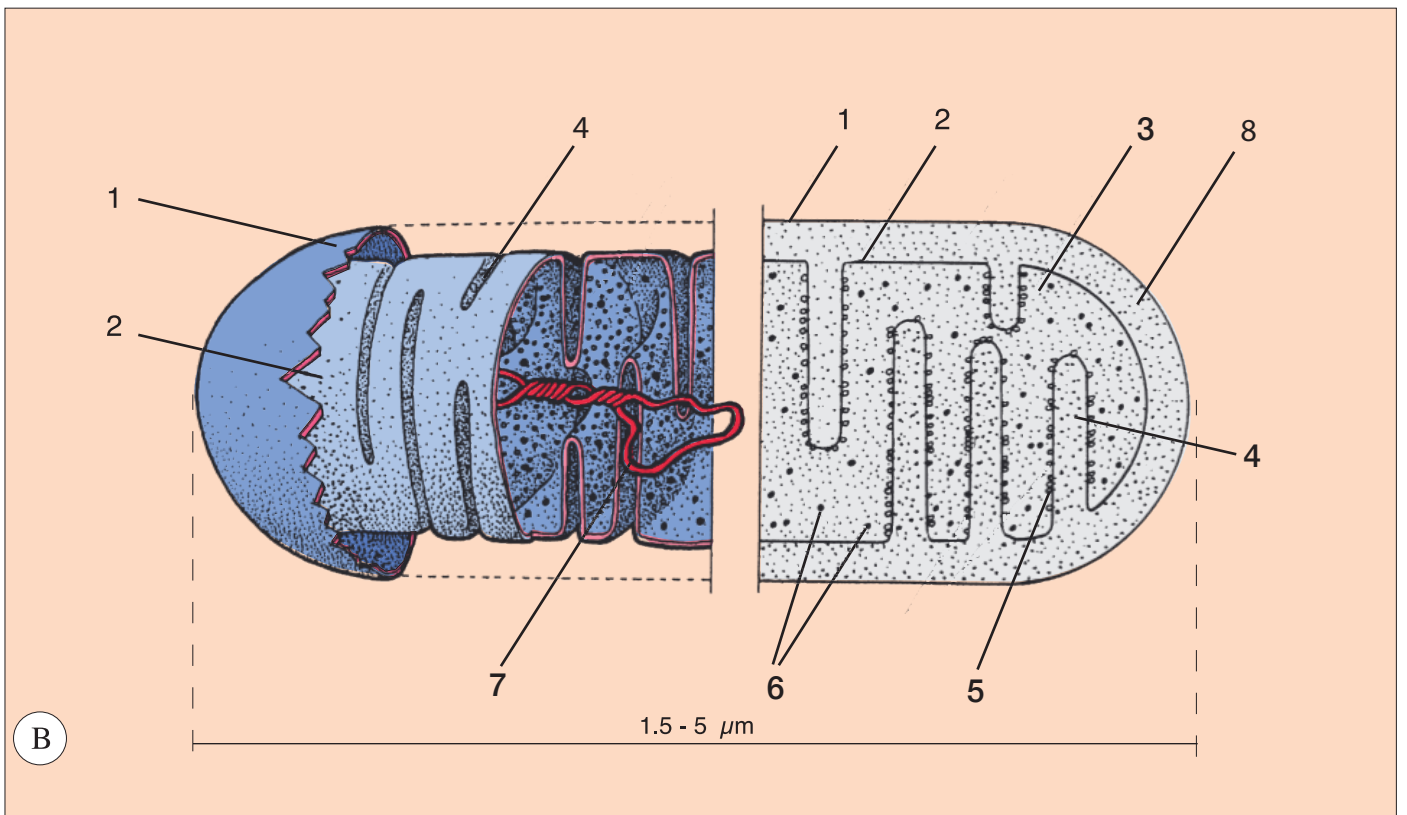
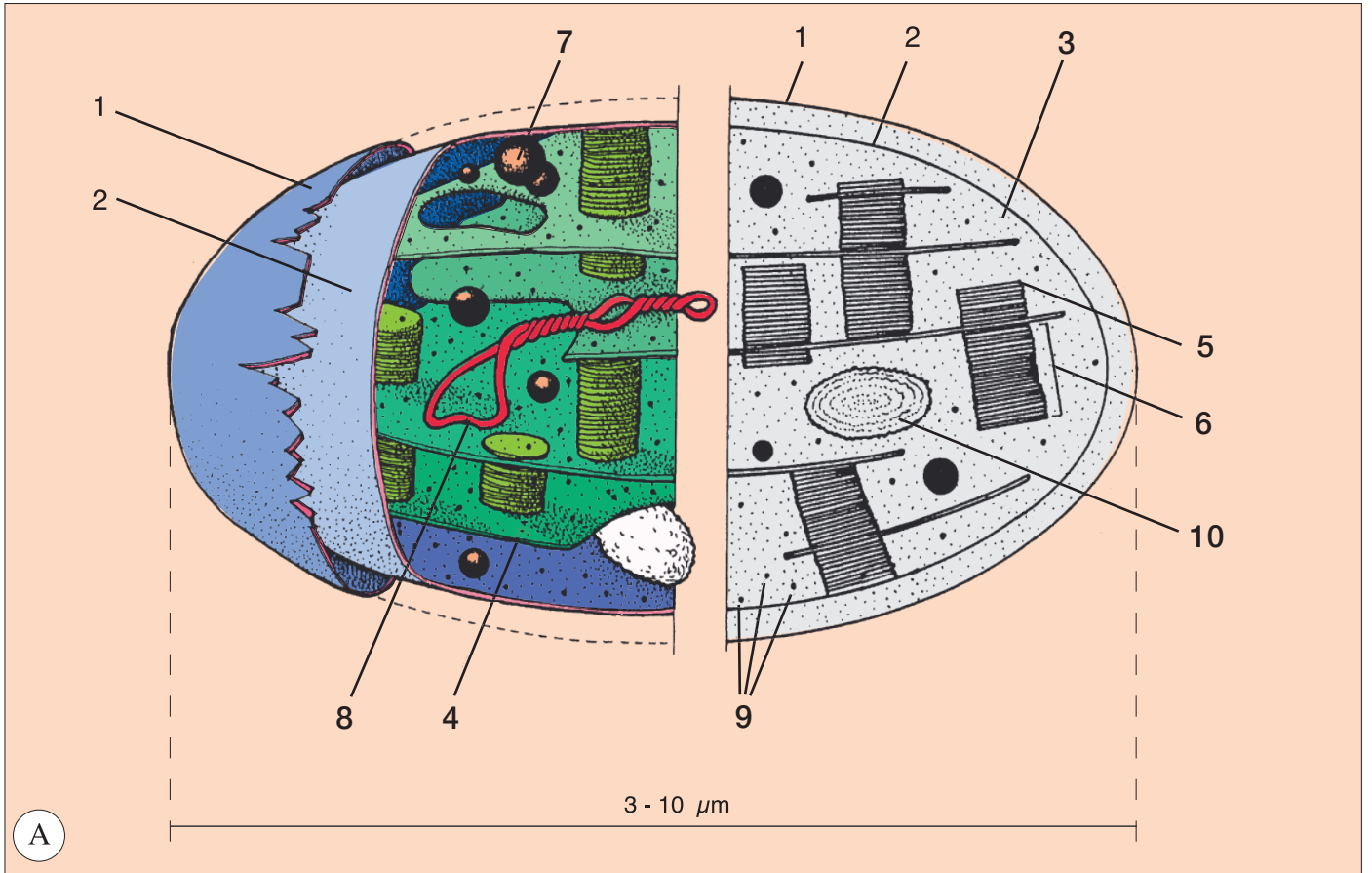
<https://commons.wikimedia.org/wiki/File:Lepidodendron.png>

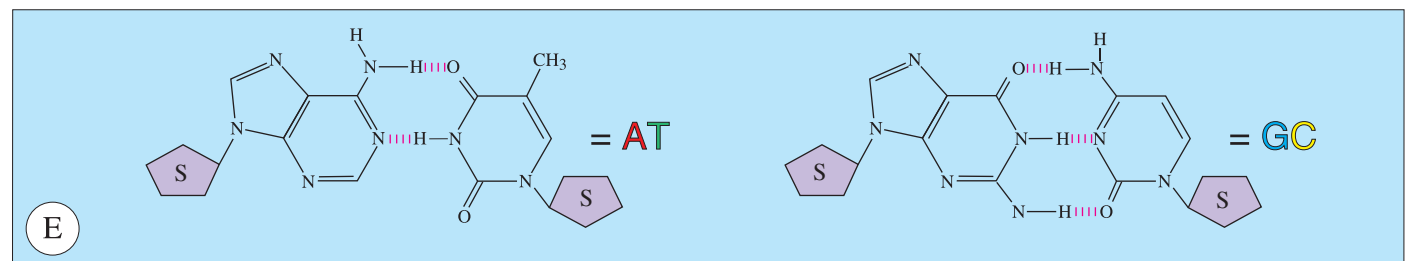
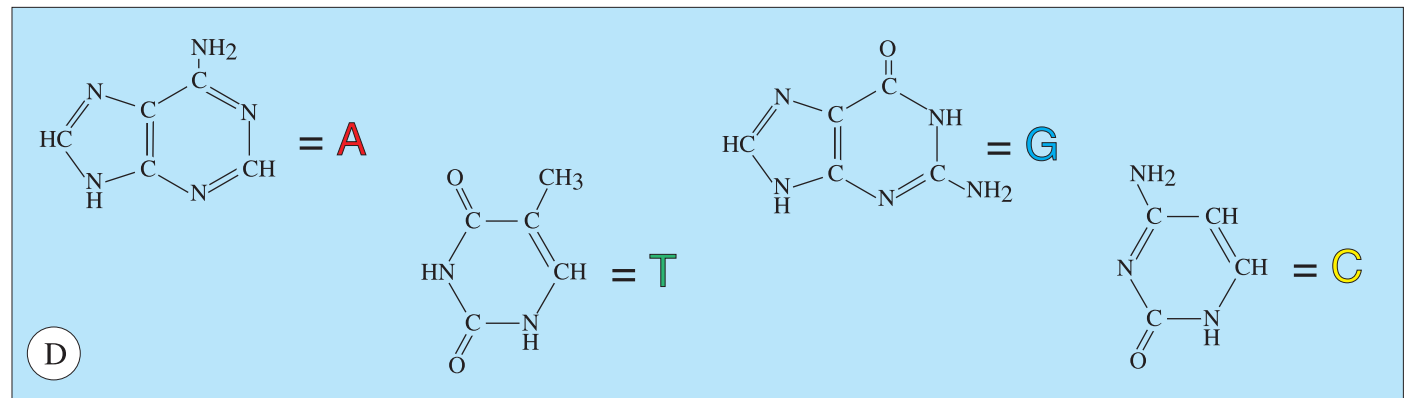
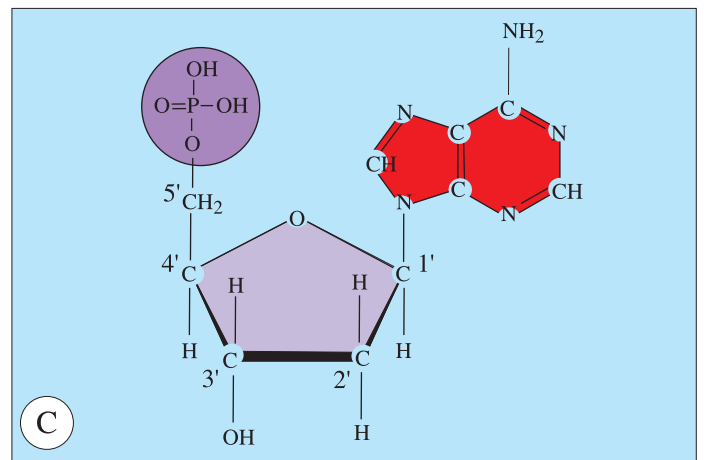
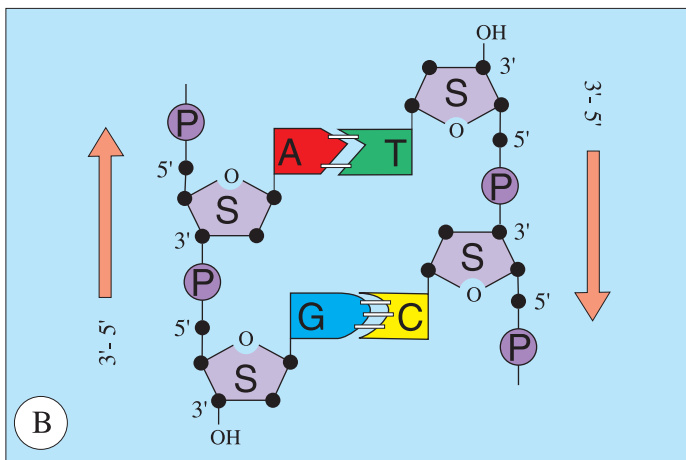
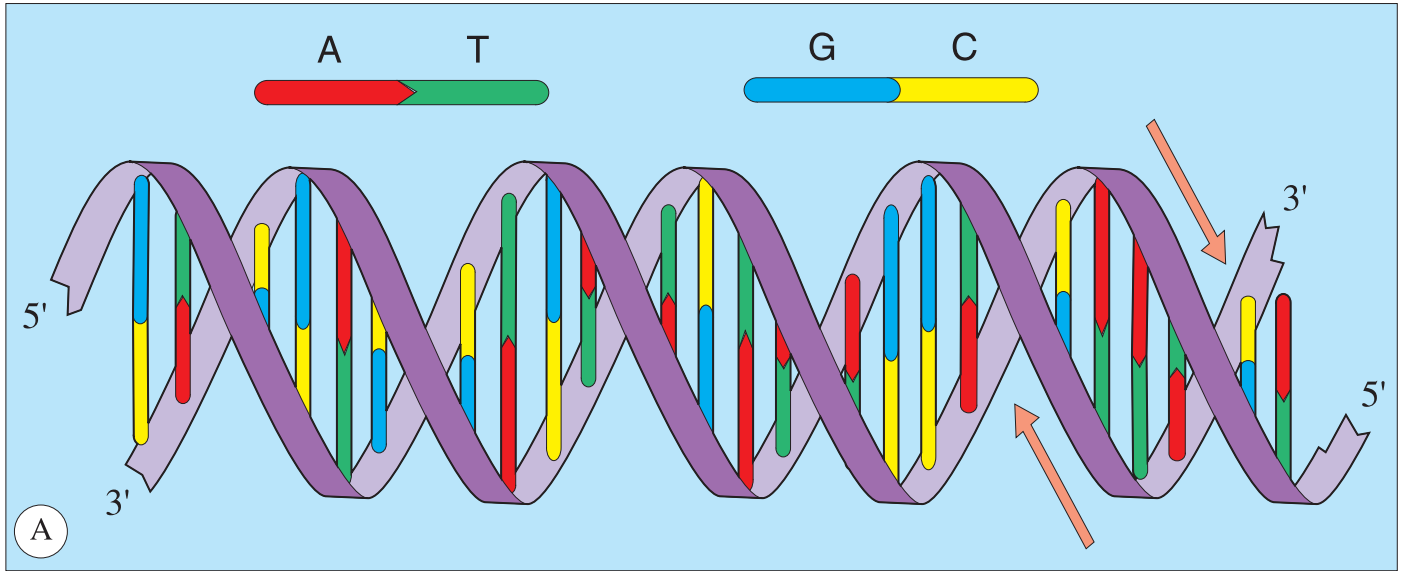
Meganeura (Carboniferous): <https://commons.wikimedia.org/wiki/File:Meganeura.jpg>

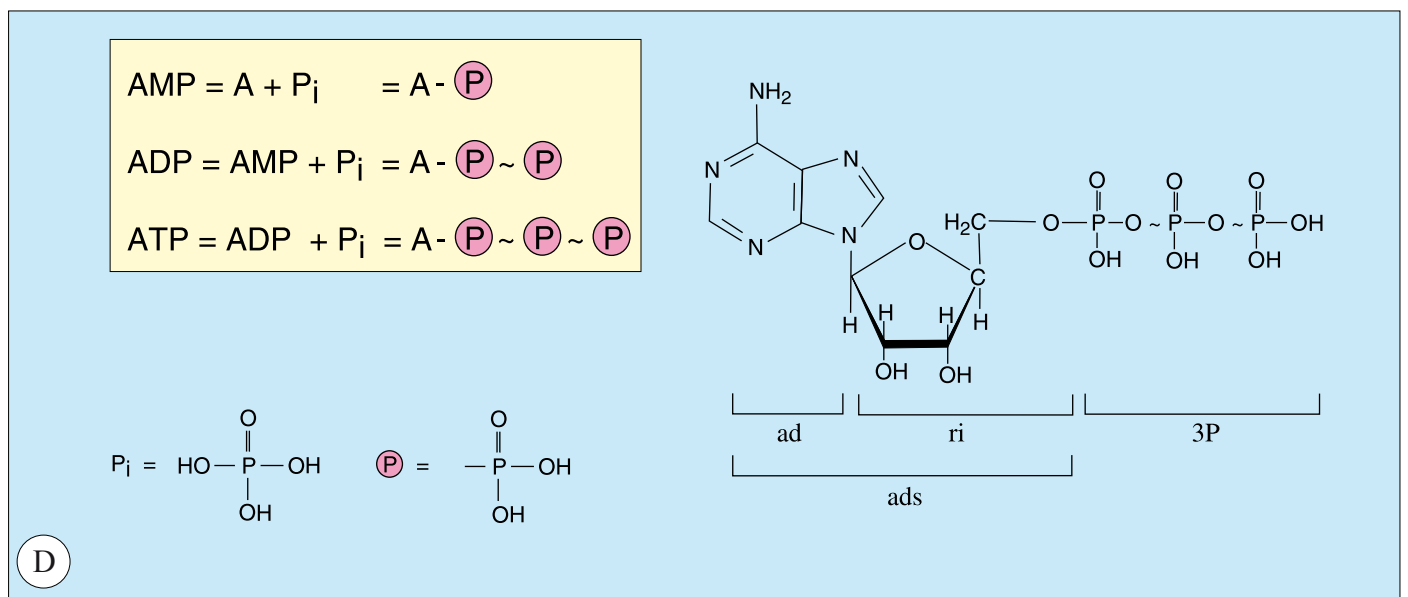
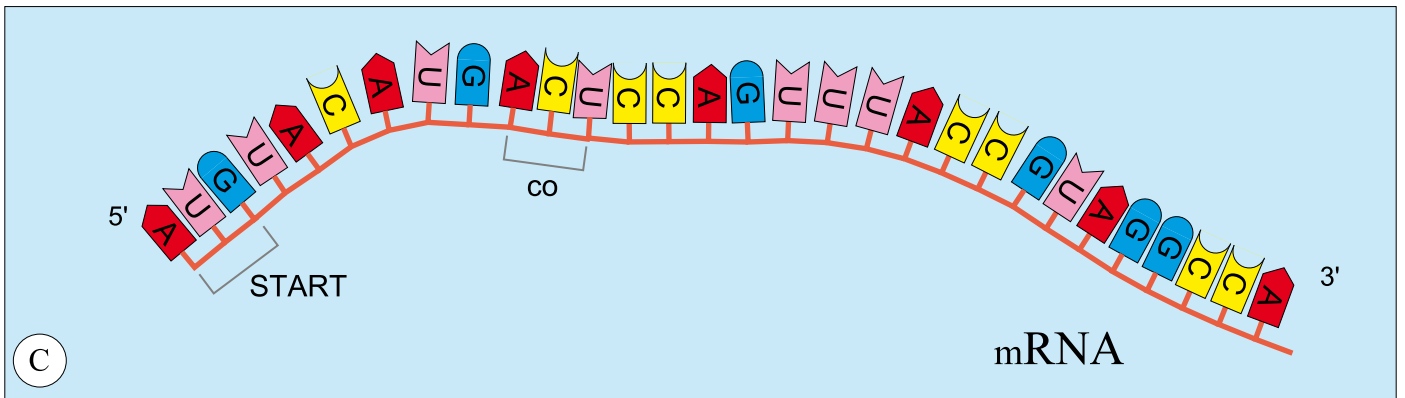
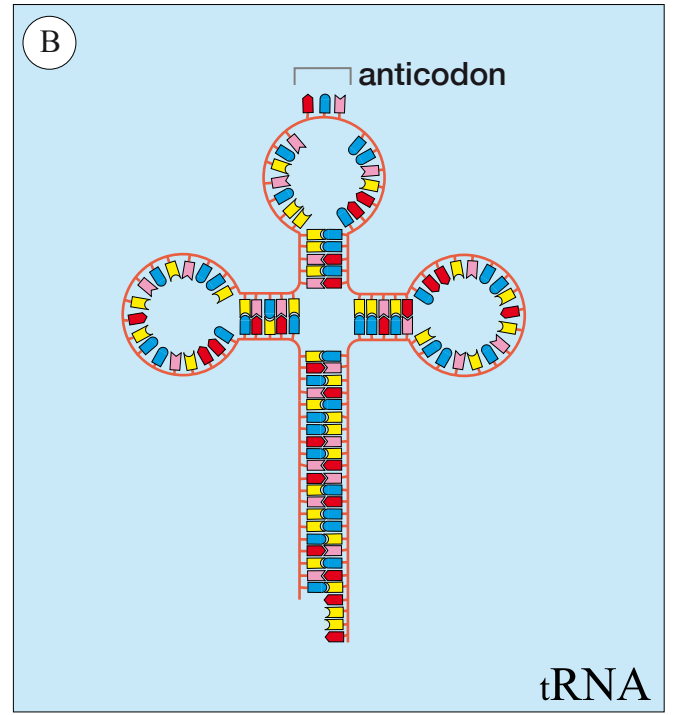
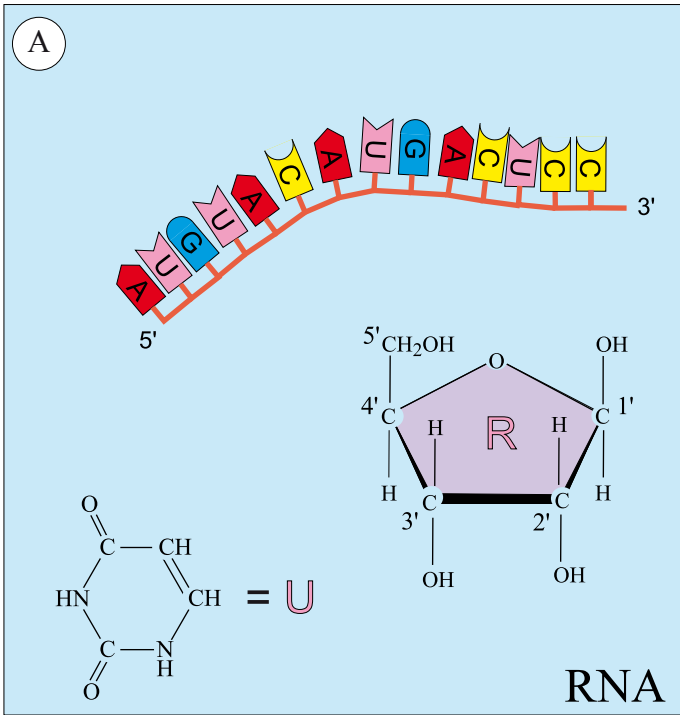
Archaeognatha (Devonian): <https://bugguide.net/user/view/7>

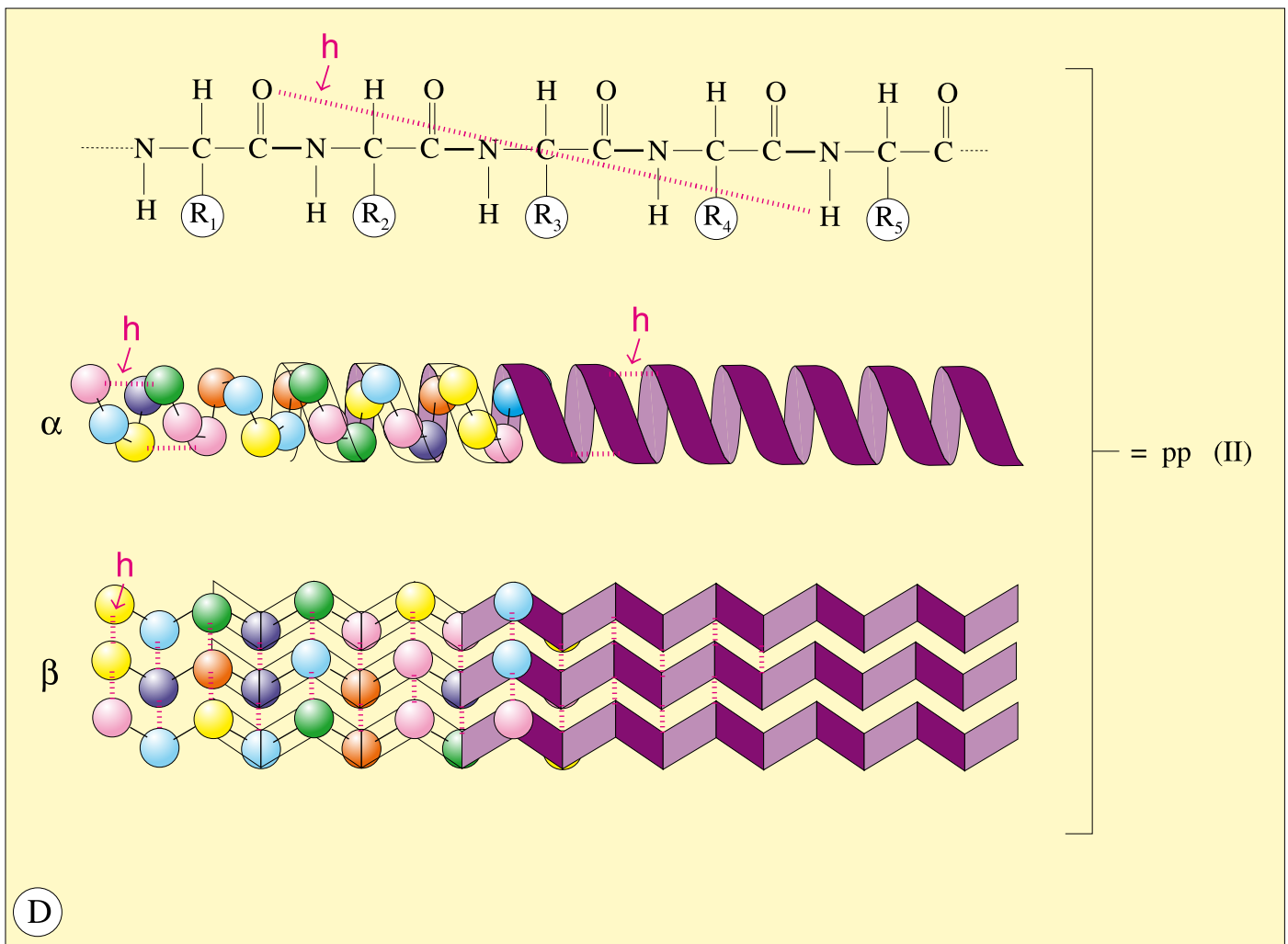
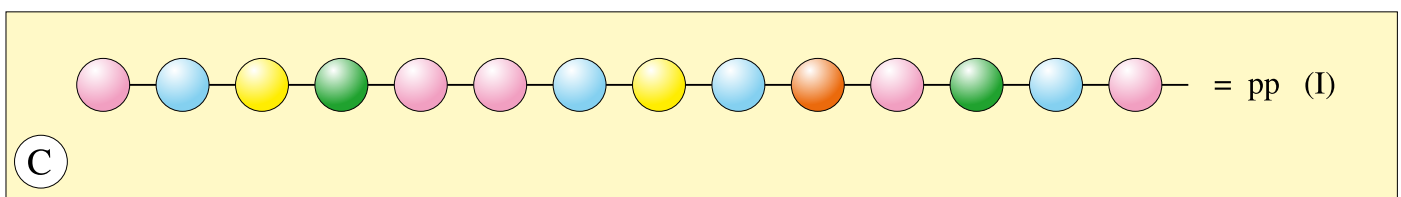
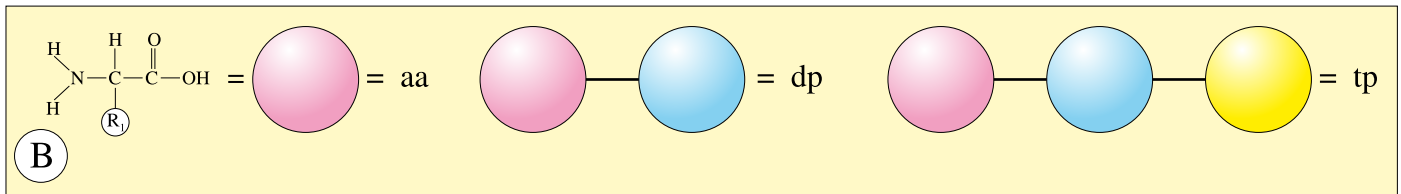
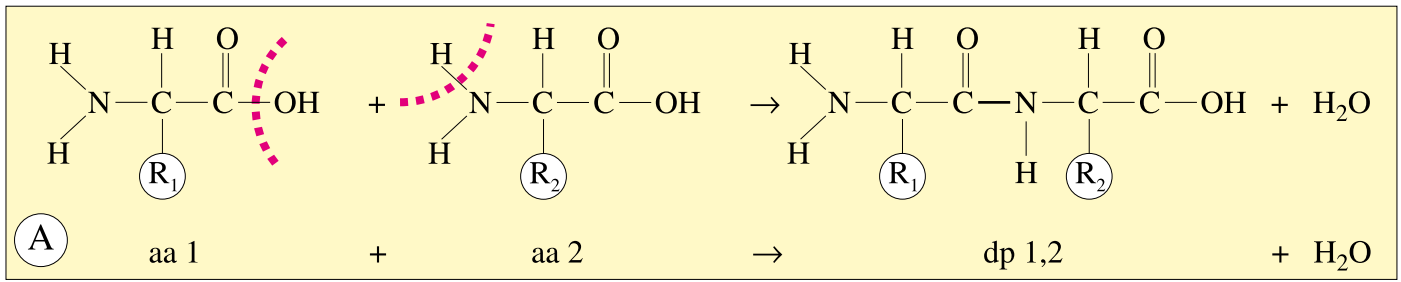
Cooksonia (Silurian): <https://en.wikipedia.org/wiki/Cooksonia>

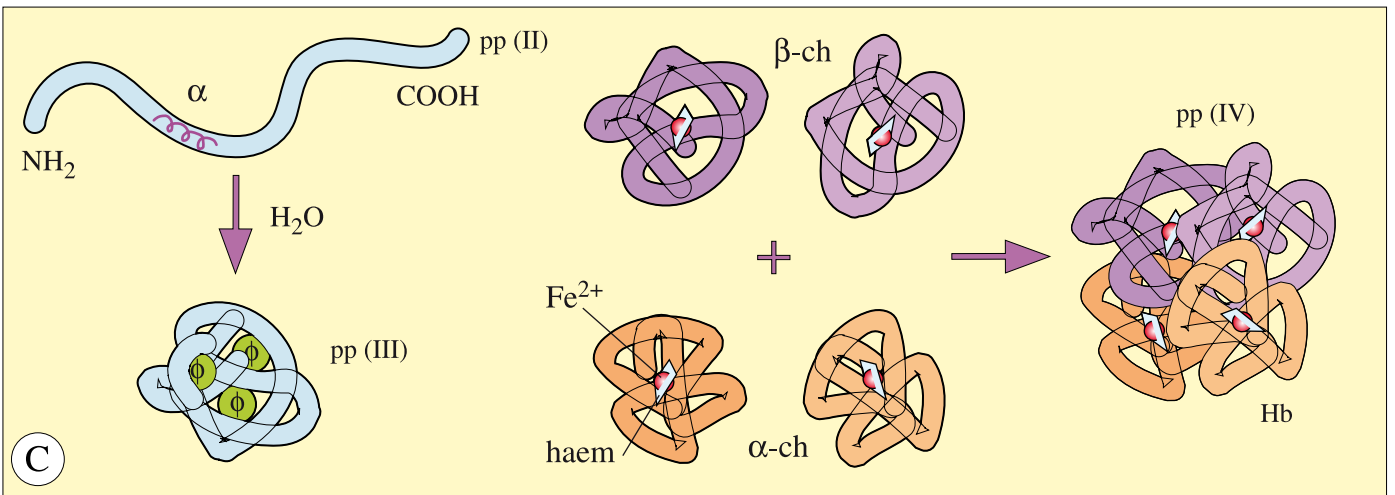
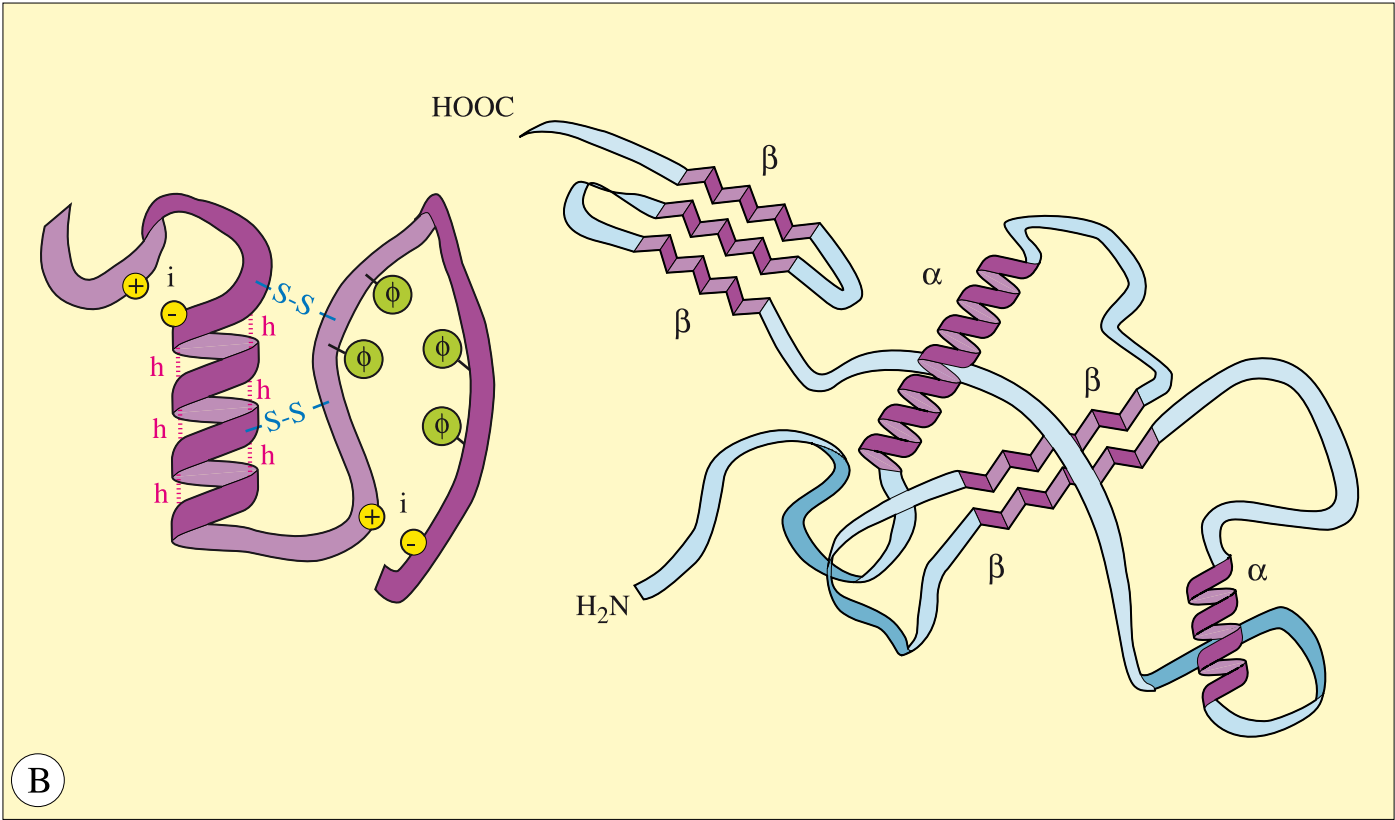
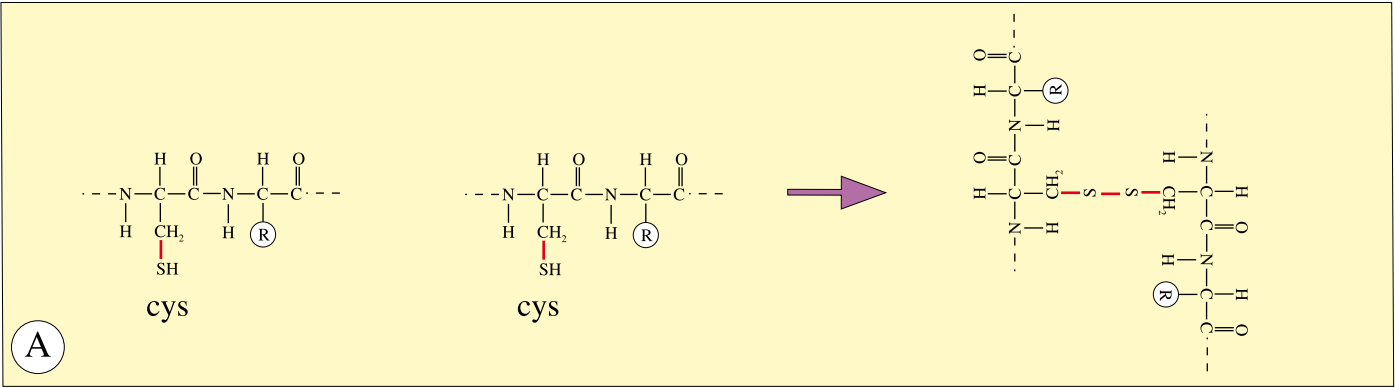


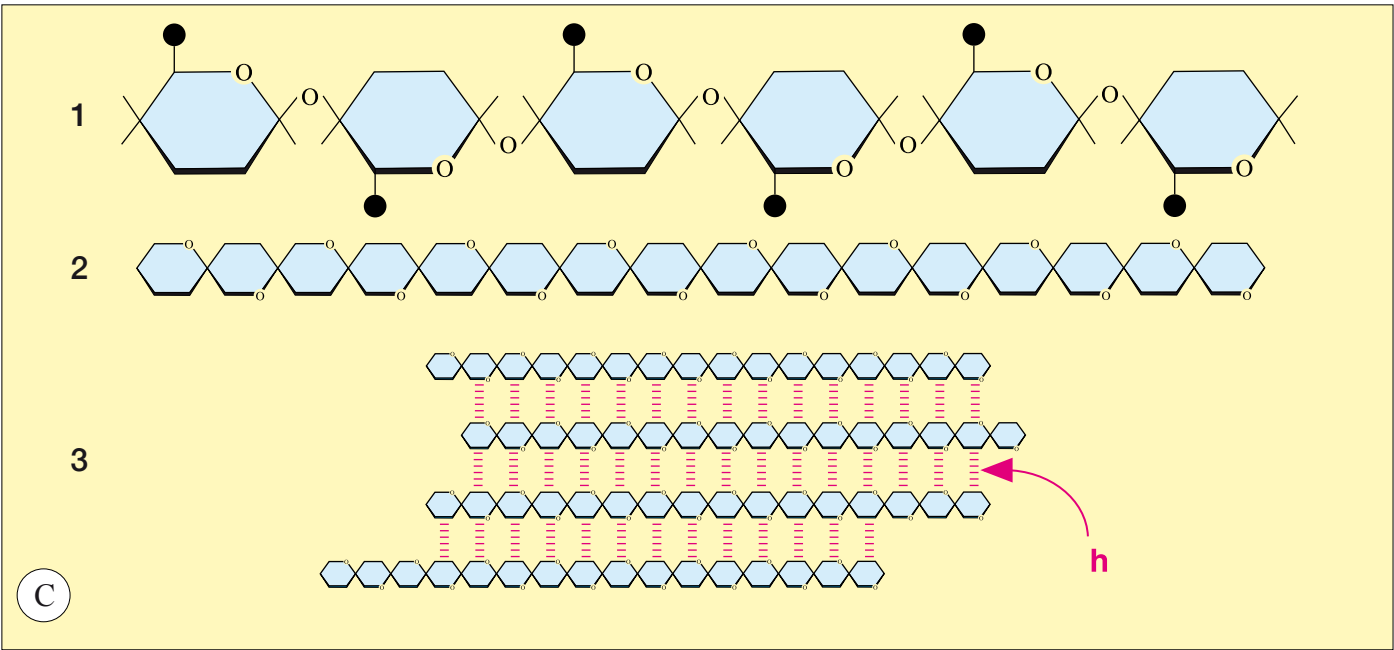
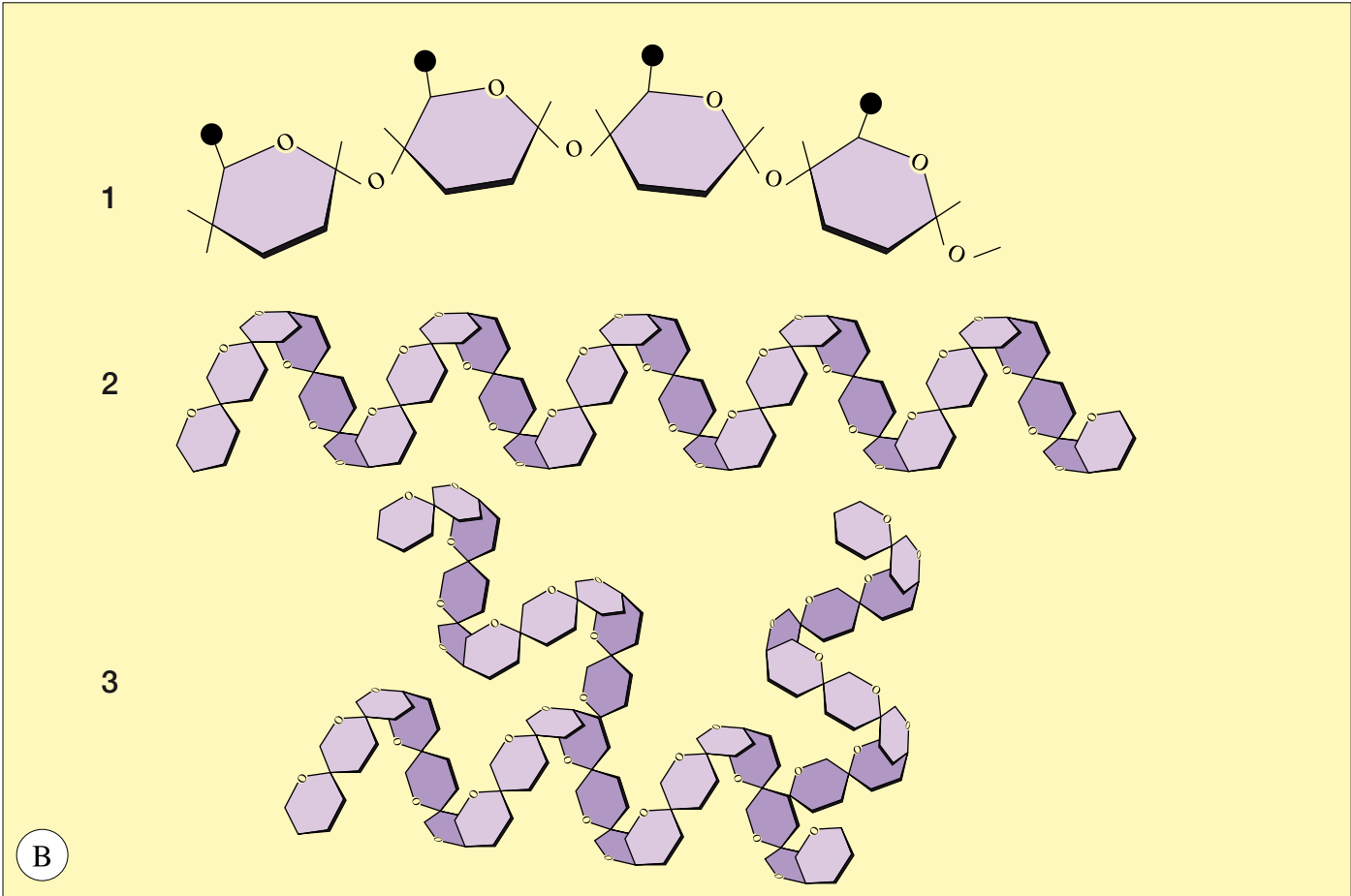
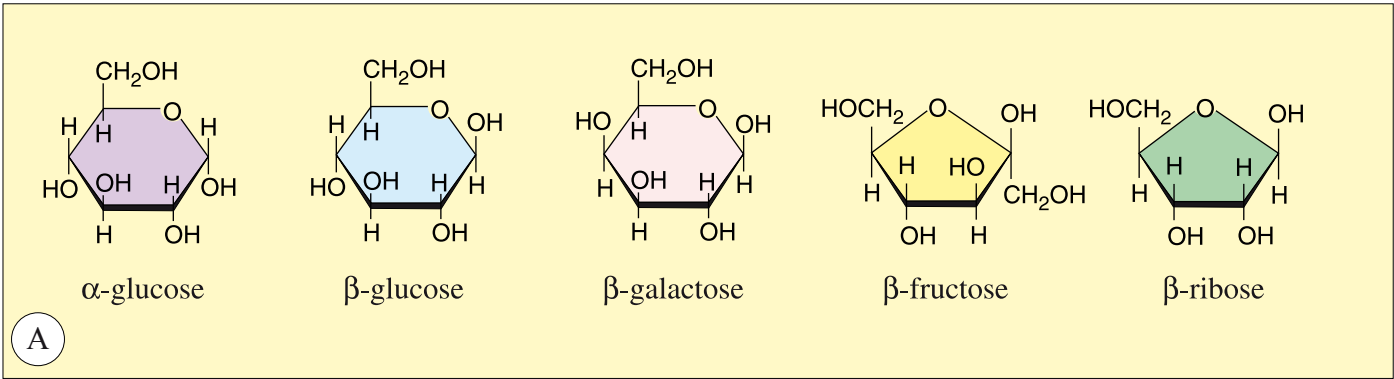


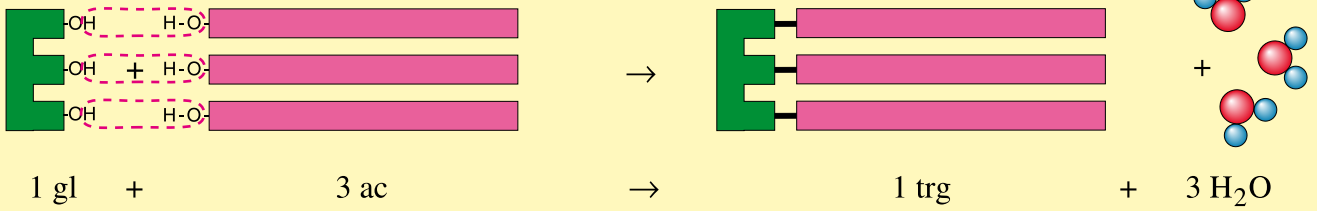
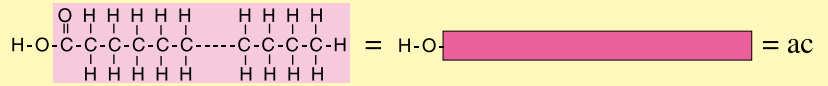
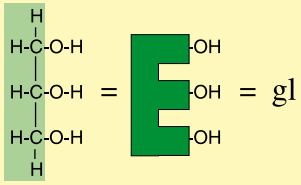




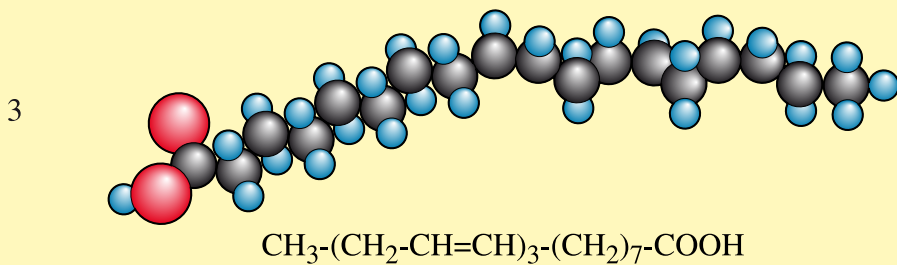
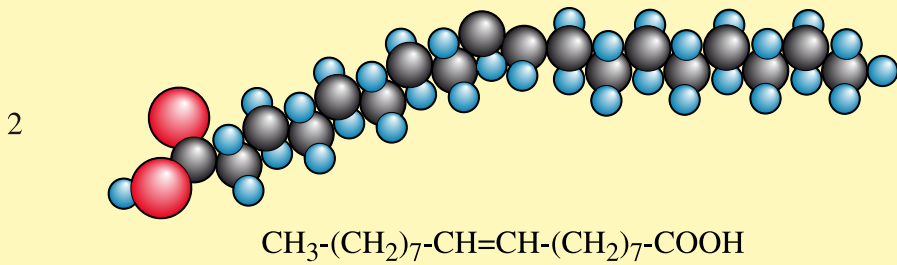
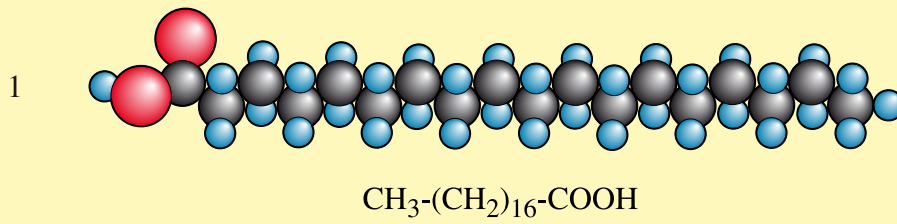




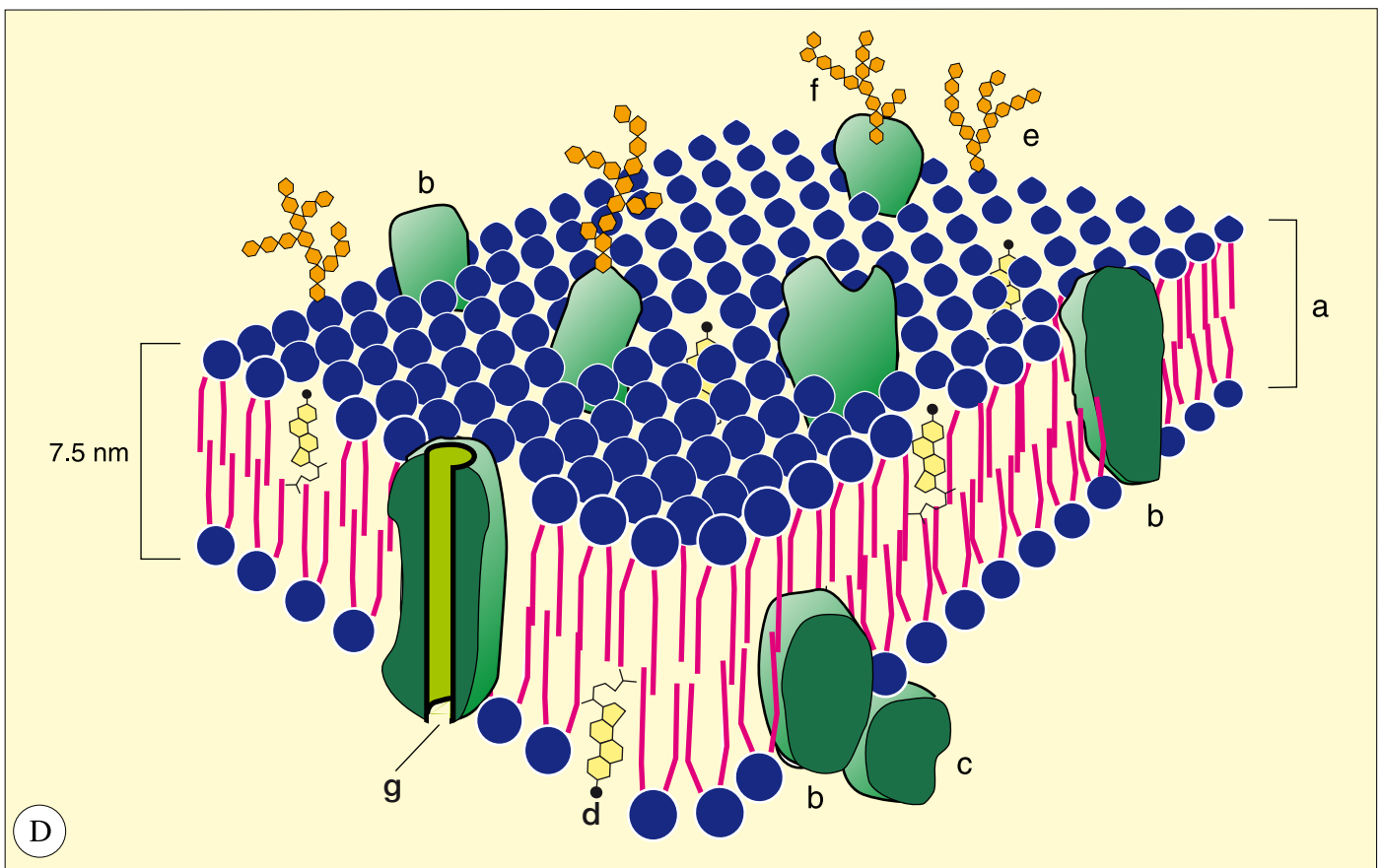
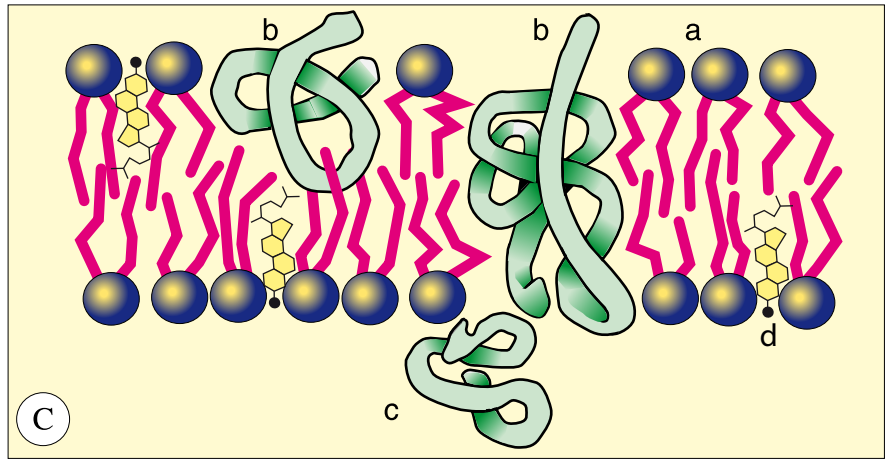
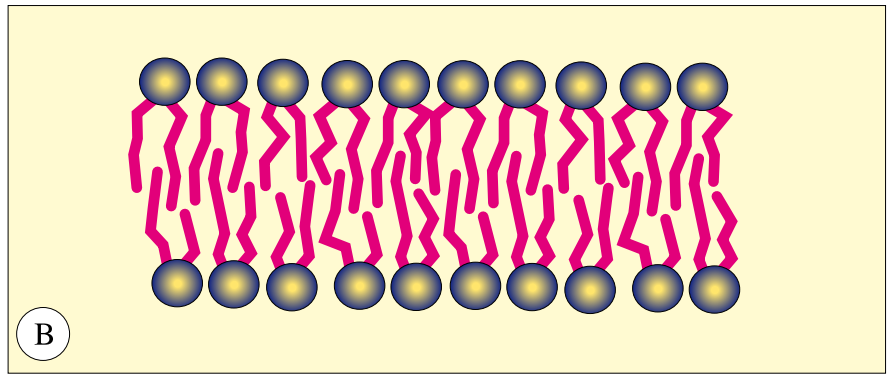
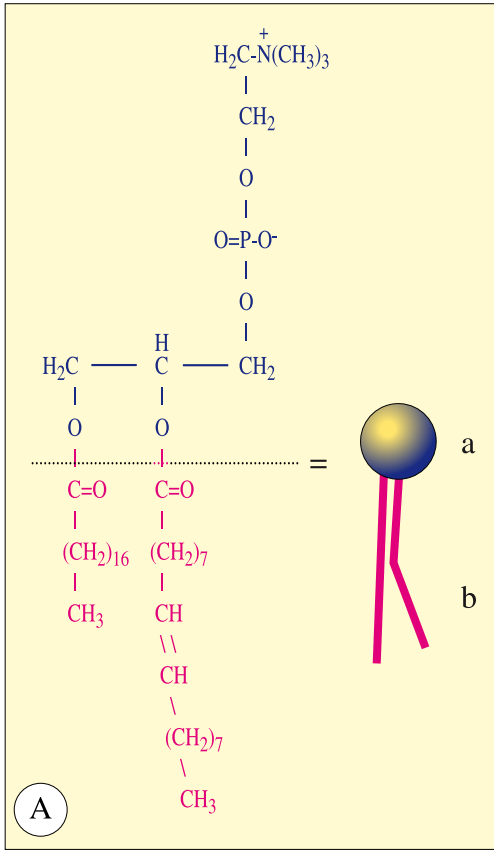


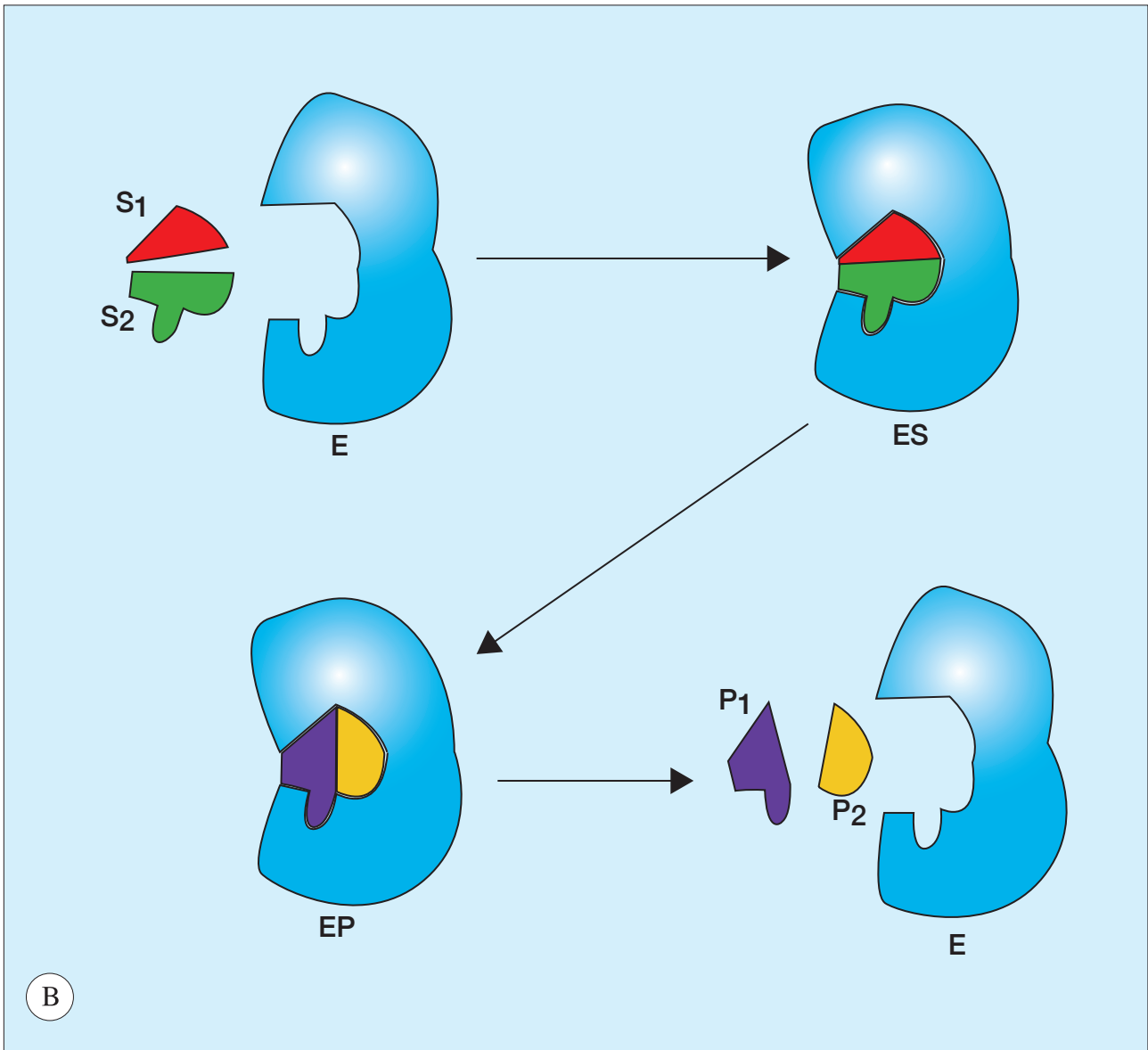
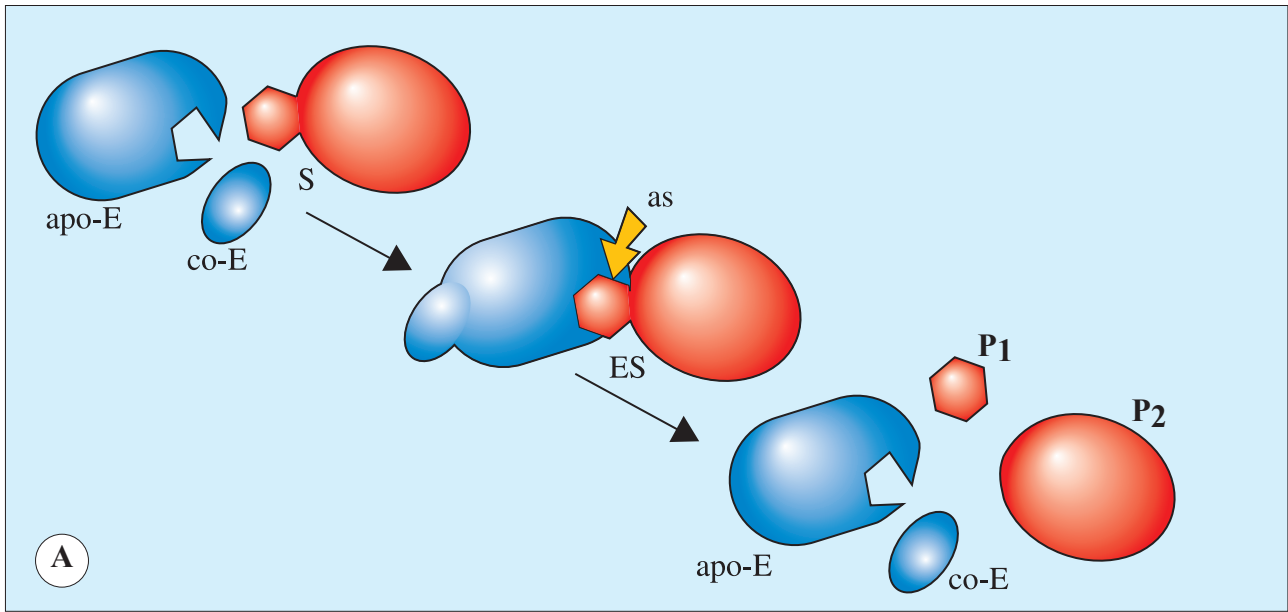


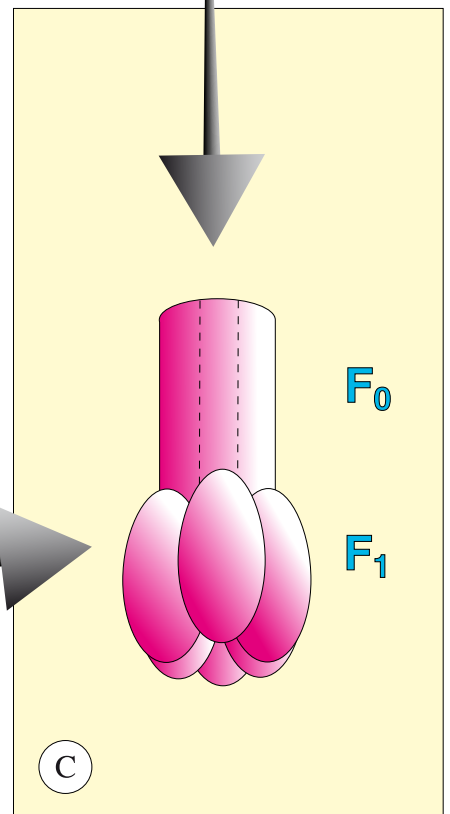
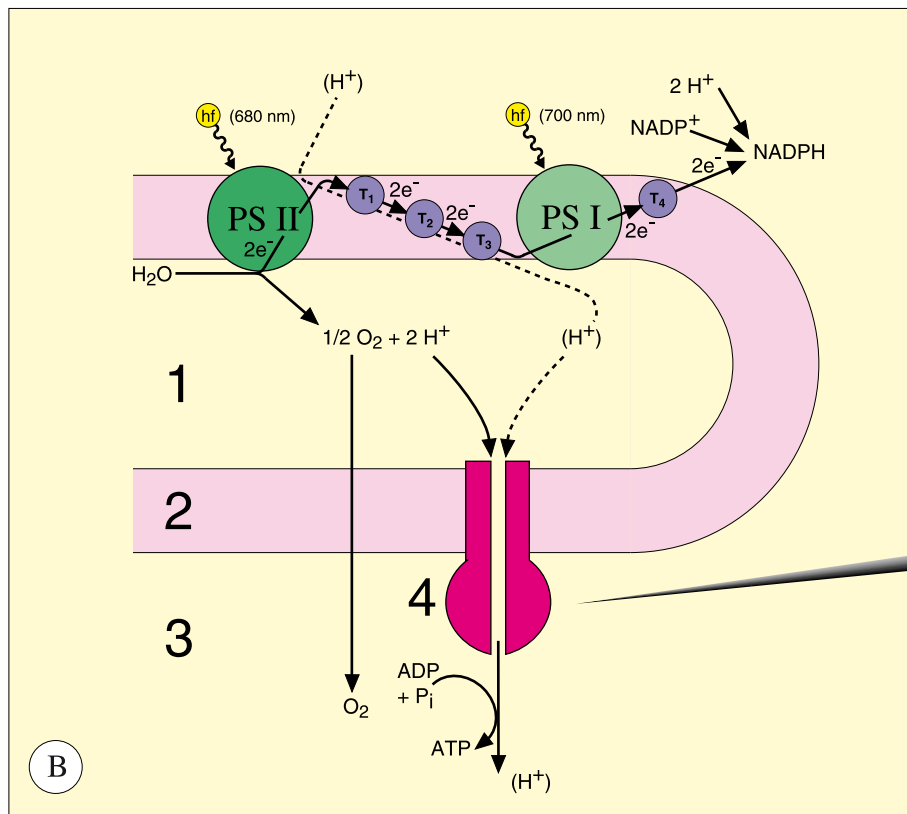
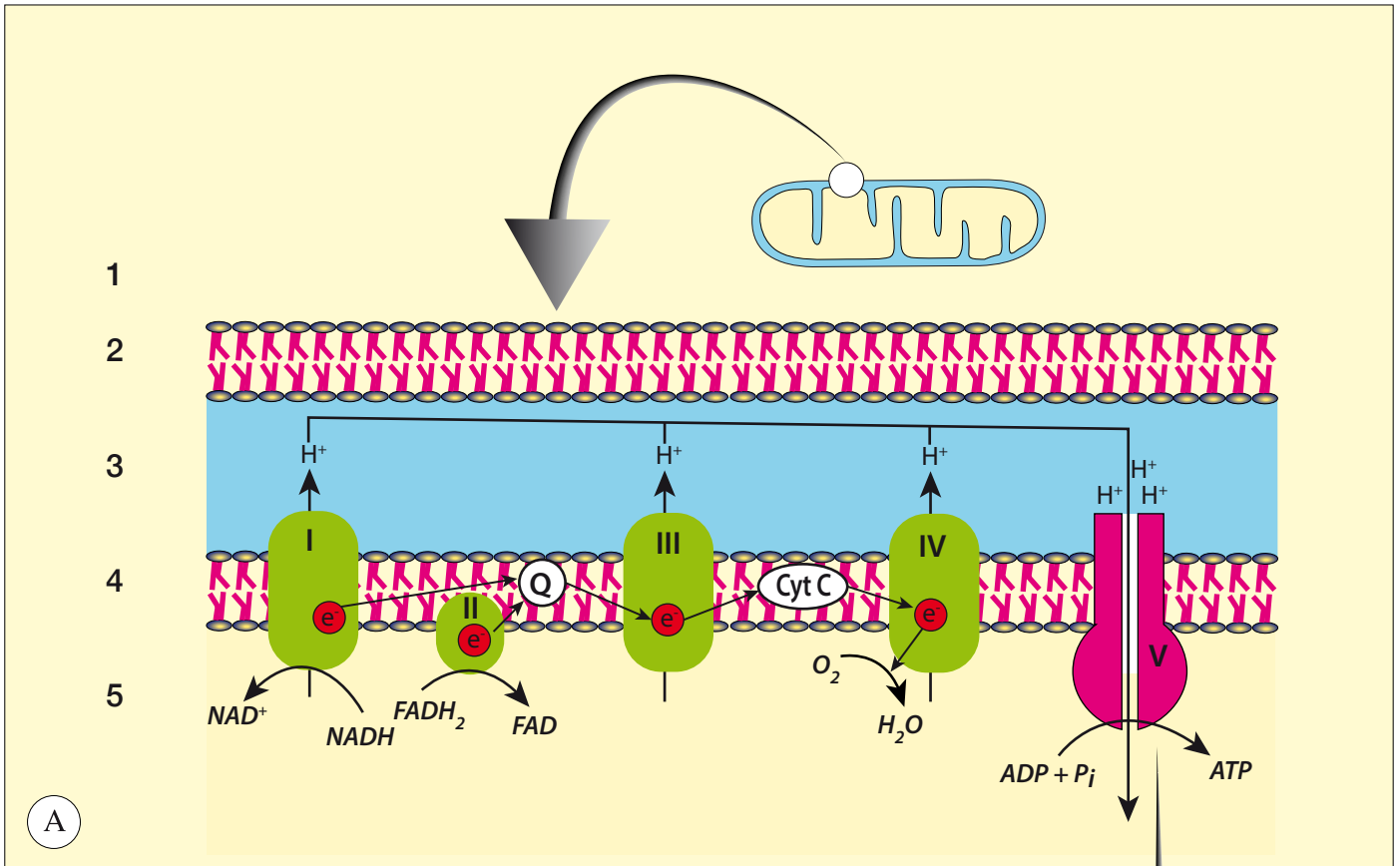
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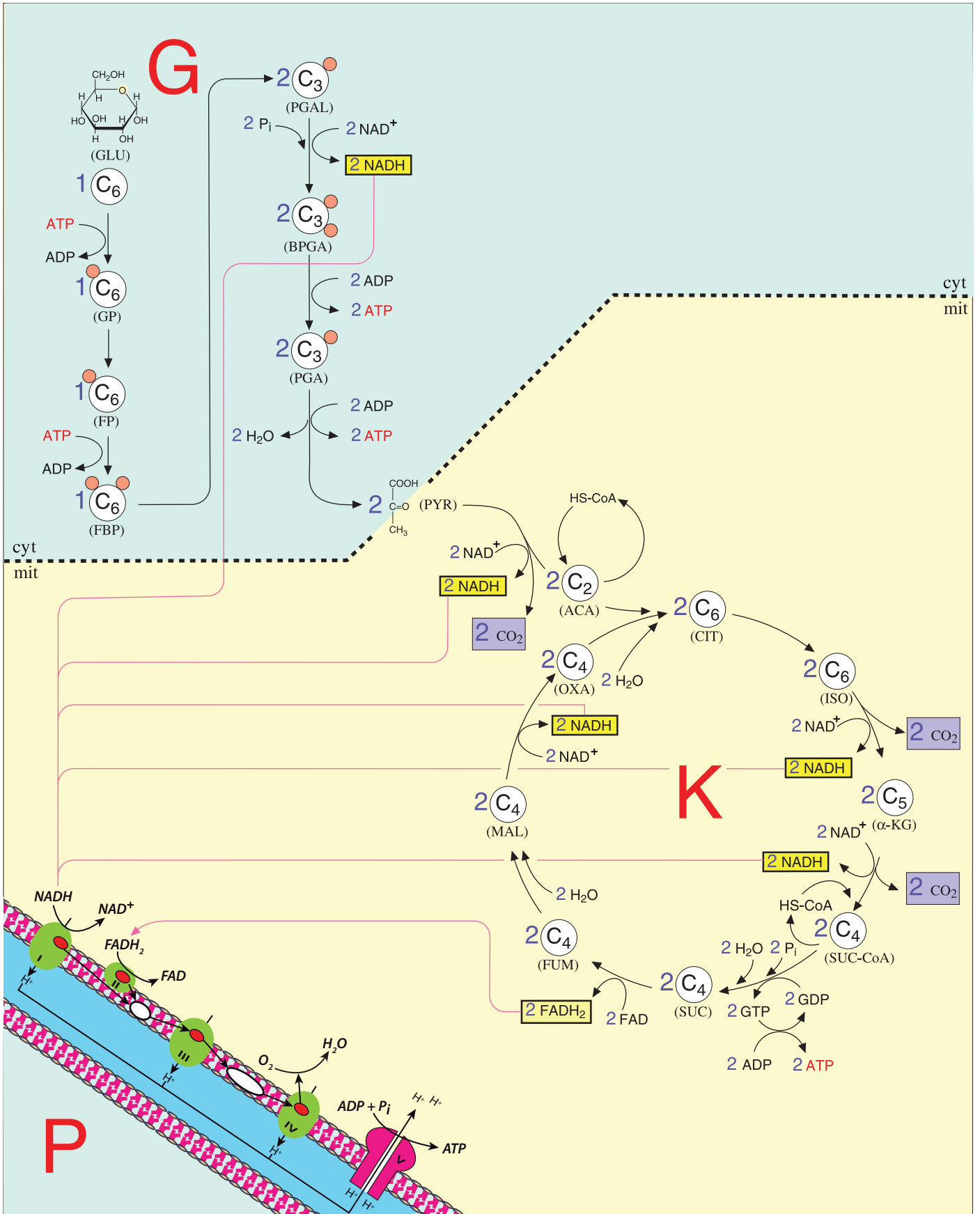


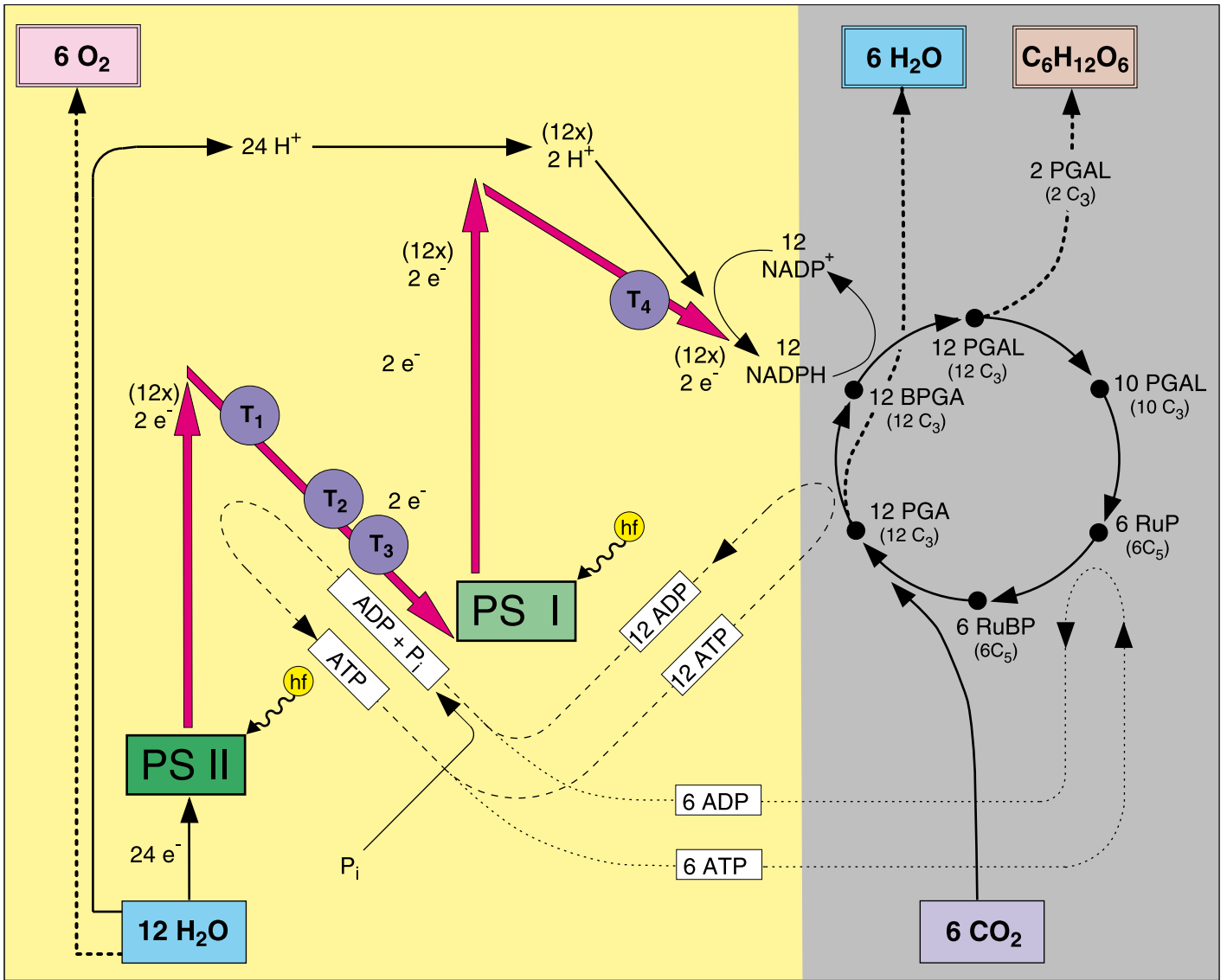
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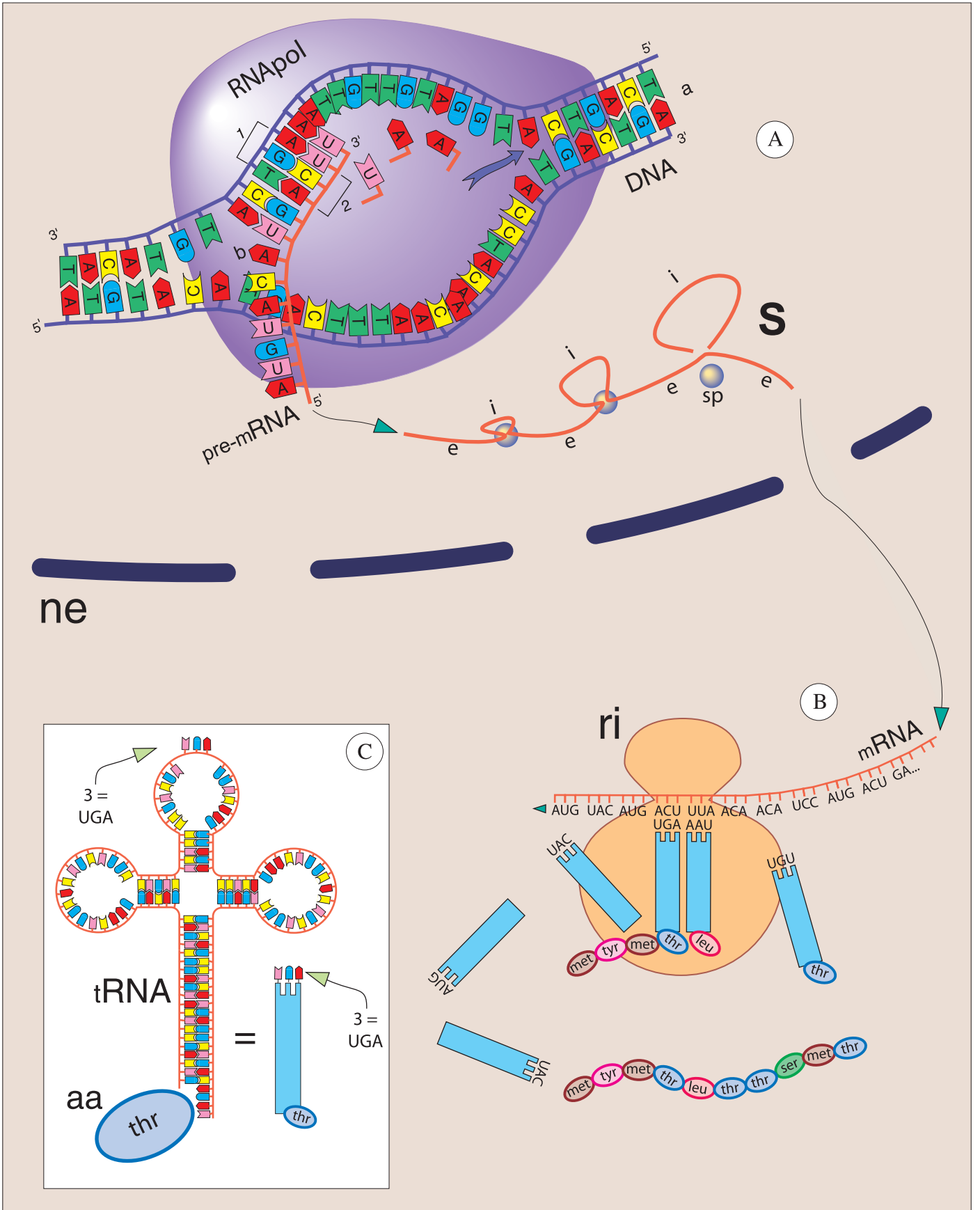


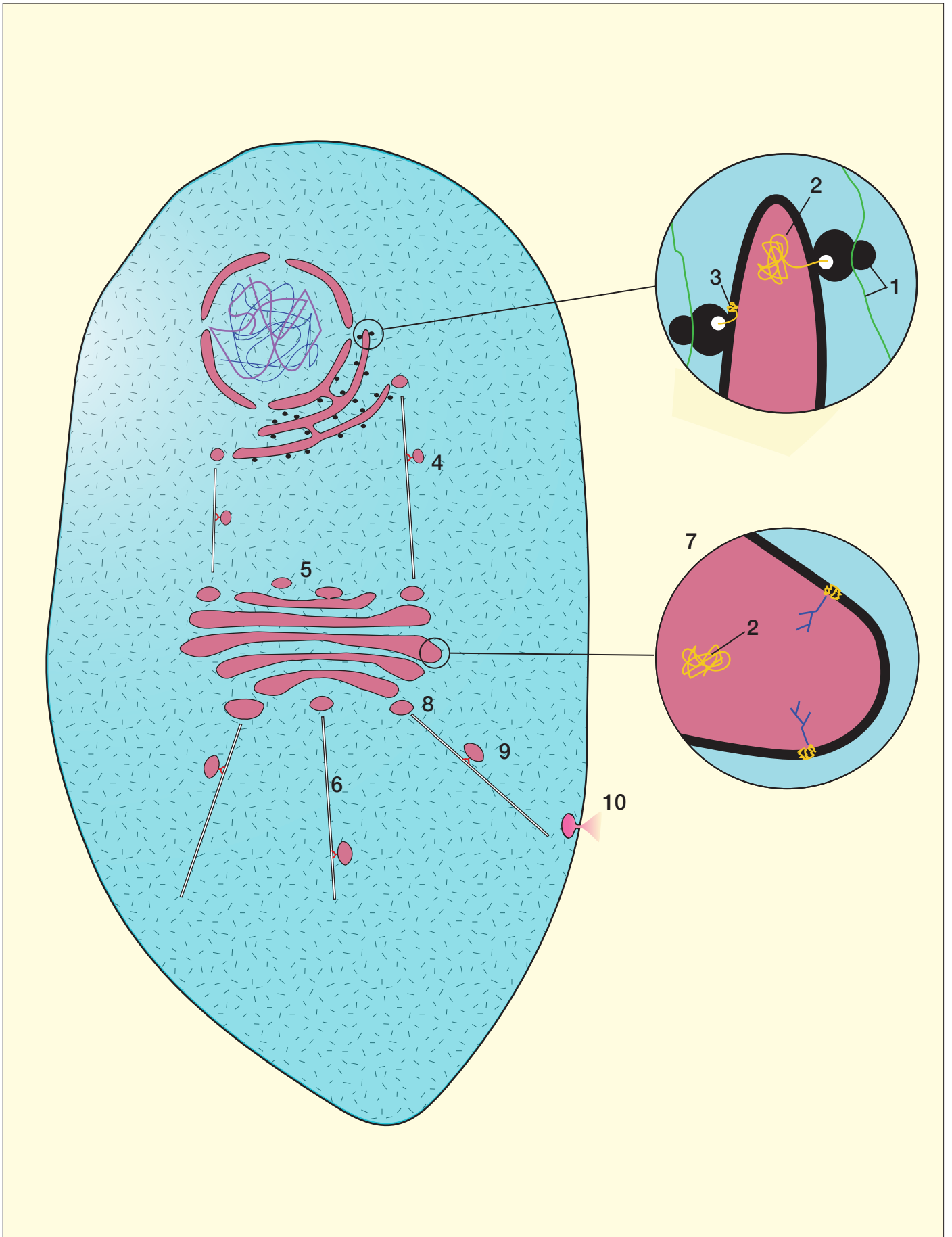






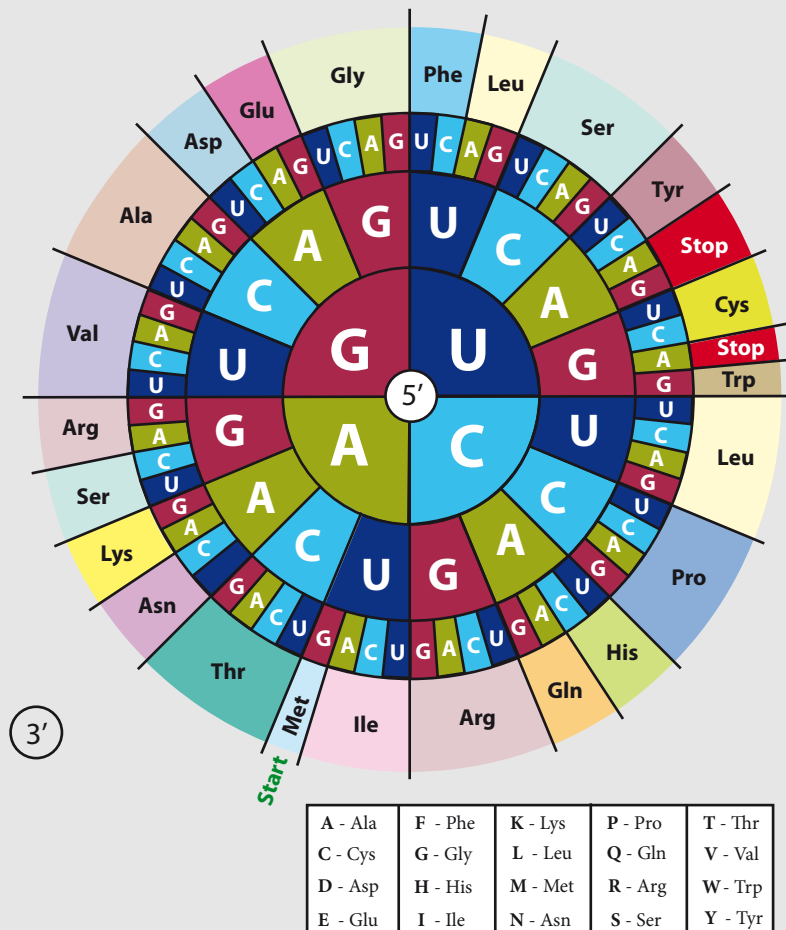


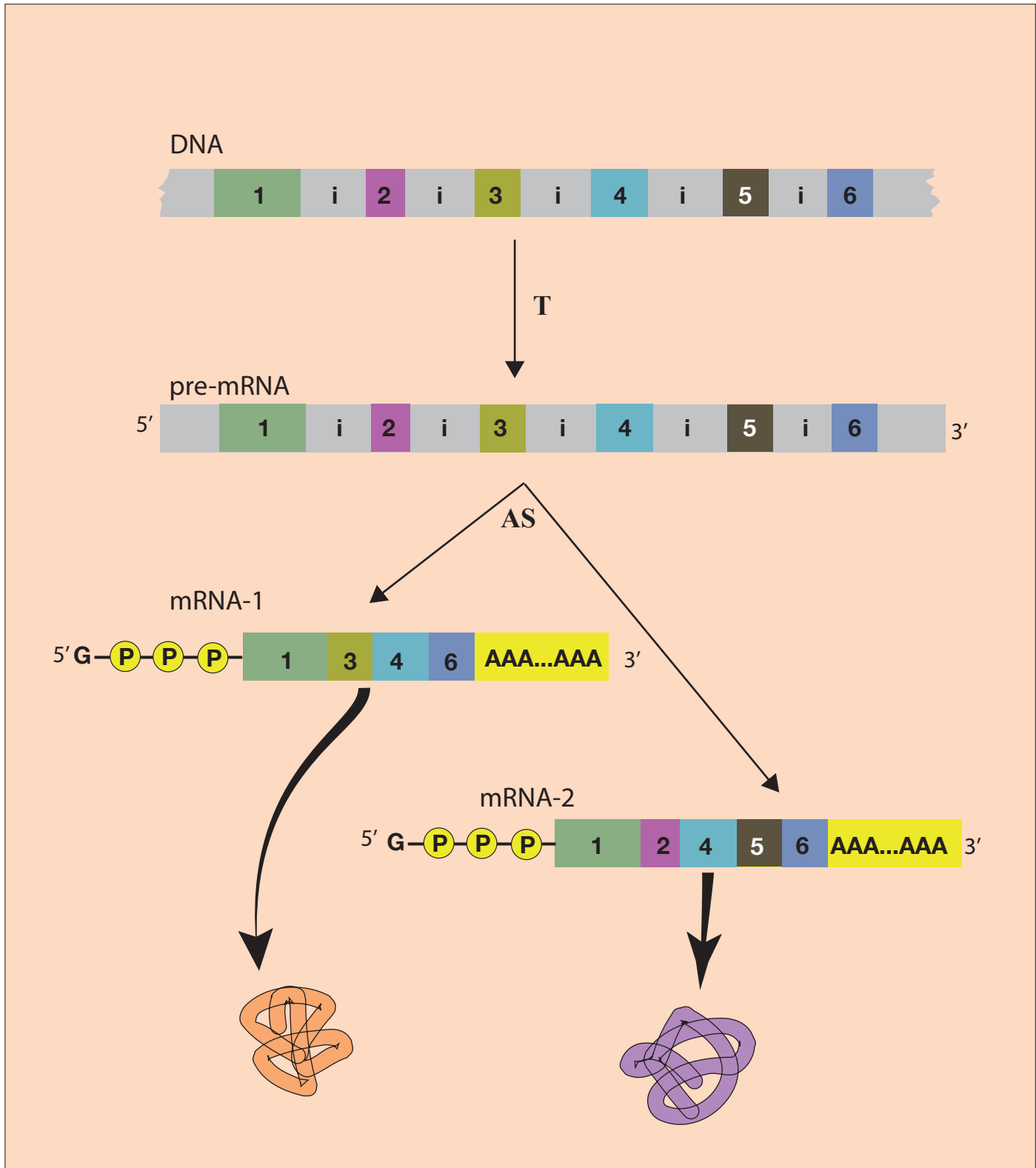


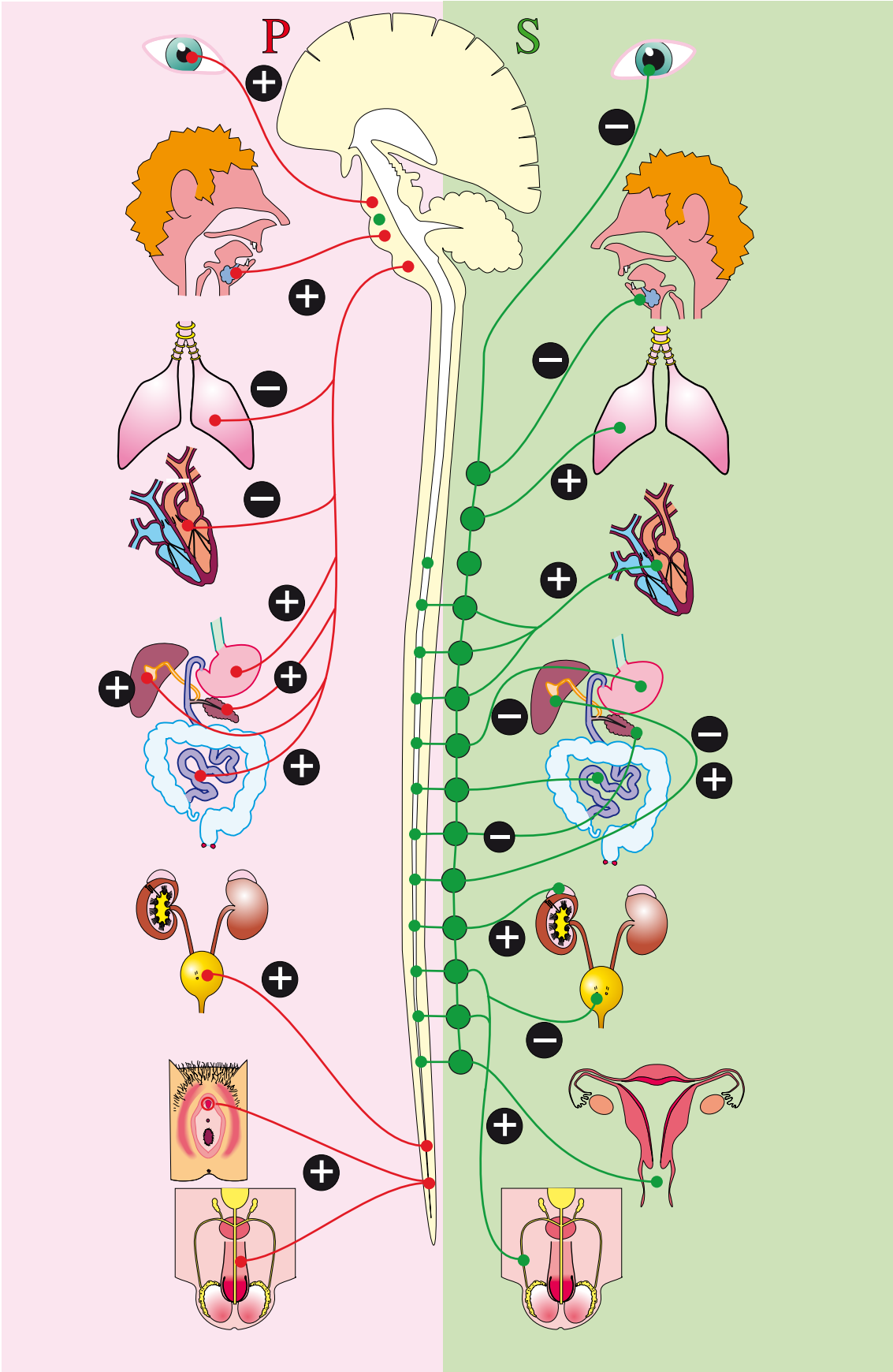


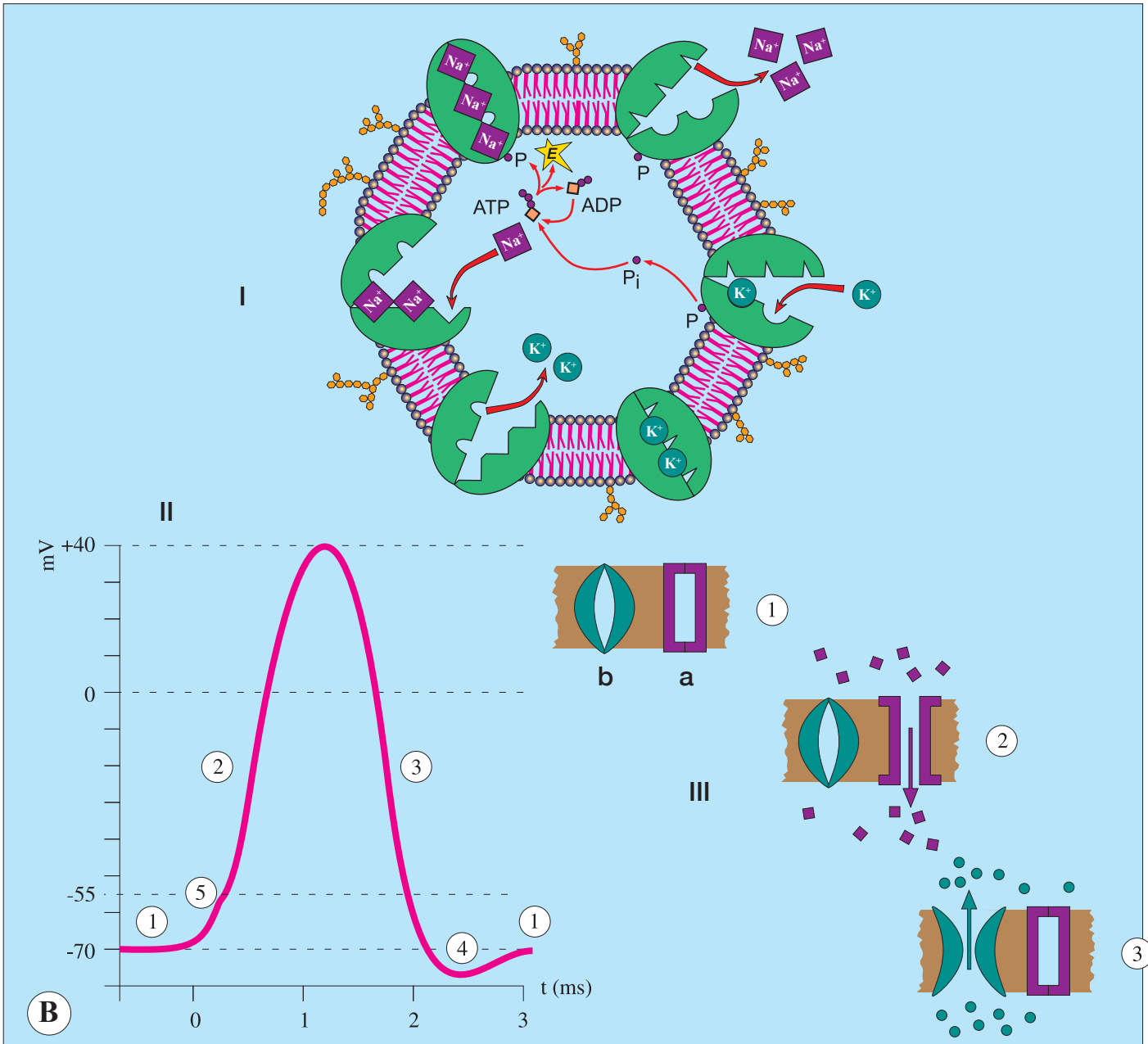
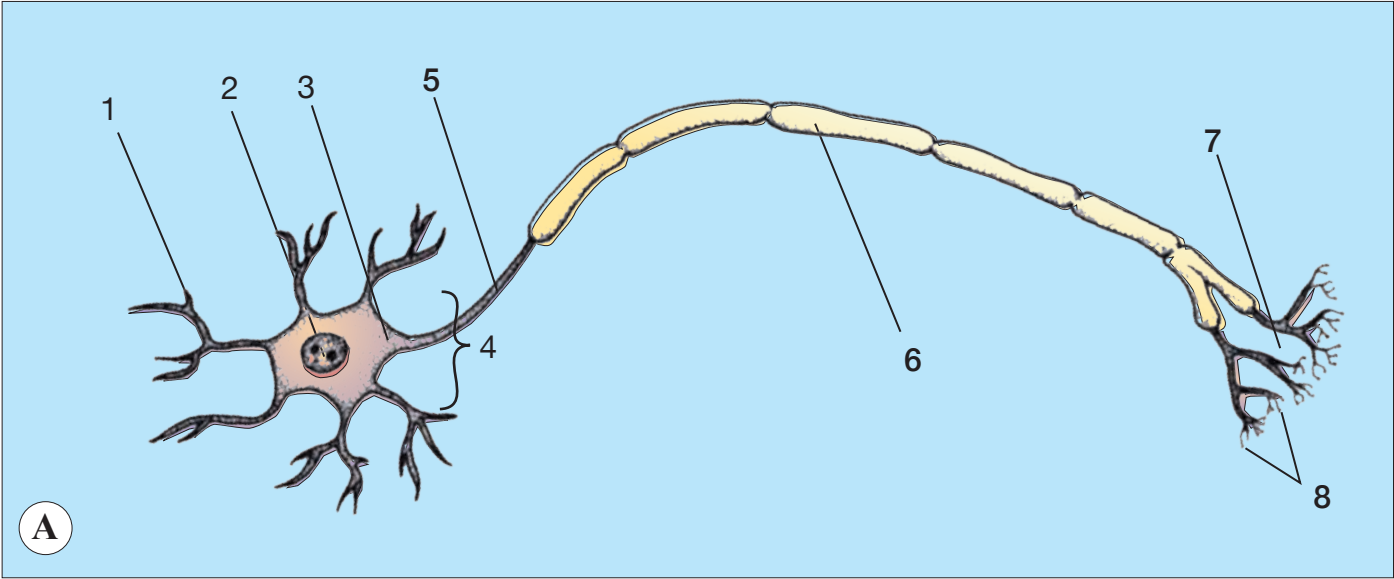
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U	Phe	Ser	Tyr	Cys	U
	Phe	Ser	Tyr	Cys	C
	Leu	Ser	(STOP)	(STOP)	A
	Leu	Ser	(STOP)	Trp	G
C	Leu	Pro	His	Arg	U
	Leu	Pro	His	Arg	C
	Leu	Pro	Gln	Arg	A
	Leu	Pro	Gln	Arg	G
A	Ile	Thr	Asn	Ser	U
	Ile	Thr	Asn	Ser	C
	Ile	Thr	Lys	Arg	A
	Met (START)	Thr	Lys	Arg	G
G	Val	Ala	Asp	Gly	U
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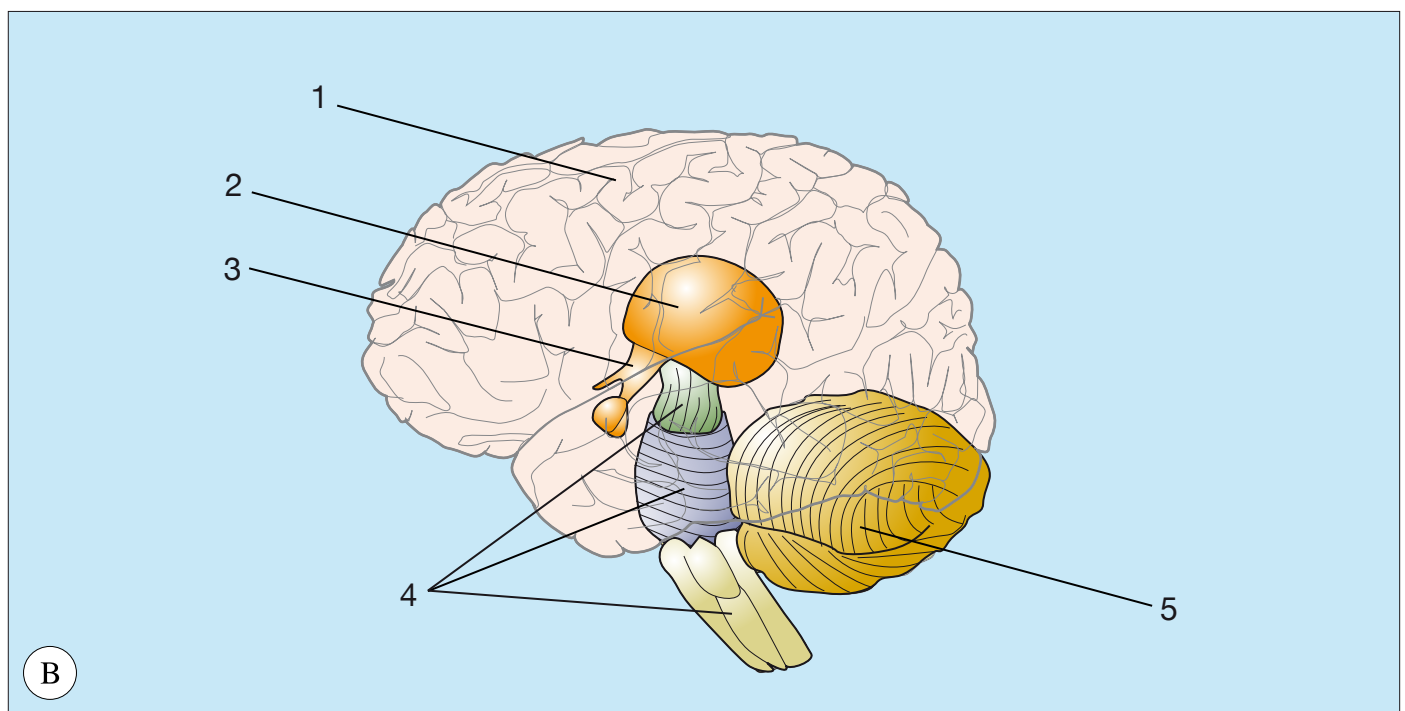
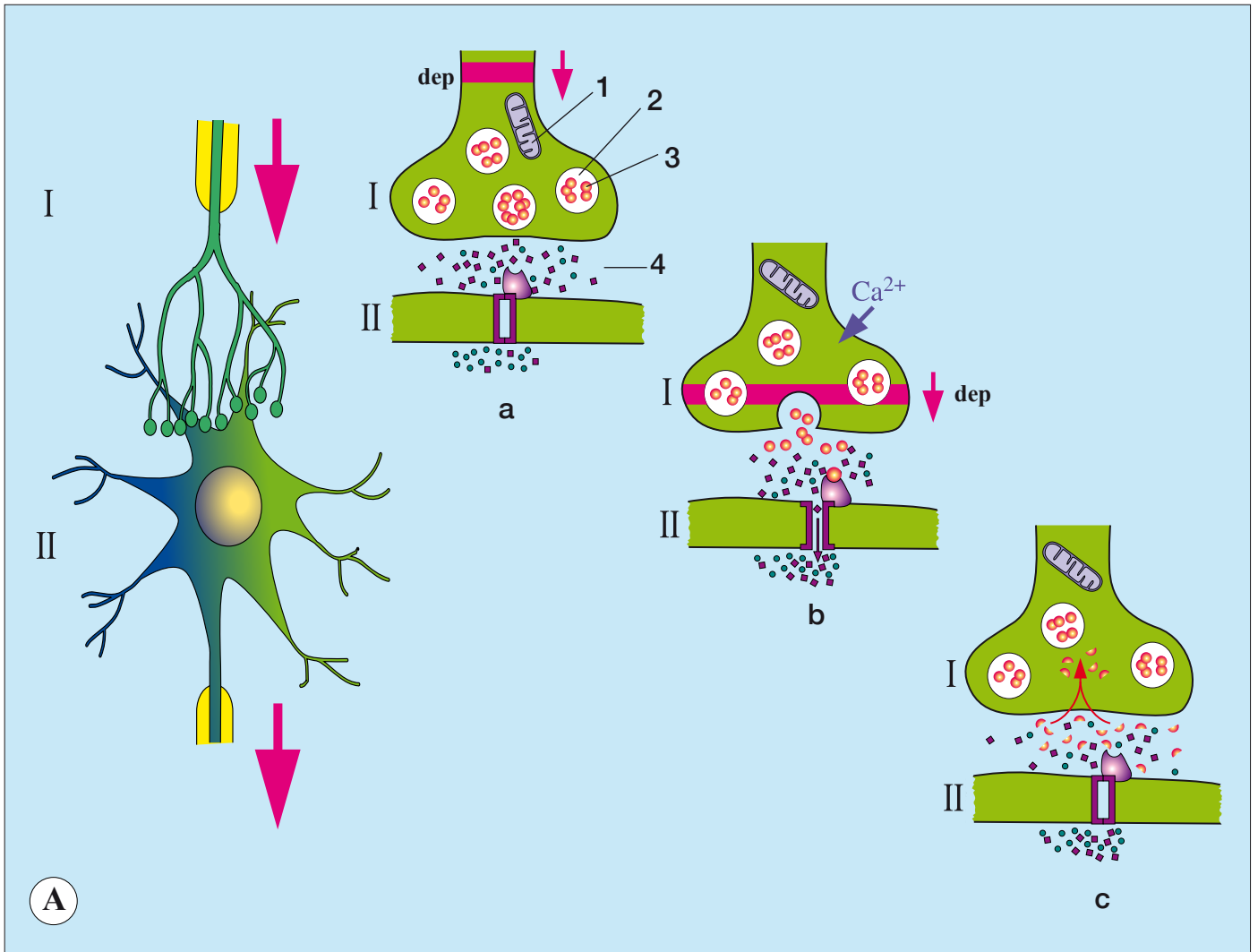
$$U = 1 (5') \quad U = 2 \quad U = 3 (3')$$

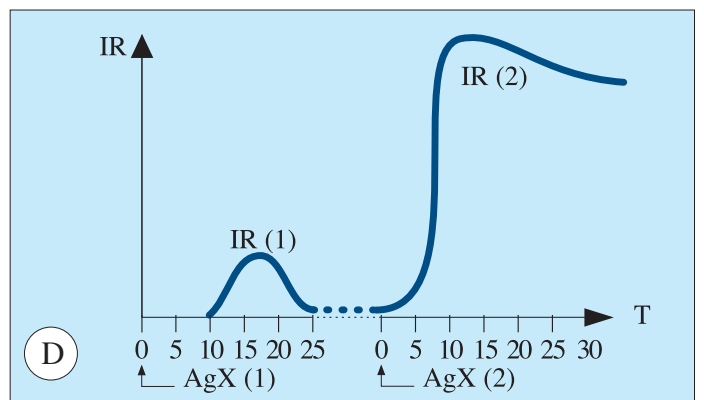
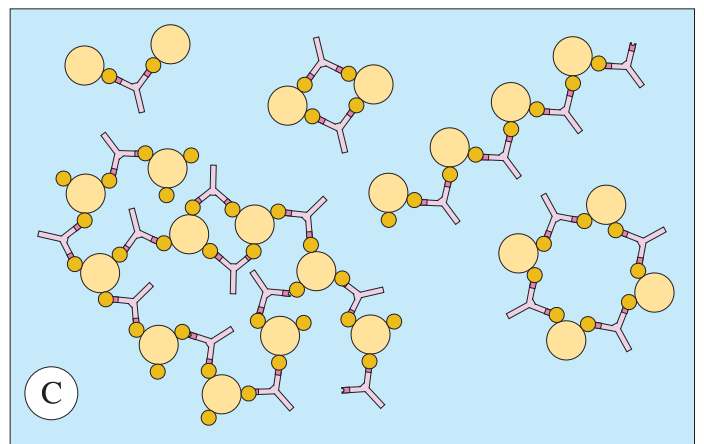
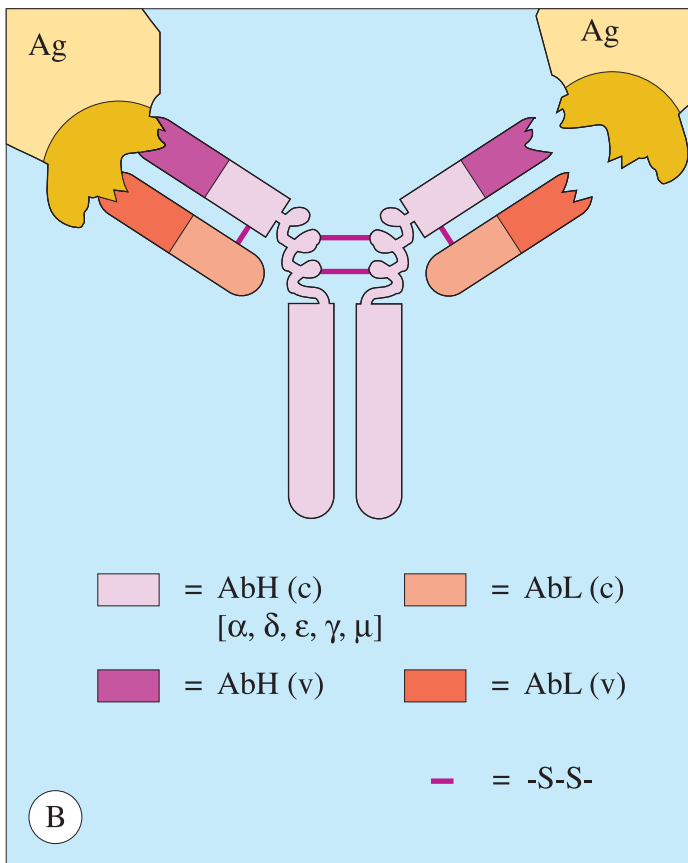
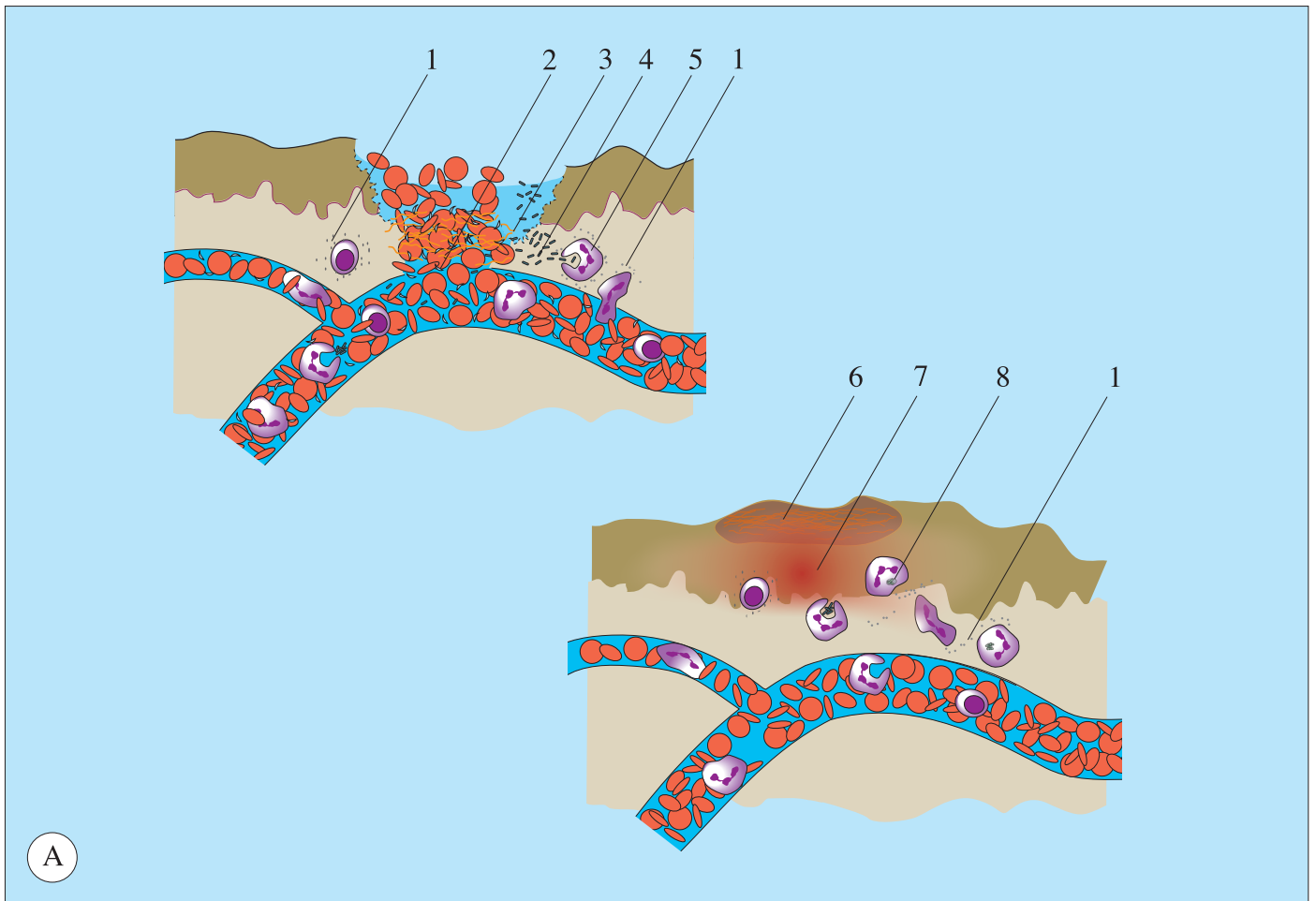


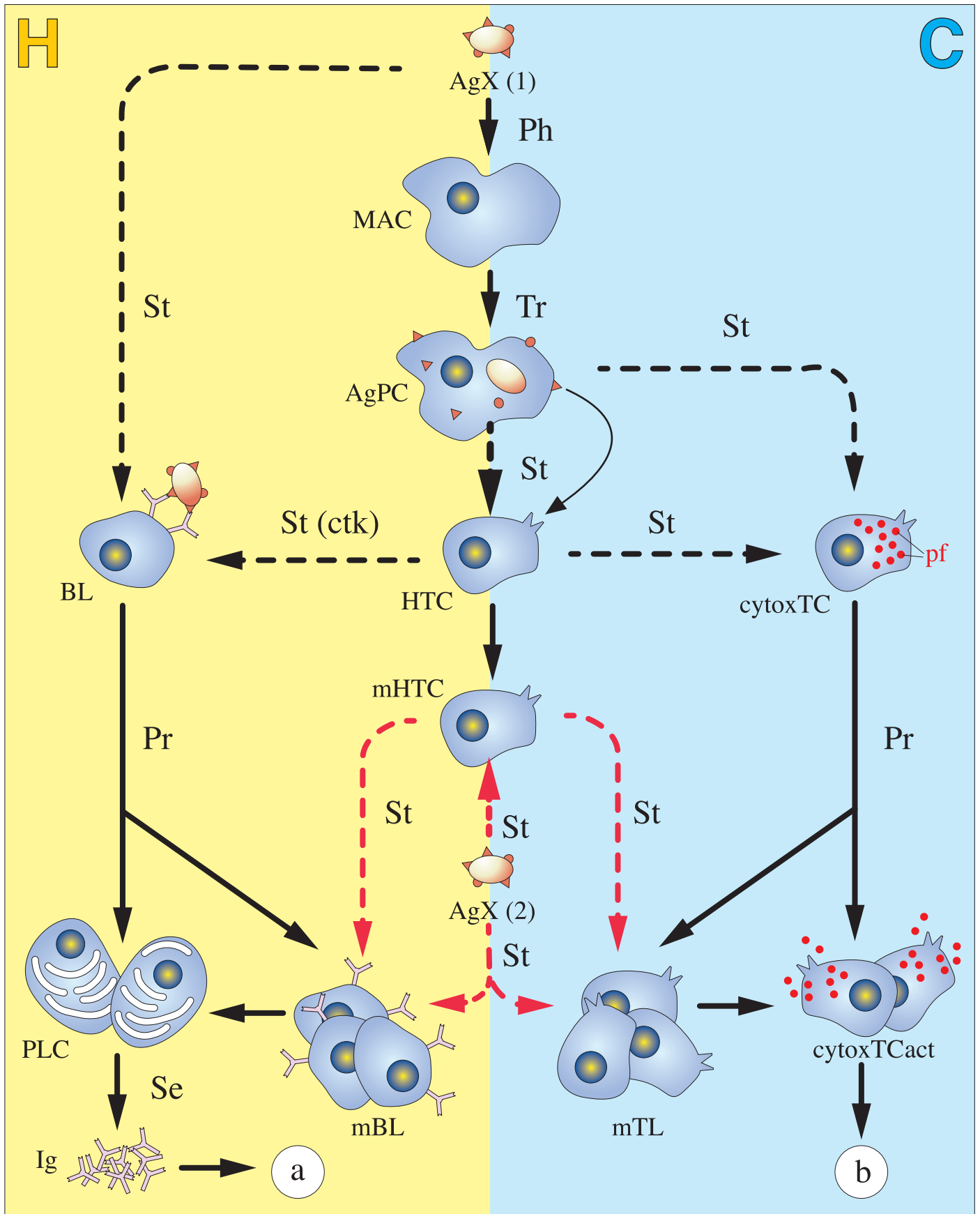




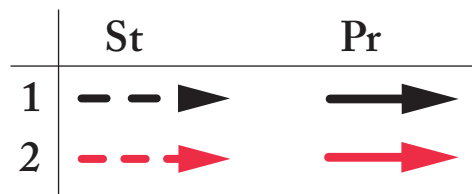


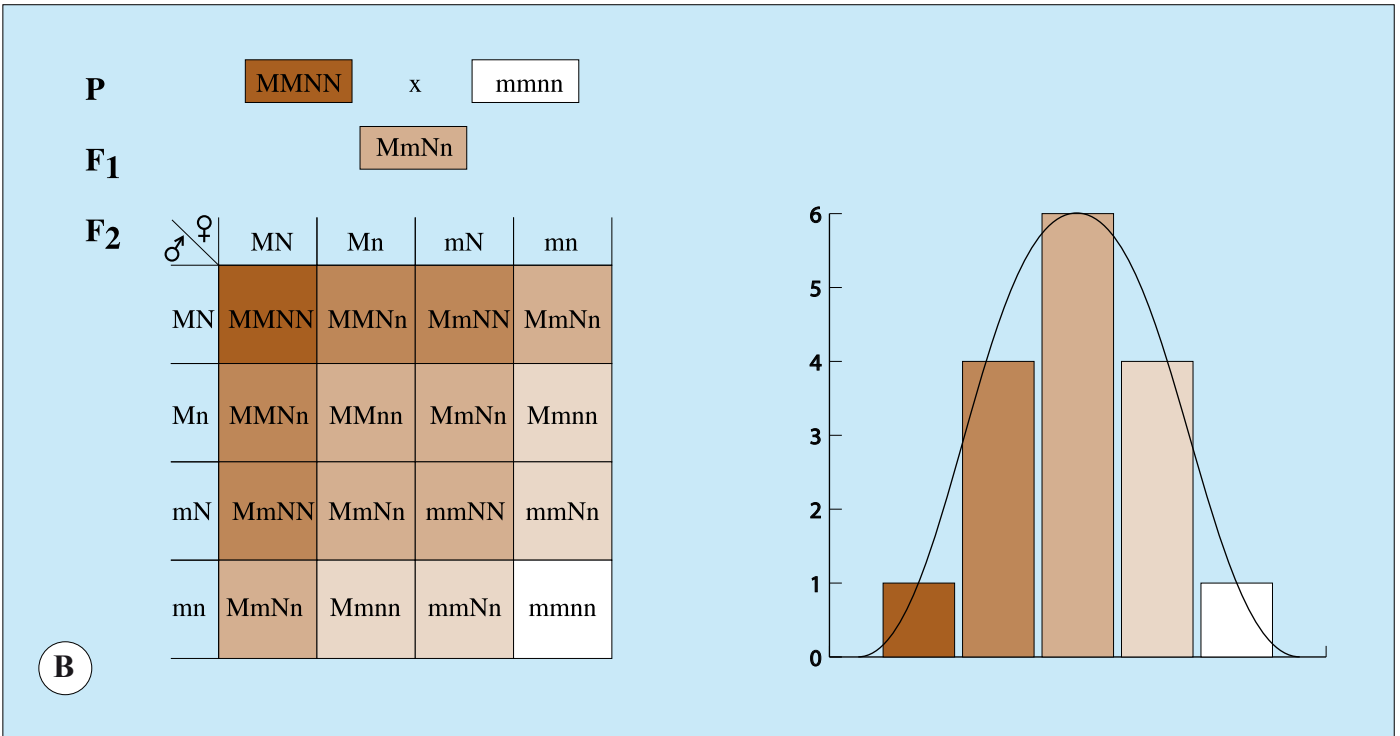
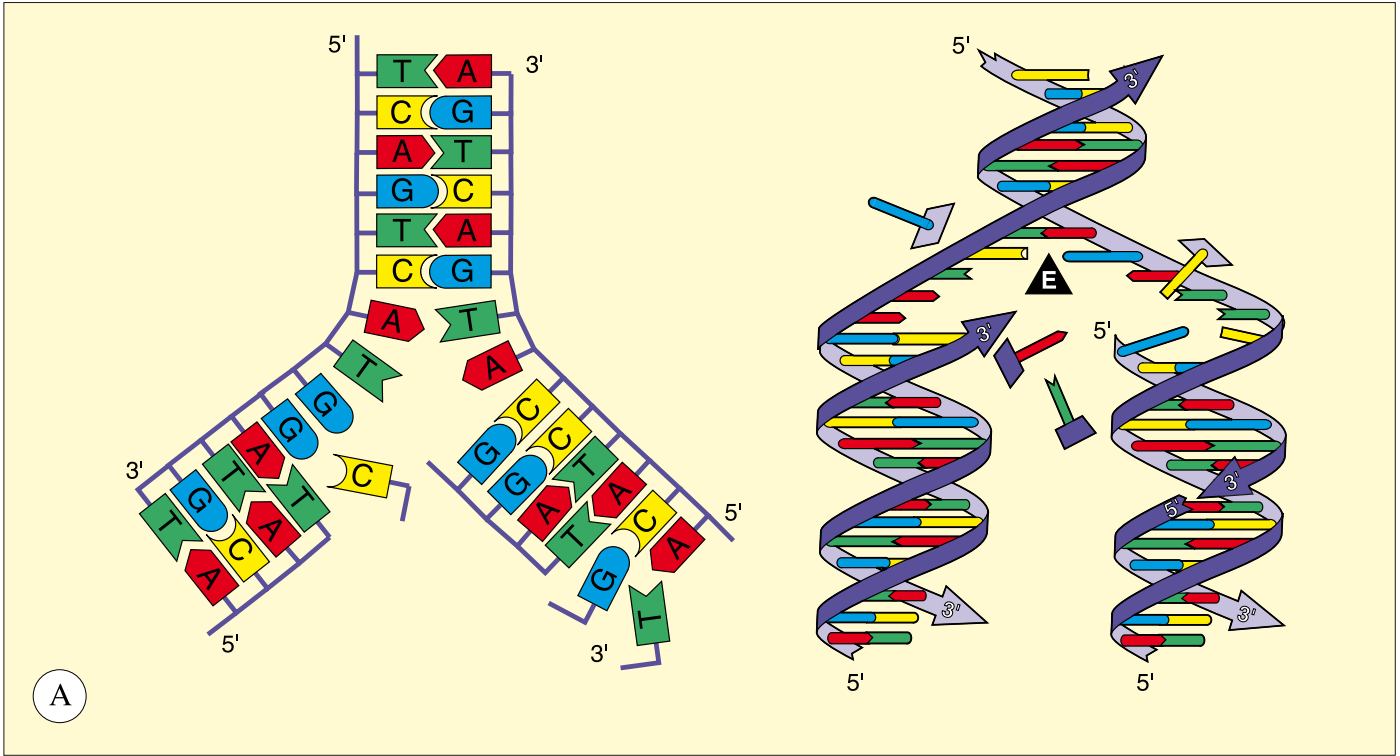


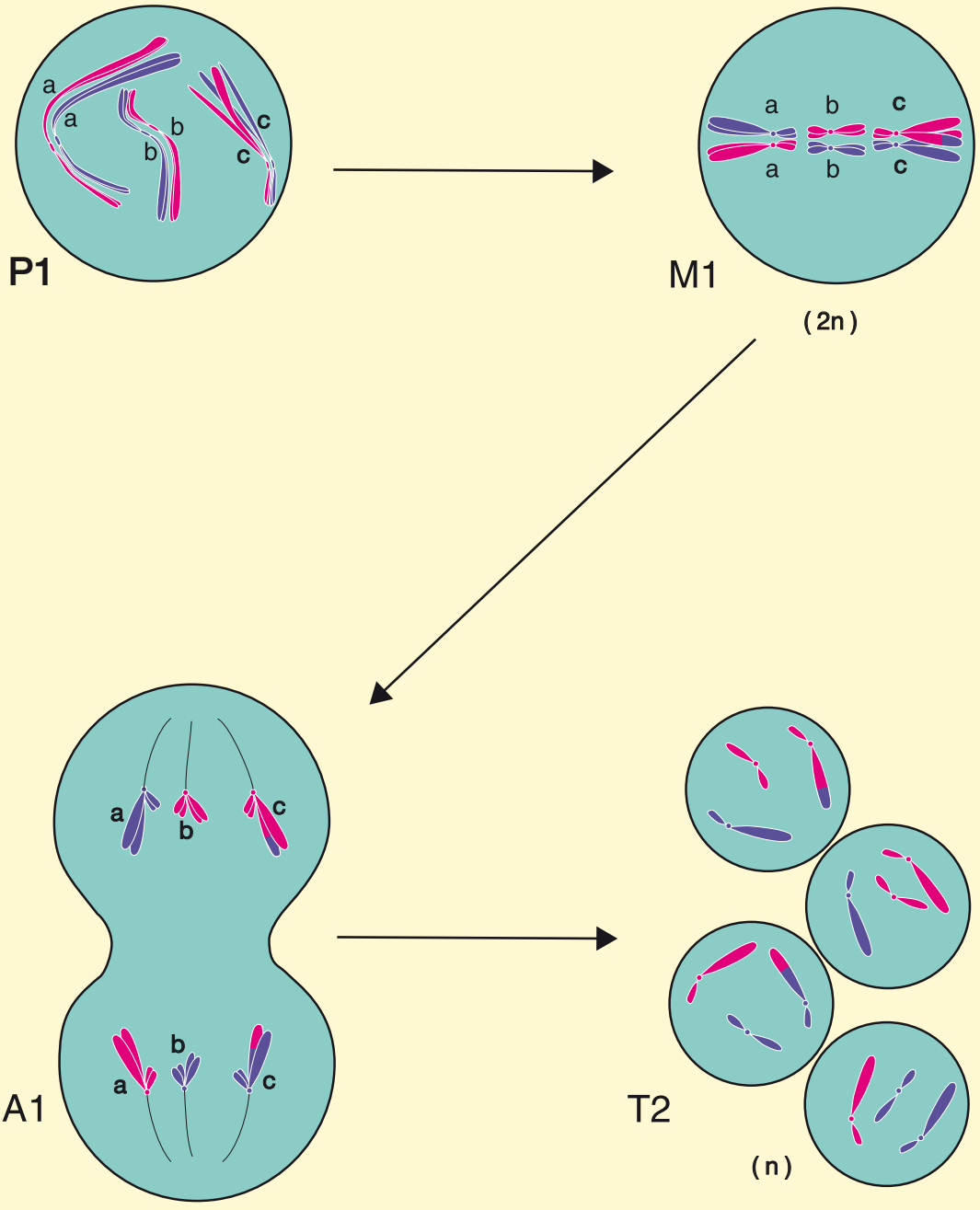


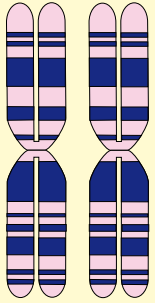


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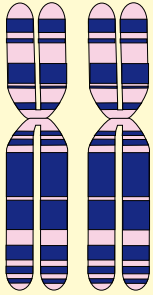




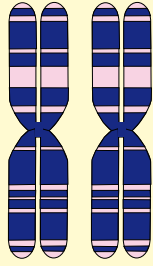




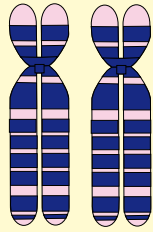
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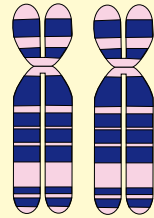
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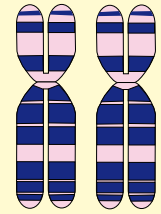
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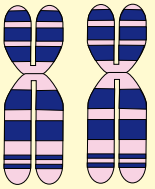
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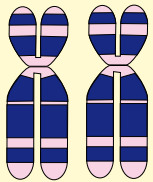
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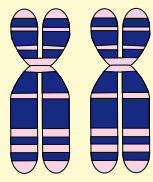
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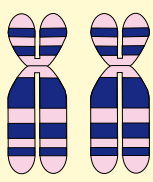
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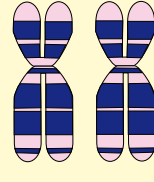
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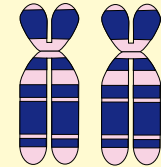
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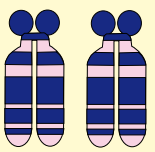
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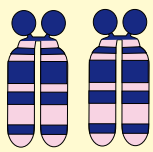
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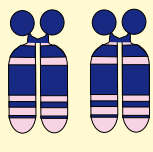
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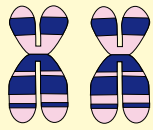
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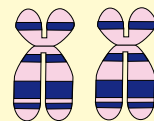
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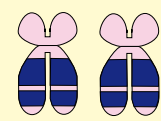
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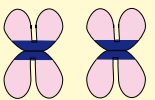
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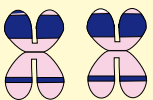
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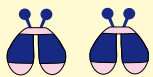
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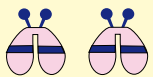
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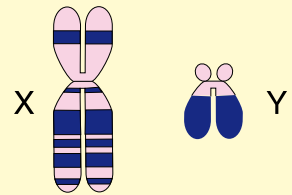
20



21

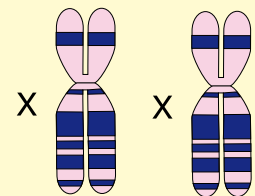


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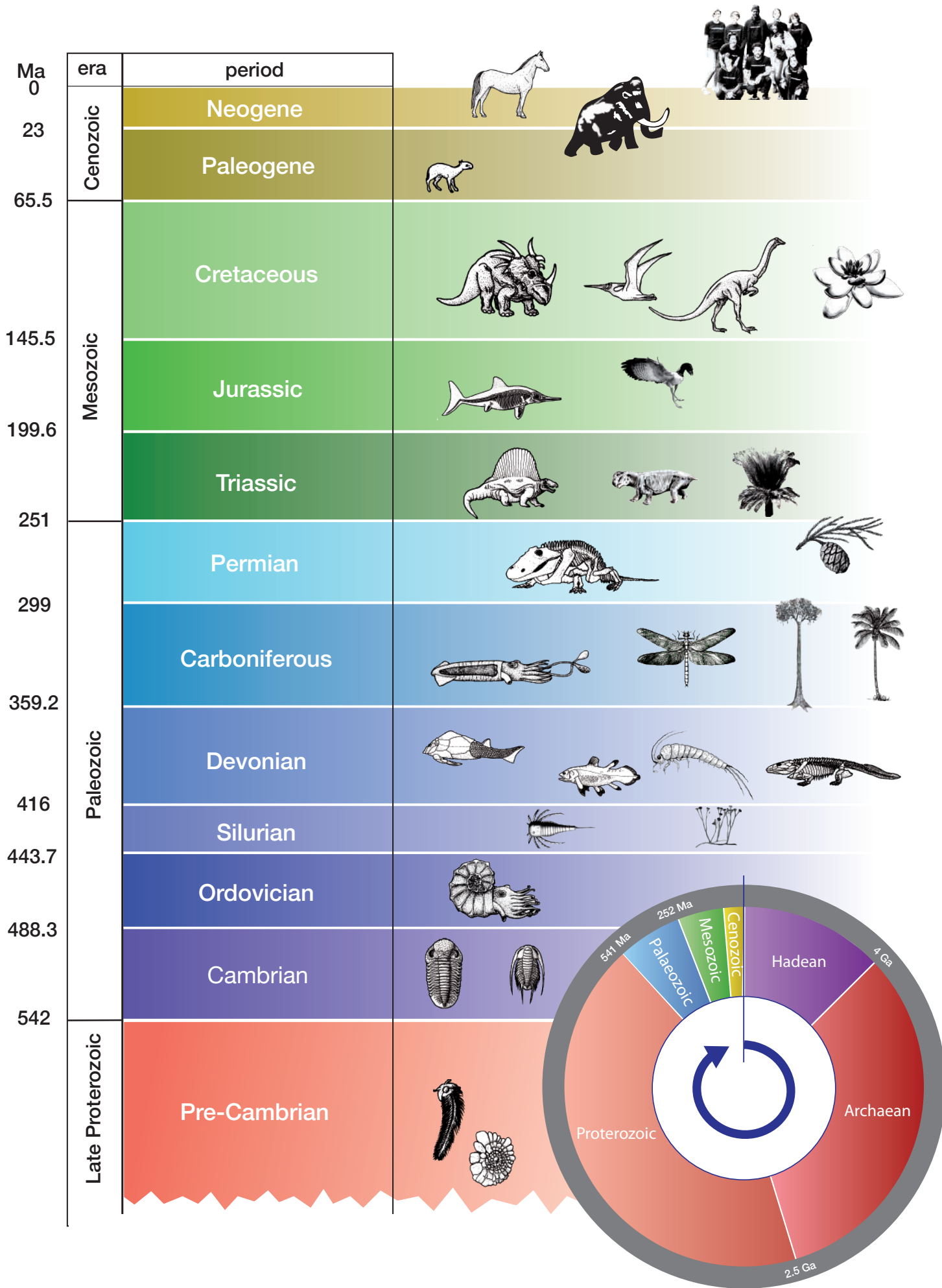
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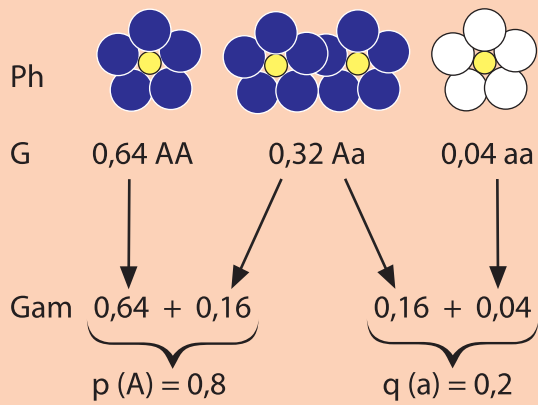
Y



X

X

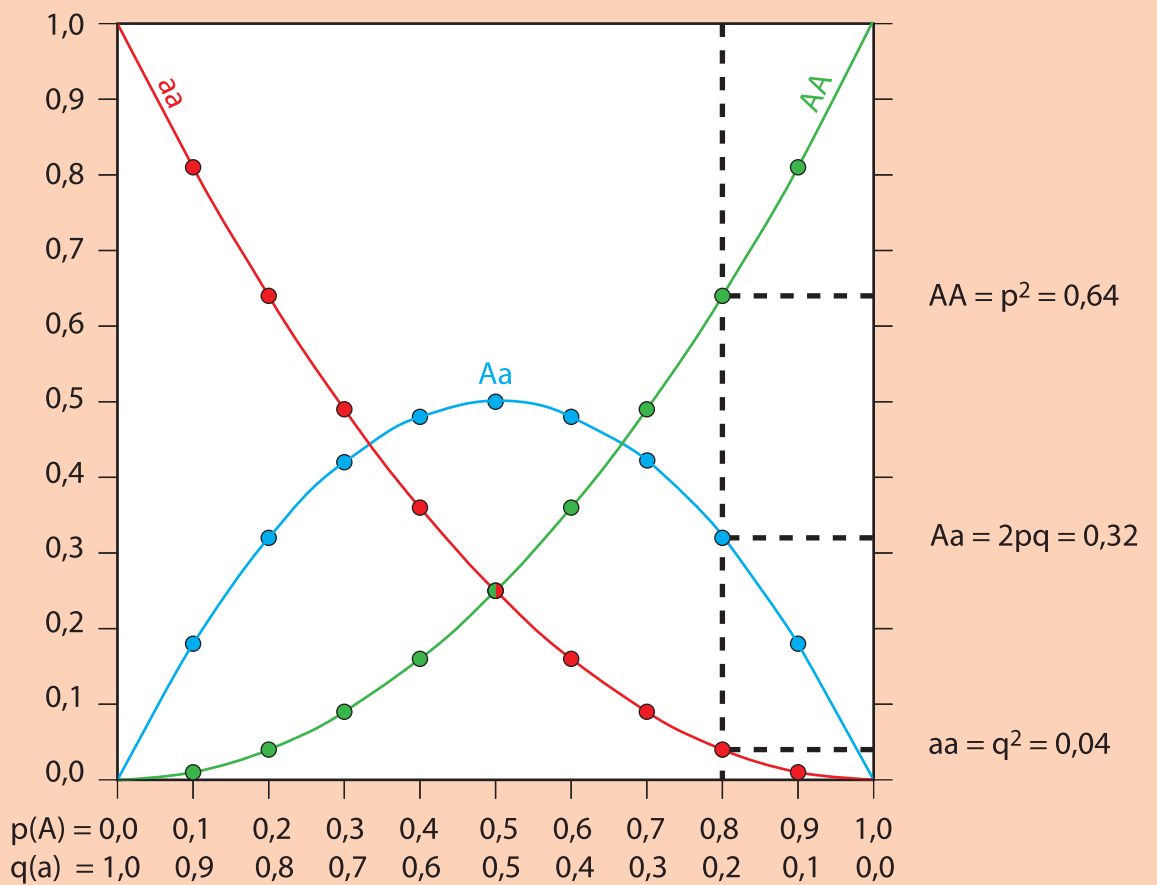


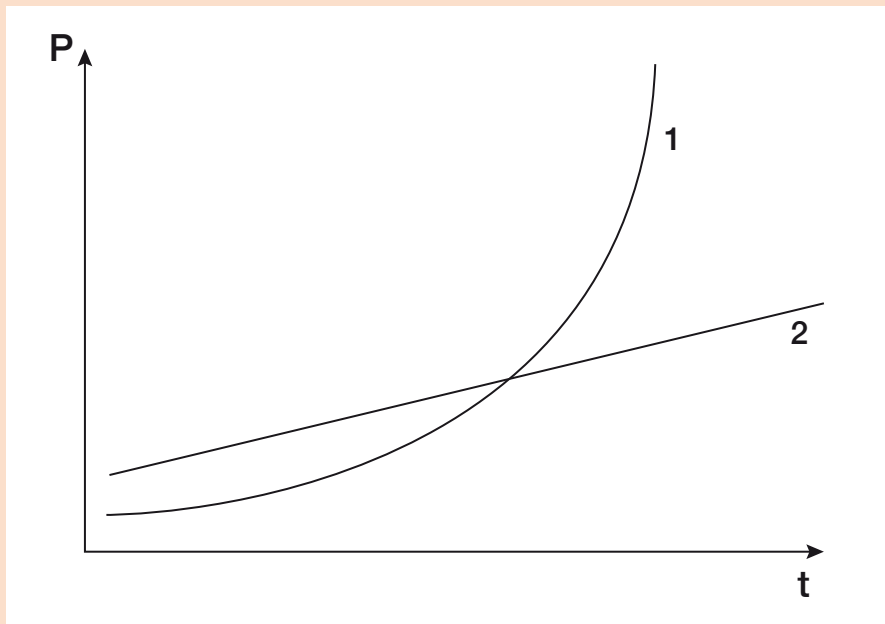


♂	♀	0,8 A	0,2 a
0,8 A		0,64 AA	0,16 Aa
0,2 a		0,16 Aa	0,04 aa

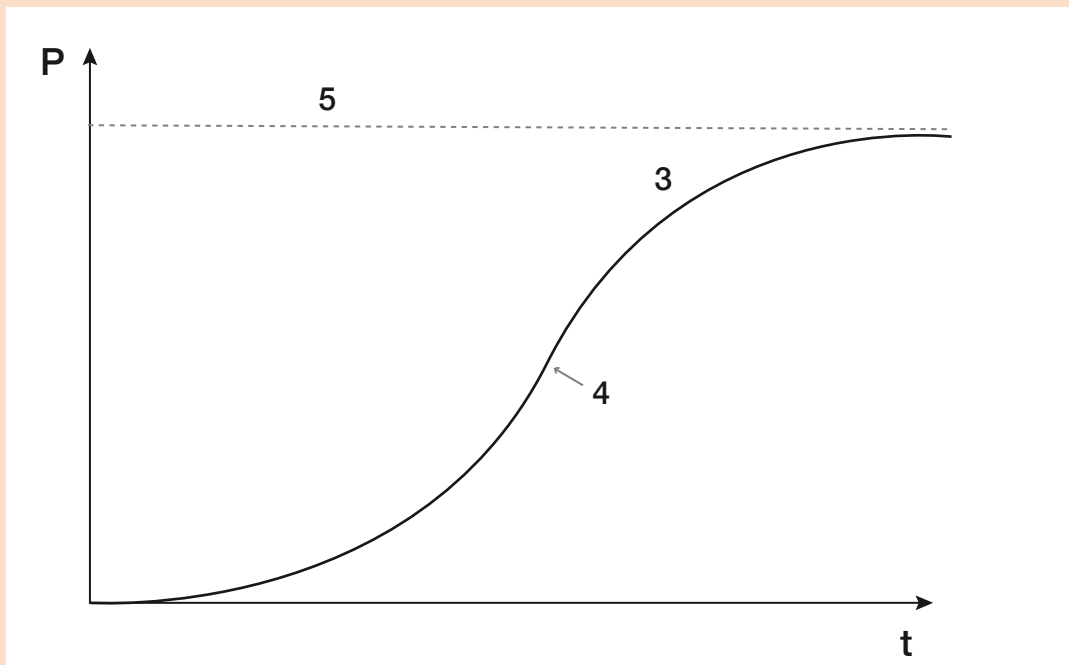
$p + q = 1$
 $p^2 + 2pq + q^2 = 1$

} Hardy-Weinberg

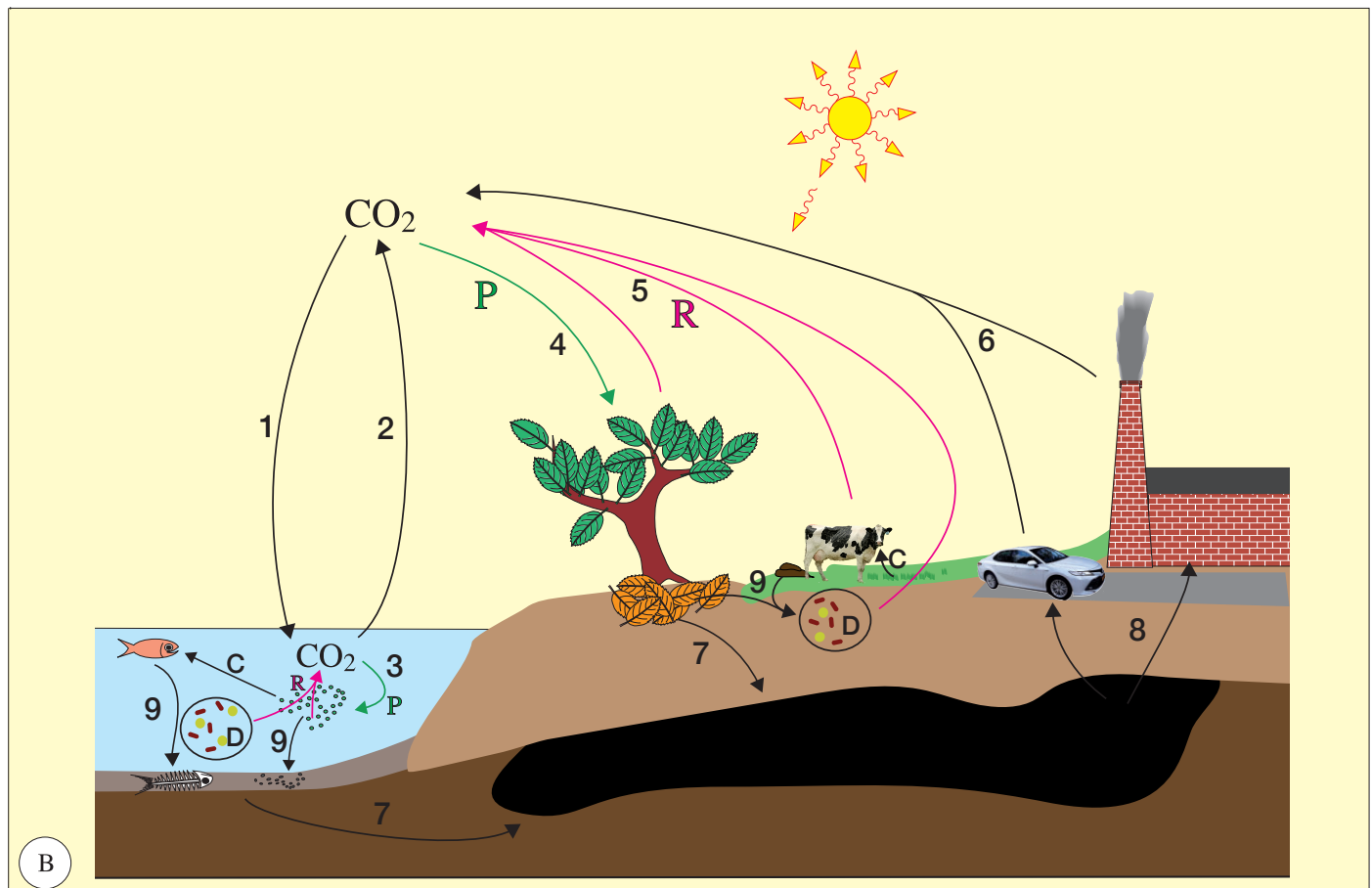
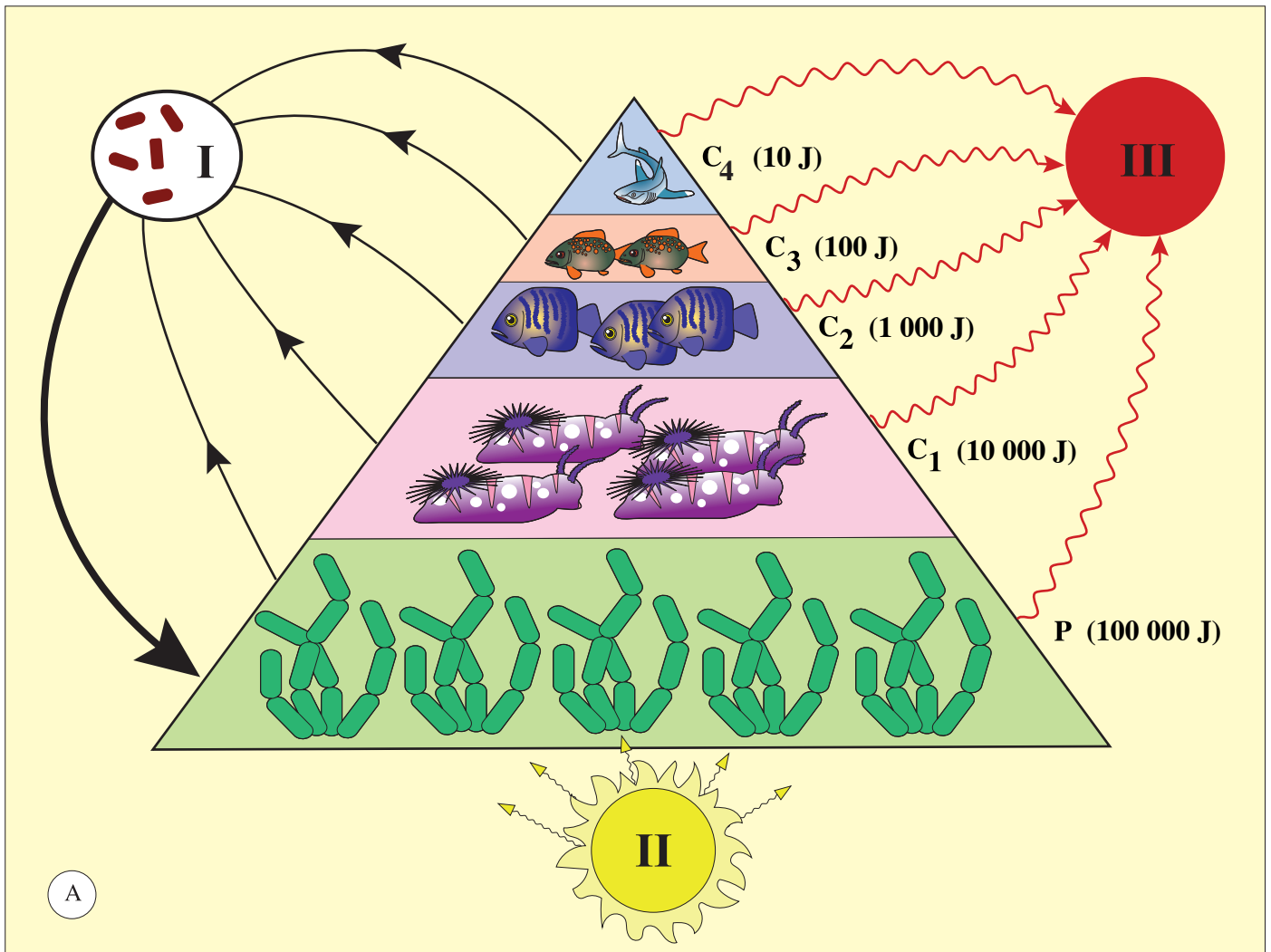


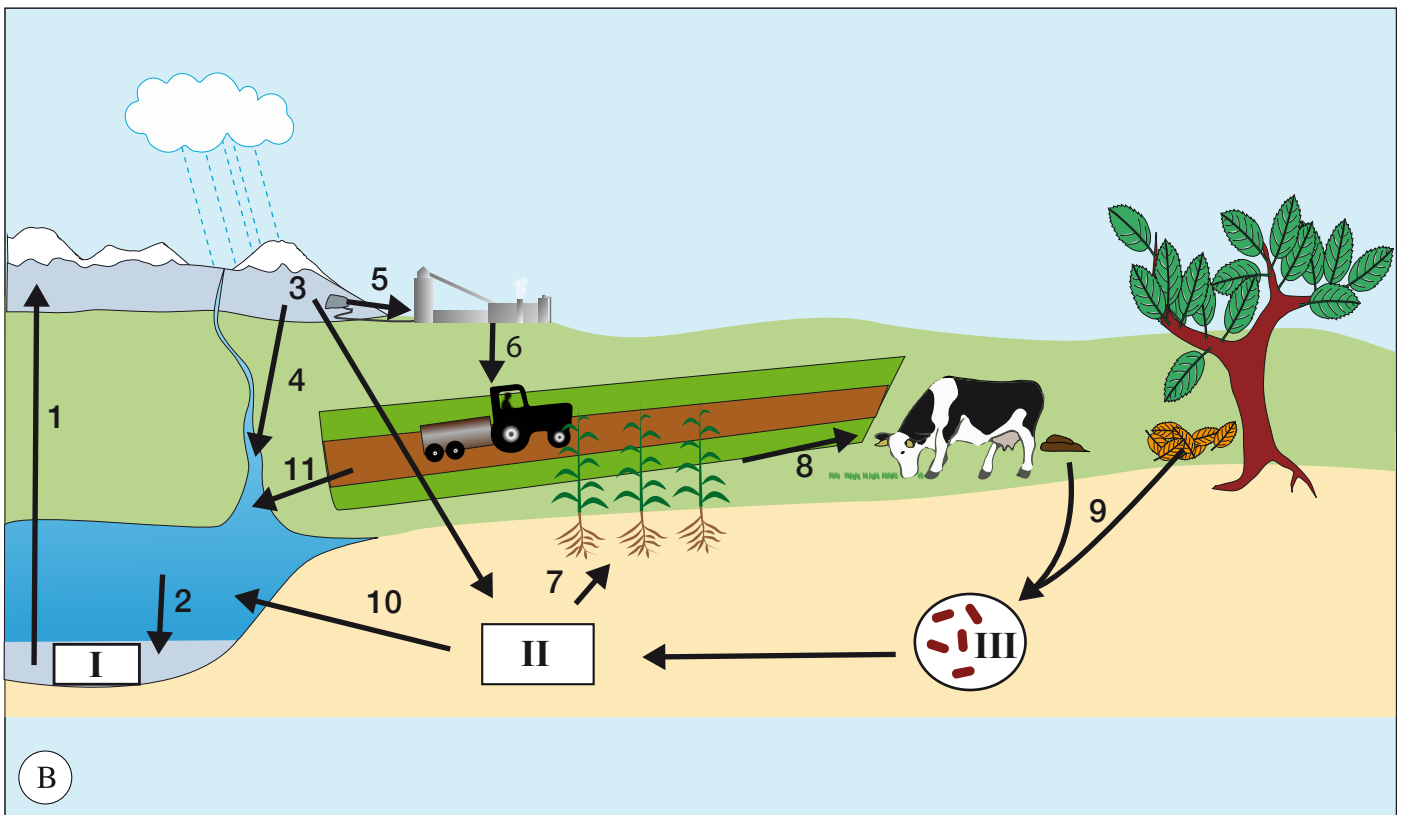
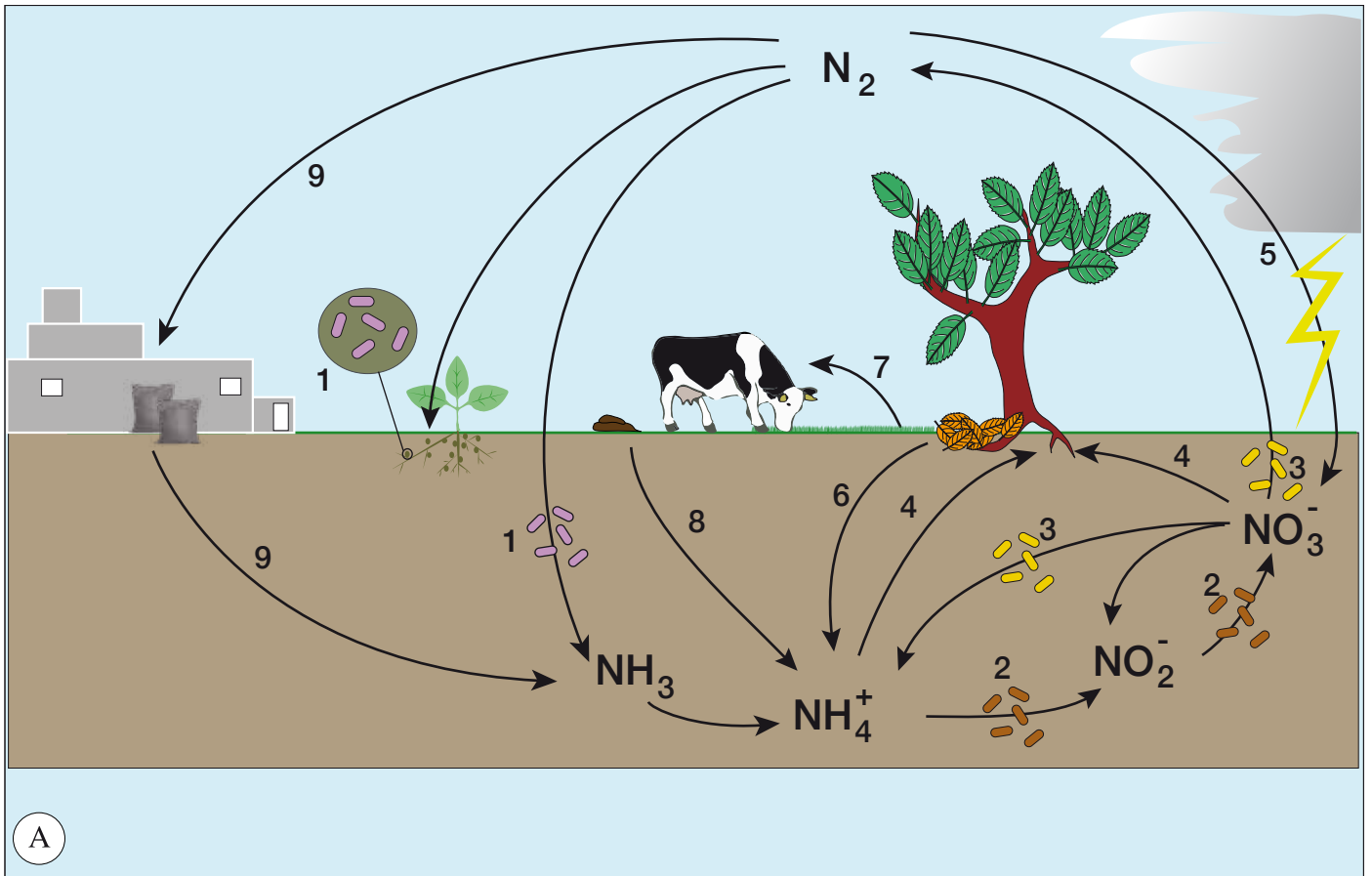


A



B





- A* *Bacterium*
- 1 DNA
 - 2 plasmid
 - 3 plasma membrane
 - 4 cell wall
 - 5 capsule (not all bacteria)
 - 6 ribosomes
 - 7 flagellum (not all bacteria)

B-D *Eukaryotic cells*

B *Fungal hypha*

C *Animal cell*

D *Plant cell*

- 1 nuclear envelope
- 2 nuclear pore
- 3 chromatin
- 4 nucleus
- 5 cytosol
- 6 plasma membrane
- 7 mitochondrion
- 8 endoplasmic reticulum (ER)
- 9 ribosome
- 10 cytoskeleton
- 11 Golgi apparatus
- 12 lysosome
- 13 vacuole
- 14 plastid (here a chloroplast)
- 15 cell wall

Page 2

Eukaryotic organelles

<i>A</i>	<i>Chloroplast</i>
1	outer membrane
2	inner membrane
3	stroma
4	intergranal thylakoid
5	granal thylakoid
6	granum
7	lipid droplet
8	DNA
9	ribosomes
10	starch grain

<i>B</i>	<i>Mitochondrion</i>
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1	outer membrane
2	inner membrane
3	matrix
4	crista
5	ATP synthase complex
6	ribosomes
7	DNA
8	Intermembrane space

Page 3

Nucleic acids 1: DNA (deoxyribonucleic acid)

<i>A</i>	<i>DNA double helix</i>
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A	adenine
T	thymine
G	guanine
C	cytosine

<i>B</i>	<i>DNA structure</i>
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P	phosphate group
S	deoxyribose
A	adenine
T	thymine
G	guanine
C	cytosine

C *Nucleotide structure (adenine)*

D *Nitrogenous bases*

A adenine (purine)
T thymine (pyrimidine)
G guanine (purine)
C cytosine (pyrimidine)

E *Nucleotide pairing*

AT adenine-thymine
GC guanine-cytosine
S deoxyribose

Page 4 ***Nucleic acids 2: RNA (ribonucleic acid)***

A *RNA structure:*

- single chain
- ribose (R)
- uracil (U)

B *tRNA*

C *mRNA*

co codon
START start codon

D *ATP*

AMP adenosine monophosphate
ADP adenosine diphosphate
ATP adenosine triphosphate
ad adenine
ri ribose
ads adenosine
3P triphosphate

Page 5

Polypeptides

A

Amino acids and dipeptides

aa 1	amino acid 1
R ₁	side chain 1
aa 2	amino acid 2
R ₂	side chain 2
dp 1,2	dipeptide of amino acids 1 and 2

B

Polymerisation

aa	amino acid
dp	dipeptide
tp	tripeptide

C

Primary structure

pp (I)	polypeptide
--------	-------------

D

Secondary structure

h	hydrogen bond
α	α-helix
β	β-sheet
pp (II)	polypeptide: secondary structure of protein

Page 6**Proteins**

<i>A</i>	<i>Disulphide bond</i>
cys	cysteine
<i>B</i>	<i>Tertiary structure</i>
h	hydrogen bonds
S-S	disulphide bonds
i	ionic bond
Φ	hydrophobic interaction
α	α-helix
β	β-sheet
<i>C</i>	<i>Quaternary structure (haemoglobin)</i>
pp(II)	secondary structure
pp(III)	tertiary structure
pp(IV)	quaternary structure
α-ch	haemoglobin alpha chain
β-ch	haemoglobin beta chain
haem	haem group
Fe ²⁺	iron cation
Hb	haemoglobin

Page 7**Sugars**

<i>A</i>	<i>Monosaccharides</i>
<i>B</i>	<i>A-glucose polysaccharides</i>
1	α-glucose linkage
2	amylose
3	amylopectin/glycogen
<i>C</i>	<i>B-glucose polysaccharides</i>
1	β-glucose linkage
2	cellulose
3	cellulose microfibril
h	hydrogen bond

Page 8

Lipids

- A* *Fats (triglycerides)*
- gl glycerol
 - ac fatty acid
 - trg triglyceride
- B* *Fatty acids*
- 1 saturated fatty acid (stearic acid)
 - 2 mono-unsaturated fatty acid (oleic acid)
 - 3 poly-unsaturated fatty acid (linolenic acid)

Page 9

Cell membrane

- A* *Phospholipid*
- a hydrophilic head
 - b hydrophobic tails
- B* *Phospholipid bilayer*
- C* *Plasma membrane*
- a phospholipid
 - b embedded (intrinsic) protein
 - c surface (extrinsic) protein
 - d cholesterol
- D* *Fluid mosaic model*
- a phospholipid bilayer
 - b embedded (intrinsic) protein
 - c surface (extrinsic) protein
 - d cholesterol
 - e glycolipid (external surface)
 - f glycoprotein (external surface)
 - g protein channel (pore)

Page 10

Enzymes

A and B

Induced fit model of catalysis

apo-E	apoenzyme
co-E	coenzyme
E	enzyme
S	substrate
as	active site
S ₁	substrate 1
S ₂	substrate 2
ES	enzyme-substrate complex
EP	enzyme product complex
P ₁	end product 1
P ₂	end product 2

Page 11

ATP phosphorylation (mitochondrion/chloroplast)

A

ATP synthesis (mitochondrion) – oxidative phosphorylation

1	cytosol
2	outer membrane
3	intermembranal space
4	inner membrane (cristae not shown)
5	matrix
NAD	nicotinamide adenine dinucleotide
FAD	flavin adenine dinucleotide
Q	coenzyme Q
Cyt C	cytochrome C
I-IV	electron transport chain complexes
V	ATP synthase

B

ATP synthesis (chloroplast) - photophosphorylation

1	thylakoid lumen
2	thylakoid membrane
3	stroma
4	ATP synthase complex
hf	photon
PSI	photosystem I (P700)
PSII	photosystem II (P680)
T ₁ -T ₄	electron transport chain complexes
P _i	inorganic phosphate
ADP	adenosine diphosphate
ATP	adenosine triphosphate
NADP	nicotinamide adenine dinucleotide phosphate

C

ATP synthase complex (detail)

Page 12**Summary diagram of respiration**

G	glycolysis
K	Krebs cycle
P	oxidative phosphorylation
cyt	cytosol
mit	mitochondrion
GLU	glucose
GP	glucose phosphate
FP	fructose phosphate
FBP	fructose biphosphate
PGAL	phosphoglyceraldehyde
BPGA	biphosphoglyceric acid
PGA	phosphoglyceric acid
PYR	pyruvic acid
ACA	acetyl coenzyme-A
HS-CoA	coenzyme-A
CIT	citric acid
ISO	isocitric acid
α -KG	alpha-ketoglutaric acid
SUC	succinic acid
FUM	fumaric acid
MAL	malic acid
OXA	oxaloacetic acid
NAD	nicotinamide adenine dinucleotide
FAD	flavin adenine dinucleotide

Page 13**Summary diagram of photosynthesis**

yellow	light-dependent reactions (thylakoid membrane)
grey	light-independent reactions (Calvin cycle, stroma)
hf	photon
PSII	photosystem II (P680)
PSI	photosystem I (P700)
T ₁ -T ₄	electron transport chain
ADP	adenosine diphosphate
P _i	inorganic phosphate
ATP	adenosine triphosphate
NADP ⁺ /NADPH	nicotinamide adenine dinucleotide phosphate
BPGA	biphosphoglycerate
PGAL	phosphoglyceraldehyde
RuP	ribulose phosphate
RuBP	ribulose biphosphate
PGA	phosphoglycerate

Page 14

Protein synthesis

<i>A</i>	<i>Transcription</i>
<i>B</i>	<i>Translation</i>
<i>C</i>	<i>Structure of a tRNA molecule with amino acid</i>
a	DNA molecule
b	synthesis of pre-mRNA
S	splicing
sp	spliceosome
i	intron
e	exon
1	DNA codon (TGA)
2	corresponding mRNA codon (ACU)
3	corresponding tRNA anticodon (UGA)
RNApol	RNA polymerase
mRNA	messenger RNA
tRNA	transfer RNA
ne	nuclear envelope
ri	ribosome

Page 15

Protein transport

1	mRNA and ribosome
2	export protein
3	membrane protein
4, 5, 8 & 9	vesicles
6	cytoskeleton
7	detail of Golgi apparatus
10	exocytosis

Page 16

Genetic code

Ala	alanine
Arg	arginine
Asn	asparagine
Asp	aspartic acid
Cys	cysteine
Gln	glutamine
Glu	glutamic acid
Gly	glycine
His	histidine
Ile	isoleucine
Leu	leucine
Lys	lysine
Met	methionine
Phe	phenylalanine
Pro	proline
Ser	serine
Thr	threonine
Trp	tryptophan
Tyr	tyrosine
Val	valine

Page 17

Eukaryotic gene

T	transcription
AS	alternative splicing
1-6	exons
i	introns

Page 18

Autonomic nervous system

P	parasympathetic nervous system
S	sympathetic nervous system
+	stimulates
-	inhibits

<i>A</i>	<i>Motor neuron</i>
1	dendrites
2	nucleus
3	axon hillock
4	soma
5	axon
6	myelin sheath
7	axon branches
8	axon terminals
<i>B</i>	<i>Signal transmission</i>
<i>I</i>	<i>Sodium-potassium pump</i>
<i>II</i>	<i>Action potential</i>
mV	potential in millivolts
t (ms)	time (milliseconds)
1	resting potential
2	depolarisation
3	repolarisation
4	hyperpolarisation
5	threshold
<i>III</i>	<i>Ion channels</i>
a	sodium channel
b	potassium channel

Page 20

Neuron (continued) and human brain

A *Impulse transmission at the synapse*

- I presynaptic neuron
- II postsynaptic neuron

a-c *Synapse*

- I presynaptic neuron
- II postsynaptic neuron

- dep depolarisation
- 1 mitochondrion
- 2 synaptic vesicles
- 3 neurotransmitter molecules
- 4 synaptic cleft

B *Human brain*

- 1 cerebrum
- 2 thalamus
- 3 hypothalamus
- 4 midbrain
- 5 cerebellum

Page 21

Passive and active immunity

A *Inflammation response*

- 1 signalling molecules
- 2 platelets
- 3 fibrin
- 4 bacteria
- 5 phagocyte
- 6 blood clot
- 7 inflammation
- 8 digestion of bacteria in a food vacuole

<i>B</i>	<i>Structure of an antibody</i>
Ag	antigen
AbH (c)	constant region of heavy chains of antibody
AbH (v)	variable region of heavy chains of antibody (with part of antigen binding site)
AbL (c)	constant region of light chains of antibody
AbL (v)	variable region of light chains of antibody (with part of antigen binding site)
-S-S-	disulphide bridge

C *Antibody antigen interactions*

D *Adaptive immune response in time*

IR	intensity of immune response
IR (1)	primary adaptive response
IR (2)	secondary adaptive response
AgX (1)	first exposure to antigen X
AgX (2)	second exposure to antigen X
T	time (days)

Page 22 *Mechanisms in adaptive immunity*

AgX(1)	Antigen X – first exposure
AgX(2)	Antigen X – secondary exposure
H	Humoral Immunity
C	Cellular Immunity
1	primary response
2	secondary response
St	stimulates
ctk	cytokines (interleukins)
Pr	produces by cell cloning (mitosis)
Se	secretion
Ph	phagocytosis
Tr	transformation
MAC	macrophage
AgPC	antigen presenting cell
HTC	helper T-cell
BL	B-lymphocyte
cytoxTC	cytotoxic T-cell
pf	perforin
mHTC	memory helper T-cell
PLC	plasma cell

mBL	memory B-lymphocyte
mTL	memory T-lymphocyte
cytoxTCact	active cytotoxic T-cell
Ig	antibodies (immunoglobulins)

a

Antibodies binding to antigens have different actions:

- Neutralization of viruses or bacteria by blocking viral binding sites or coating bacterial toxins.
- Agglutination of viral or bacterial particles.
- Precipitation of soluble antigens (macromolecules).

The above 3 actions enhance phagocytosis.

b

Active cytotoxic T-cells bind to infected cells, cancer cells or non-self cells (transplantation) which are then lysed by perforins.

Page 23 ***DNA replication and polygenes***

<i>A</i>	<i>DNA replication</i>
<i>E</i>	helicase

<i>B</i>	<i>Polygenic inheritance</i>
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Page 24 ***Meiosis***

<i>P1</i>	prophase 1 (Note crossover in chromosome pair c.)
<i>M1</i>	metaphase 1
<i>A1</i>	anaphase 1
<i>T2</i>	telophase 2

Page 25 ***Human karyotype***

1-22	chromosome pairs 1 to 22 (autosomes)
X	X-chromosome (sex chromosome)
Y	Y-chromosome (sex chromosome)

Page 26 ***Geological record***

Ma	millions of years ago
Ga	billions of years ago

Page 27

Hardy-Weinberg equilibrium

Ph	phenotype
G	genotype (with frequency in population)
Gam	gametes
p	frequency of allele A in the population
q	frequency of allele a in the population

Page 28

Population growth

P	population size
t	time
1	exponential growth
2	linear growth
3	population dependent growth
4	maximum growth
5	carrying capacity of environment

Page 29

Trophic levels, carbon cycle

<i>A</i>	<i>Rule of tenths</i>
P	primary producer
C ₁	primary consumer
C ₂	secondary consumer
C ₃	tertiary consumer
C ₄	quaternary consumer
I	decomposers (organic matter → mineral salts)
II	light energy
III	energy loss in the form of heat

B *Carbon cycle*

P	photosynthesis
R	respiration
D	decomposers
C	consumer eats producer
1	absorption of CO ₂ into bodies of water
2	release of dissolved CO ₂ into air
3	aquatic absorption of CO ₂ , photosynthesis
4	terrestrial absorption of CO ₂ , photosynthesis
5	CO ₂ release (respiration)
6	CO ₂ released by fossil fuel combustion
7	organic sedimentary rock formation
8	fossil fuels
9	decomposition

A

Nitrogen cycle

- 1 nitrogen fixing bacteria
- 2 nitrifying bacteria
- 3 denitrifying bacteria
- 4 uptake by plants
- 5 lightning nitrogen fixation
- 6 decomposition of organic matter
- 7 animal food intake
- 8 animal excretion
- 9 industrial nitrogen fixation

B

Phosphorus cycle

- I subaquatic phosphate reserves
- II terrestrial phosphate reserves
- III decomposers
- 1 geological uplift
- 2 phosphate rich sedimentation
- 3 weathering of rocks
- 4 runoff of phosphate rich water
- 5 phosphate mining
- 6 industrial fertiliser production
- 7 uptake by plants
- 8 uptake by animals
- 9 organic decomposition
- 10 leaching
- 11 agricultural runoff

