Интенсив по молекулярной биологии и генетике

Александр Ткаченко, СПбГУ

План занятий

1. Строение клетки, базовые метаболические процессы в клетке
2. Межклеточные взаимодействия, сигналинг
3. Матричные процессы
4. Генетика

Свойства жизни

- Being
- Doing
- Developing
- Evolving

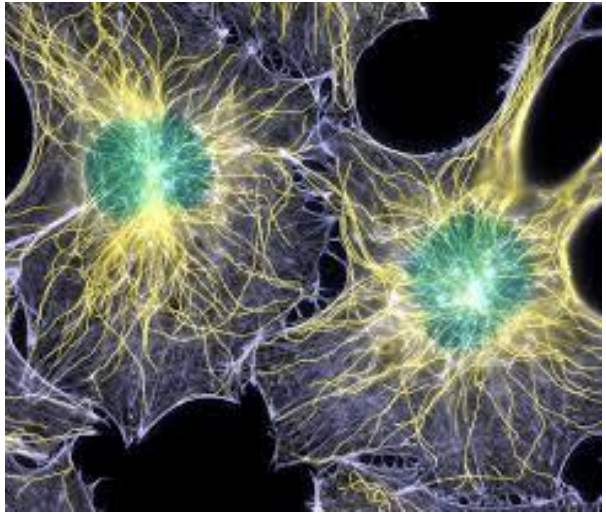
Froese, 2014

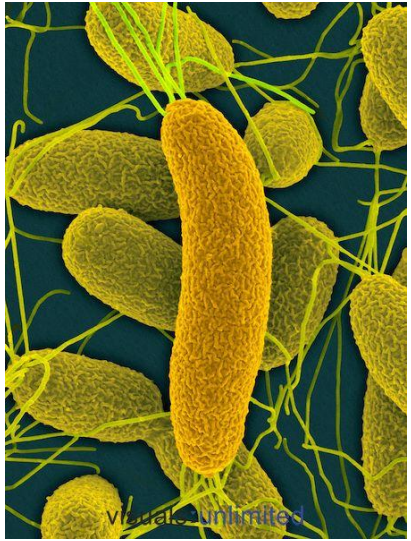
Свойства жизни

- Гомеостаз
- Клеточное строение
- Метаболизм
- Рост
- Адаптация
- Ответ на внешние воздействия
- Размножение

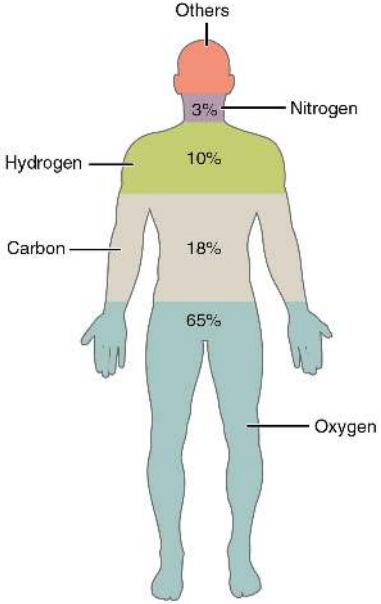
Клеточная теория

1. Всё живое состоит из клеток
2. Клетка это базовая единица живого
3. Всякая клетка получается в результате деления другой клетки

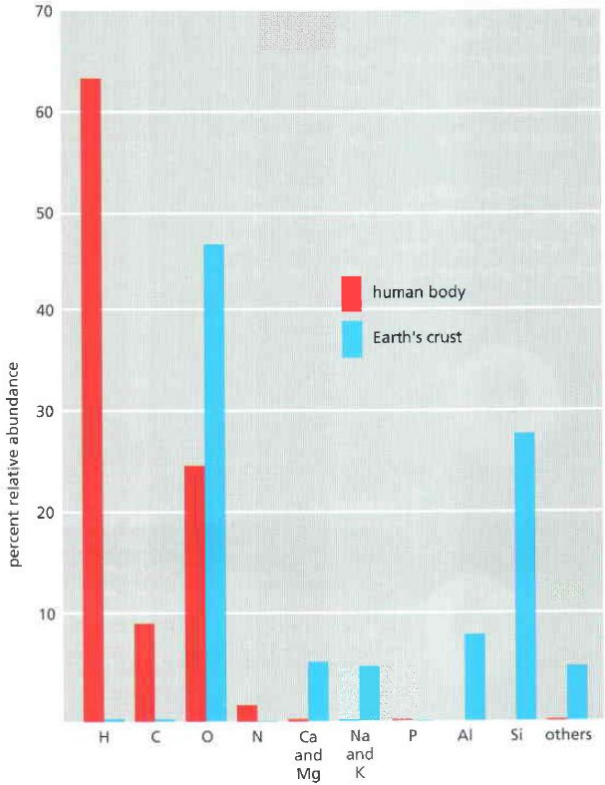




Химический состав клетки

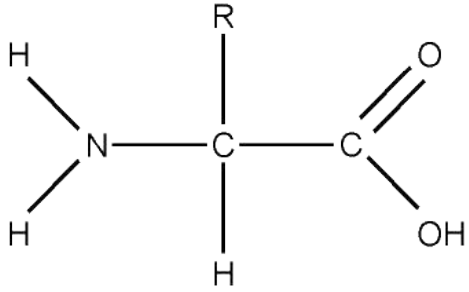


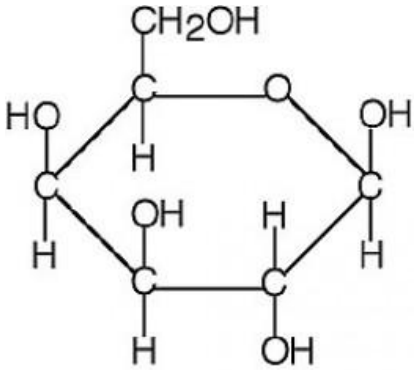
Element	Symbol	Percentage in Body
Oxygen	O	65.0
Carbon	C	18.5
Hydrogen	H	9.5
Nitrogen	N	3.2
Calcium	Ca	1.5
Phosphorus	P	1.0
Potassium	K	0.4
Sulfur	S	0.3
Sodium	Na	0.2
Chlorine	Cl	0.2
Magnesium	Mg	0.1
Trace elements include boron (B), chromium (Cr), cobalt (Co), copper (Cu), fluorine (F), iodine (I), iron (Fe), manganese (Mn), molybdenum (Mo), selenium (Se), silicon (Si), tin (Sn), vanadium (V), and zinc (Zn).		less than 1.0

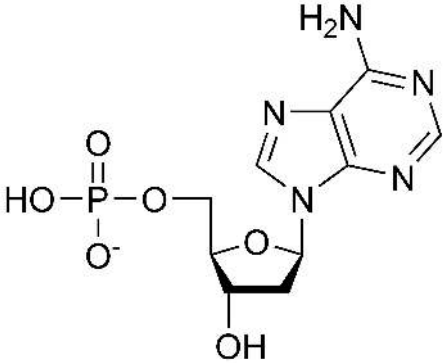


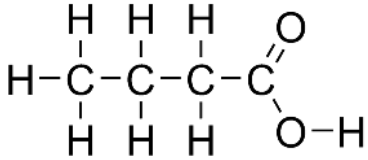
Основные классы биомолекул

- Аминокислоты
- Углеводы
- Нуклеотиды
- Жирные кислоты



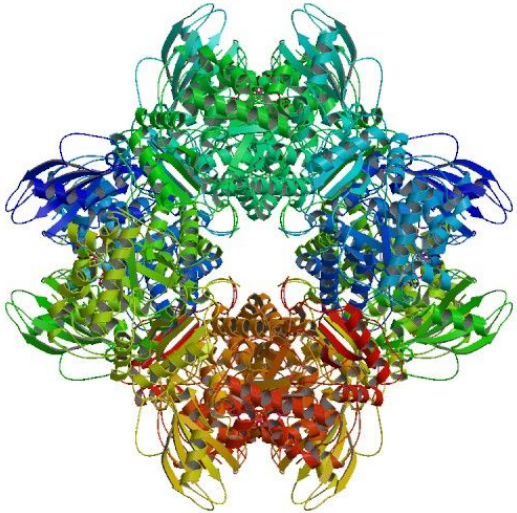


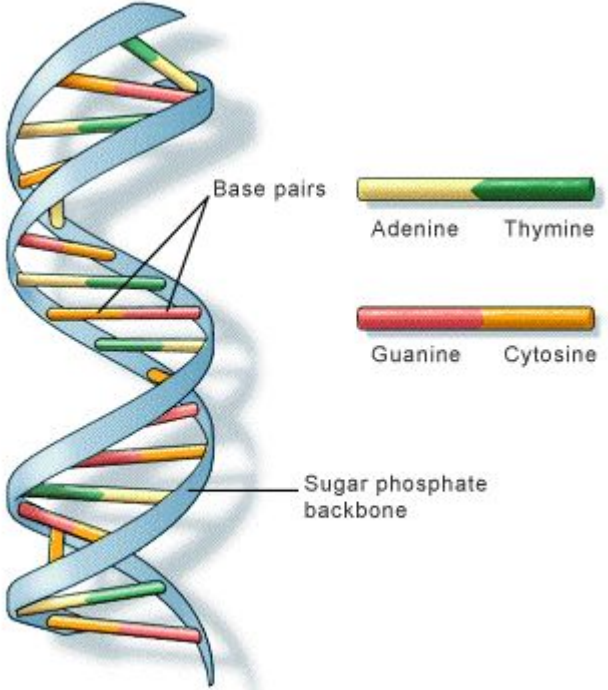




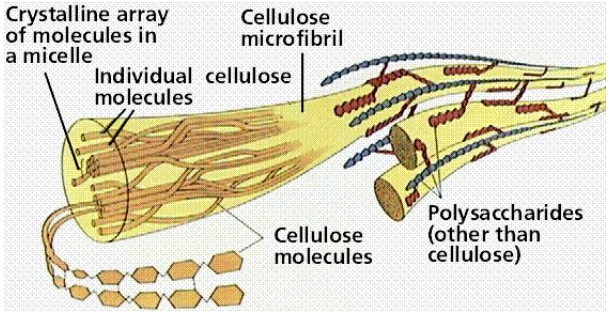
Соответствующие макромолекулы

- Белки
- Полинуклеотиды
- Полисахариды
- Липиды

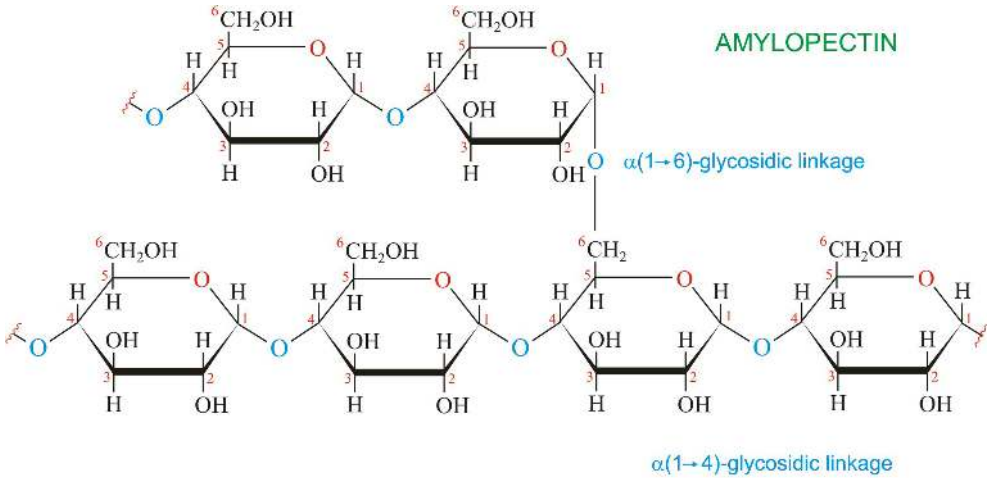


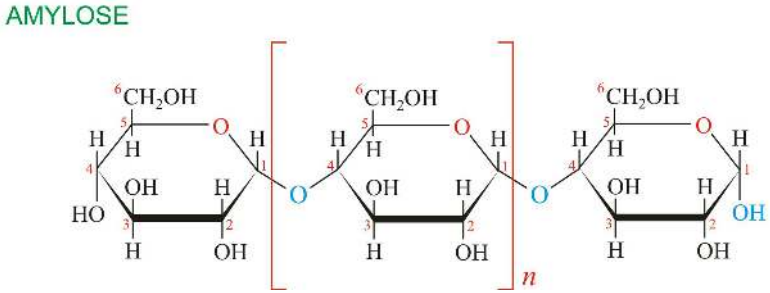


U.S. National Library of Medicine

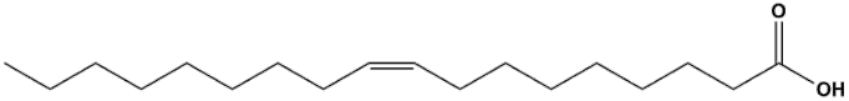


Углеводы

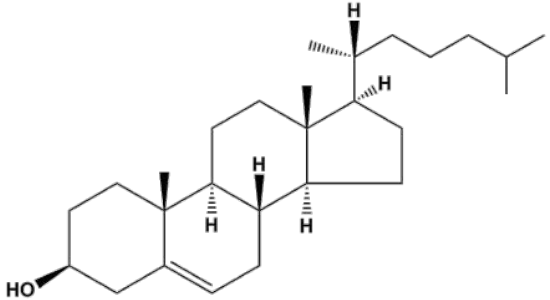

AMYLOPECTIN
α(1→6)-glycosidic linkage
α(1→4)-glycosidic linkage


AMYLOSE

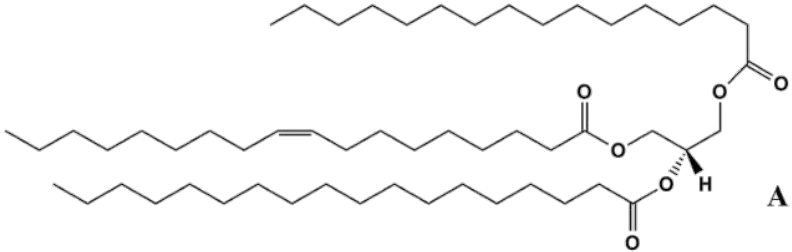
Липиды



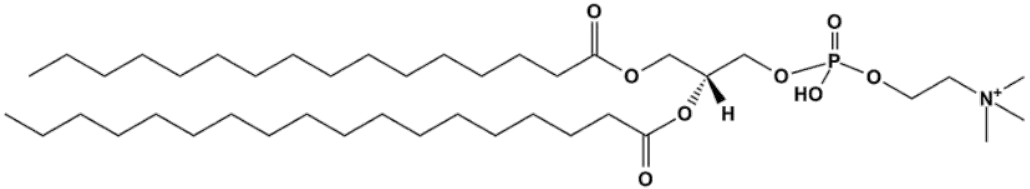
A free fatty acid



Cholesterol

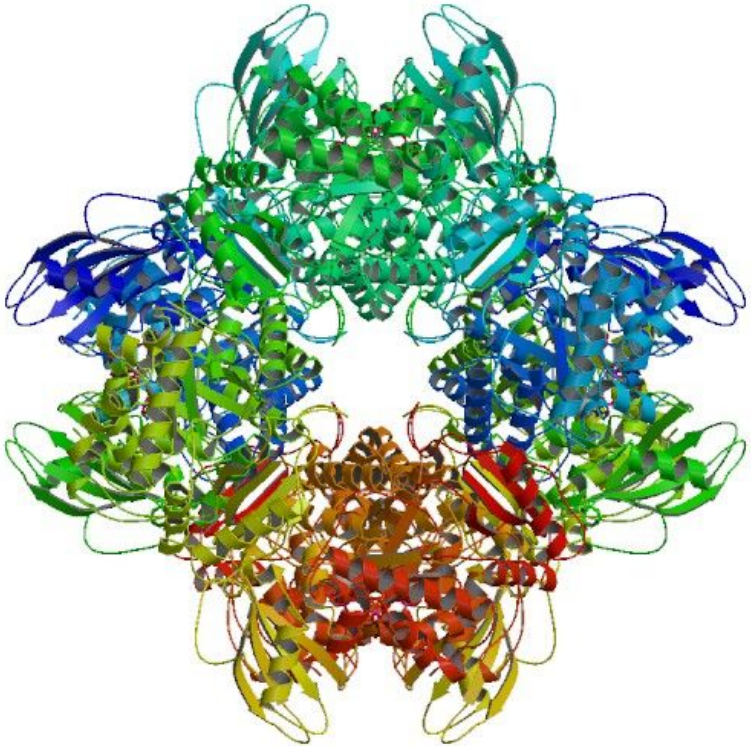


A triglyceride

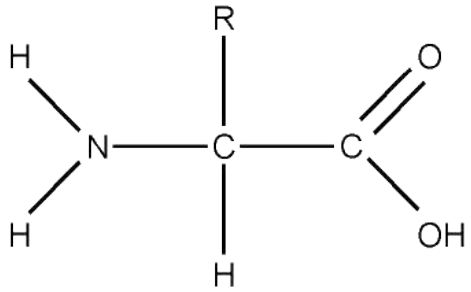


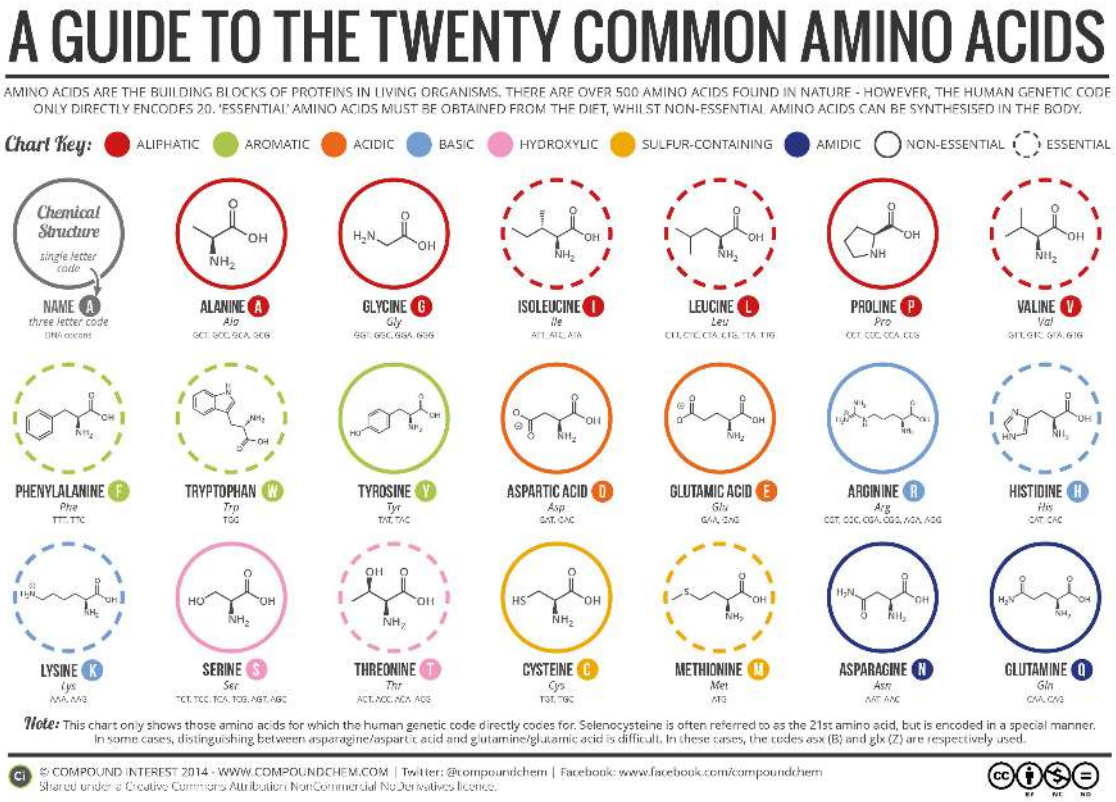
A phospholipid

Белки

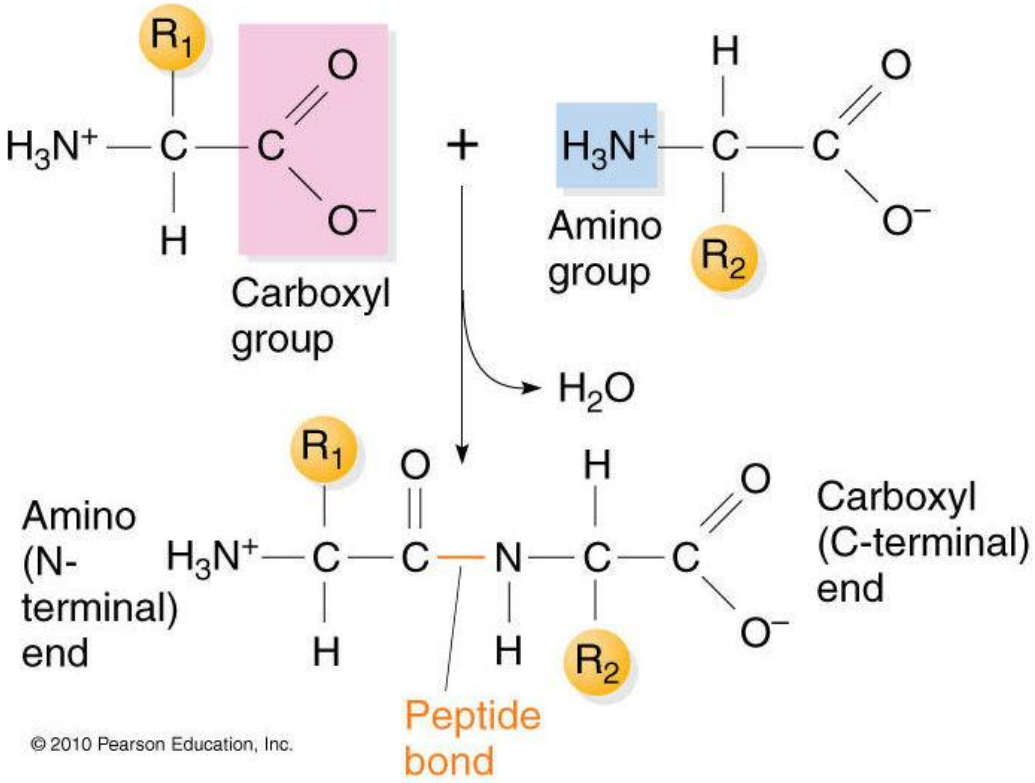


Аминокислоты

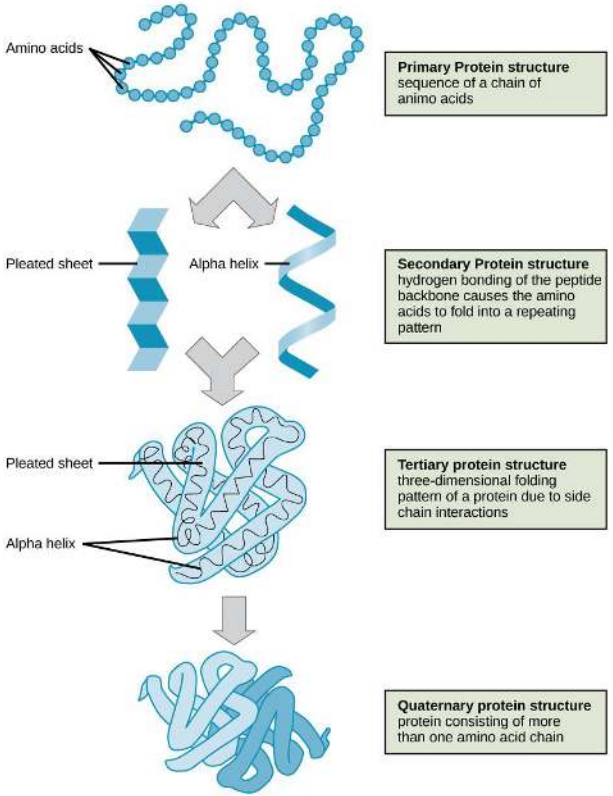




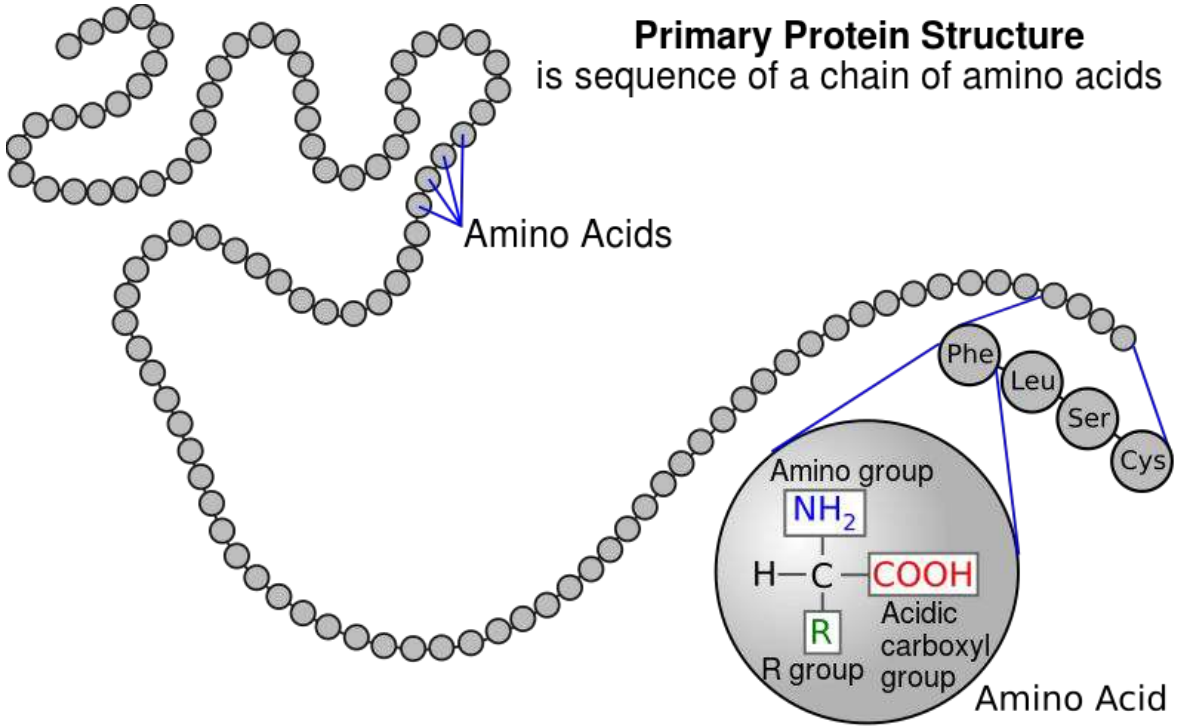
Пептидная связь



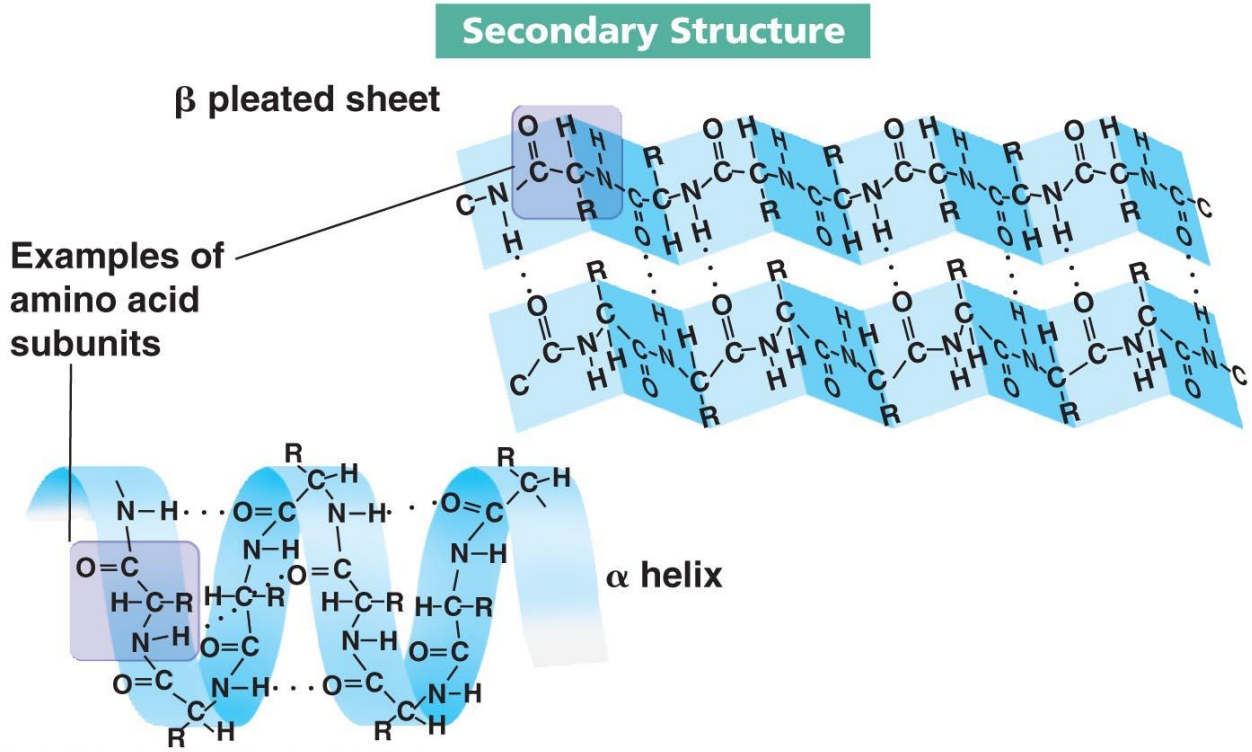
Уровни организации белков



Первичная структура белка

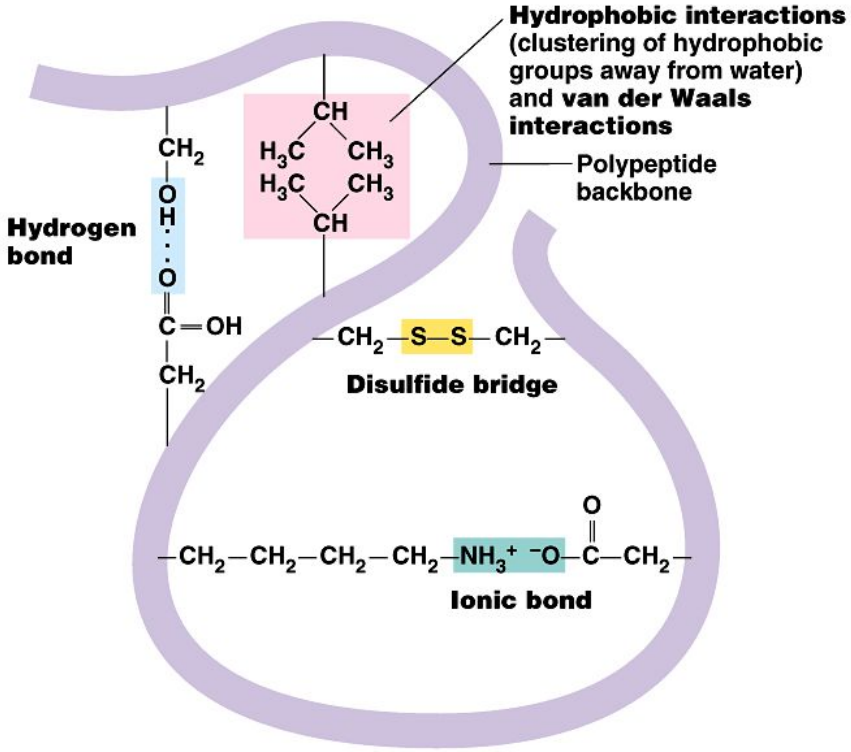


Вторичная структура белка



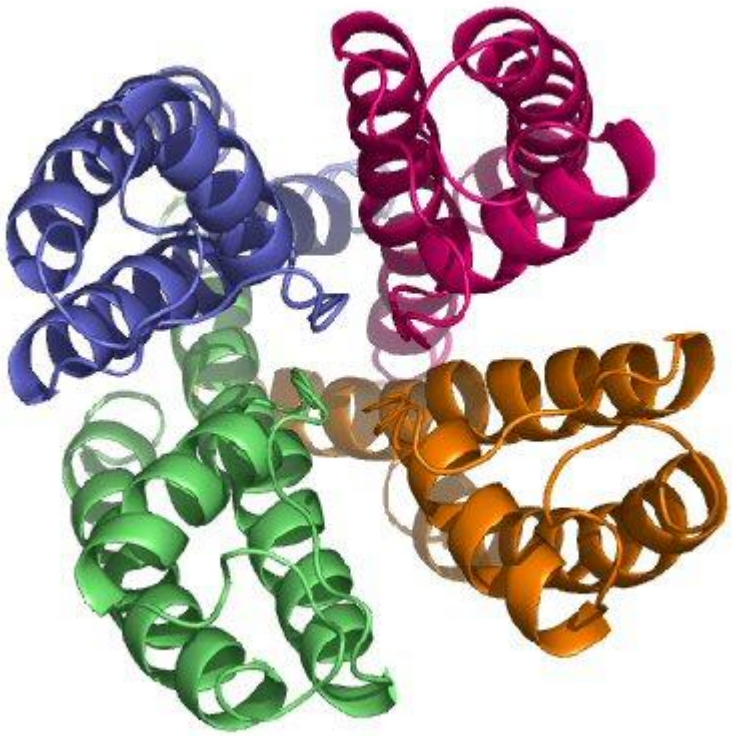
Copyright © 2008 Pearson Education, Inc., publishing as Pearson Benjamin Cummings.

Третичная структура белка

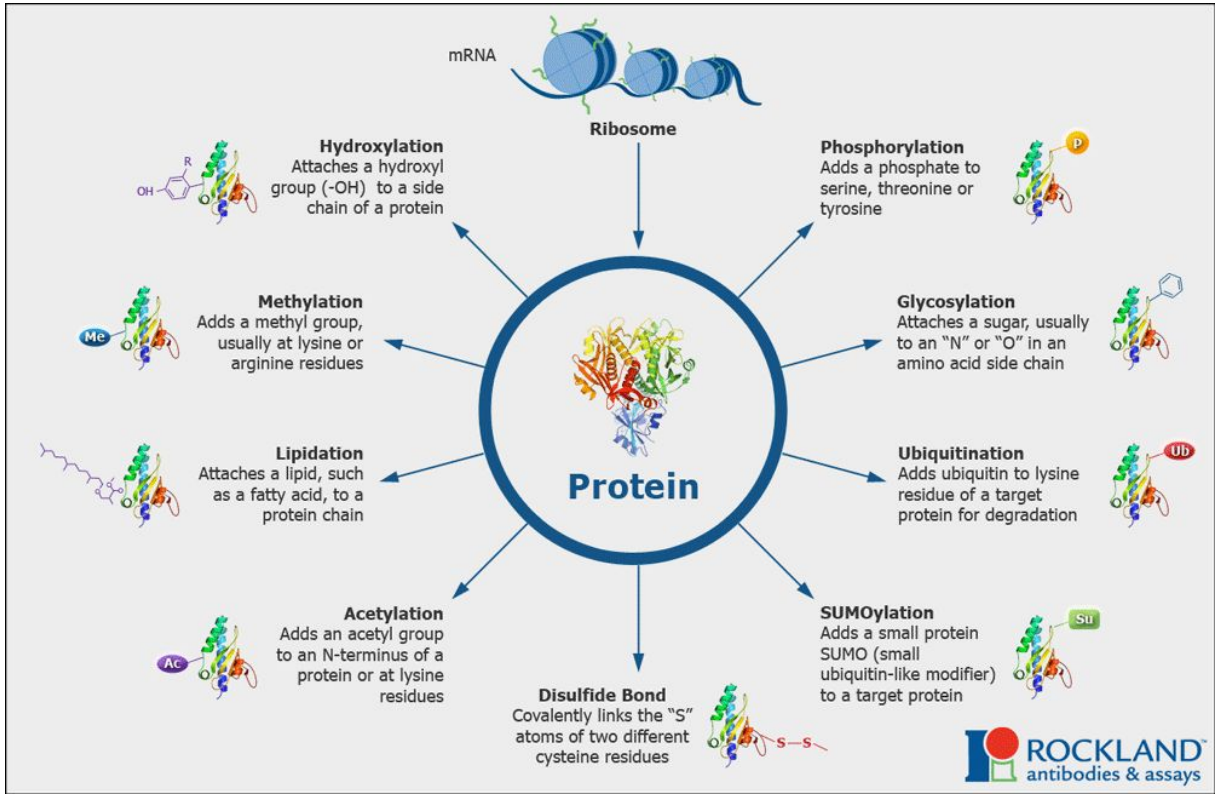


Copyright © Pearson Education, Inc., publishing as Benjamin Cummings.

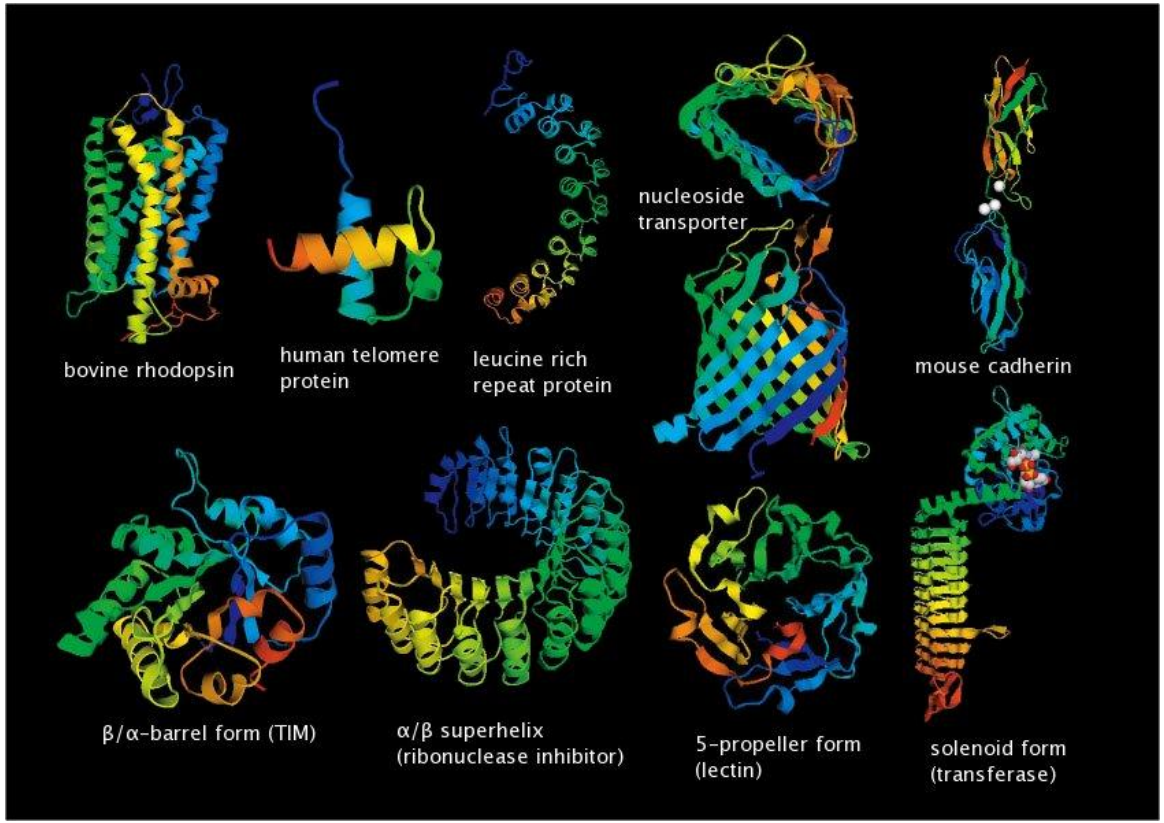
Четвертичная структура белка



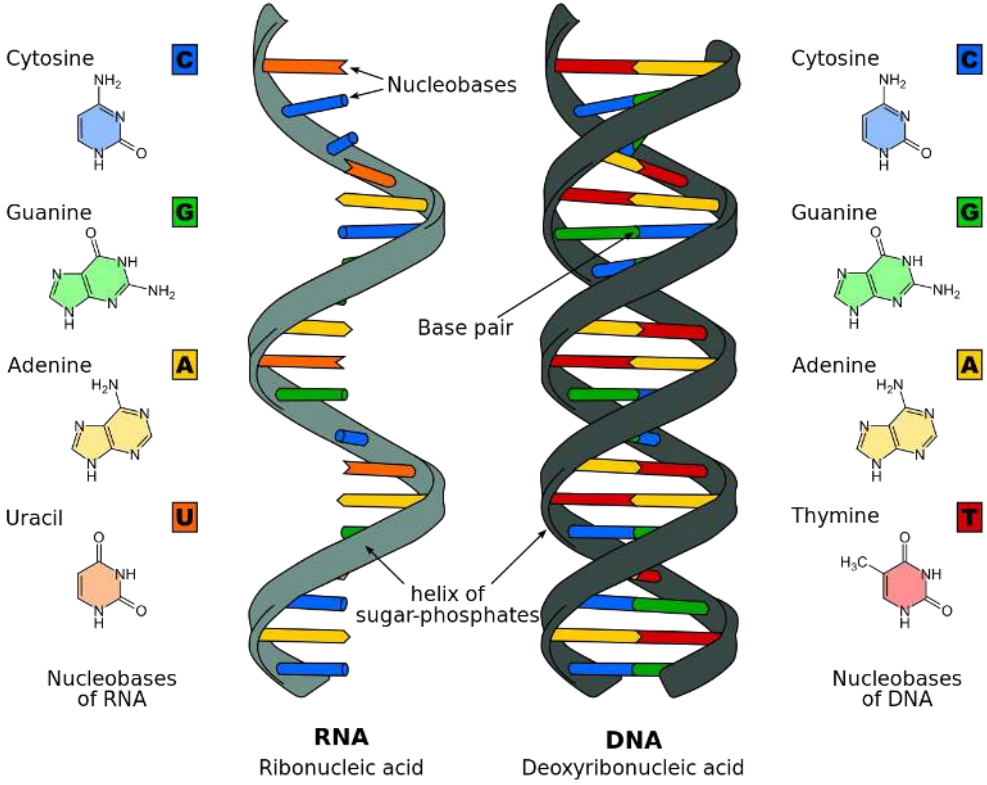
Посттрансляционные модификации белков



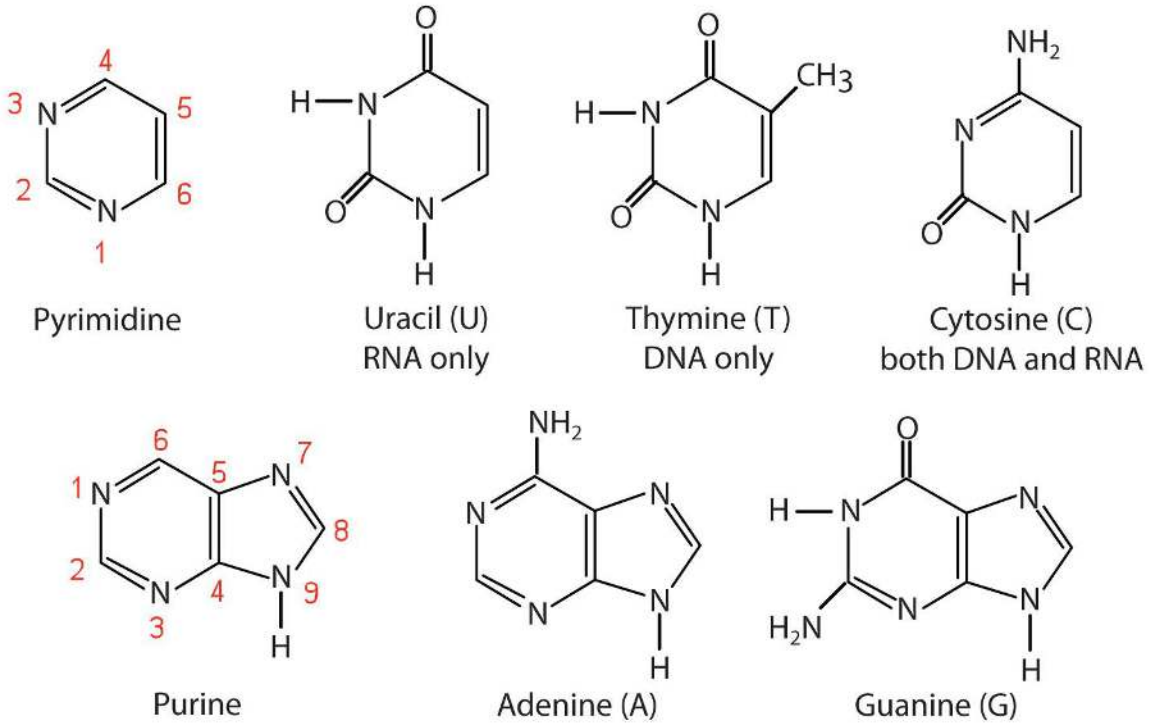
Белки


bovine rhodopsin
human telomere protein
leucine rich repeat protein
nucleoside transporter
mouse cadherin
β/α-barrel form (TIM)
α/β superhelix (ribonuclease inhibitor)
5-propeller form (lectin)
solenoid form (transferase)

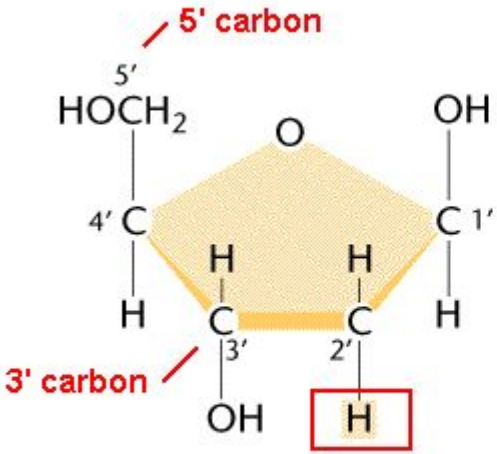
Нуклеиновые кислоты



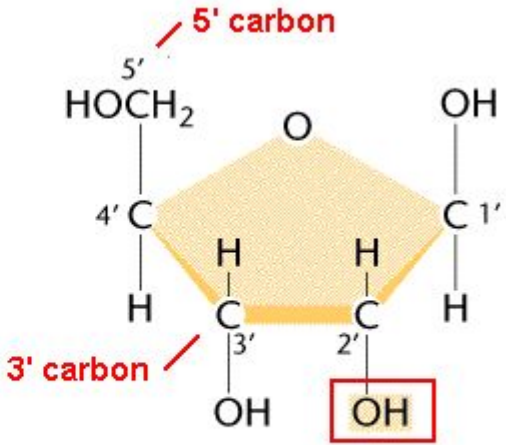
Азотистые основания



Углеводы в нуклеиновых кислотах

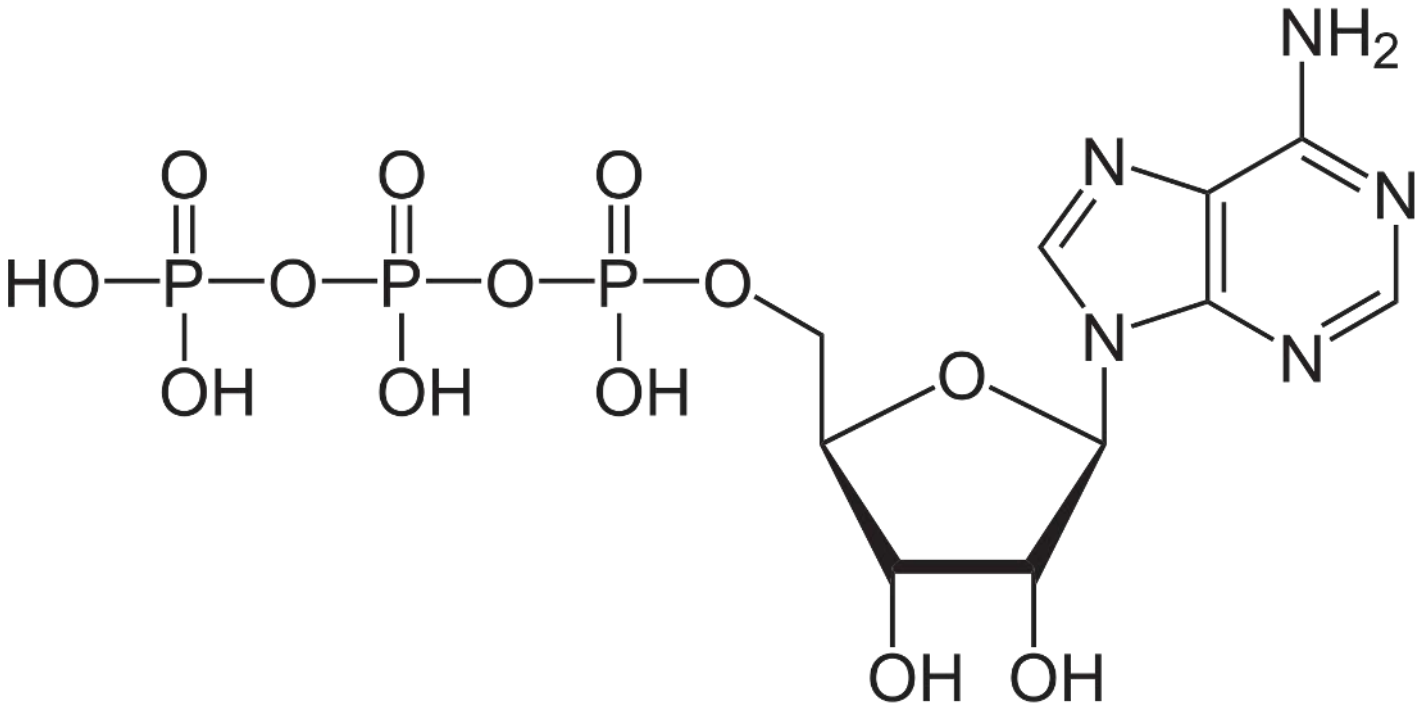


2-Deoxyribose

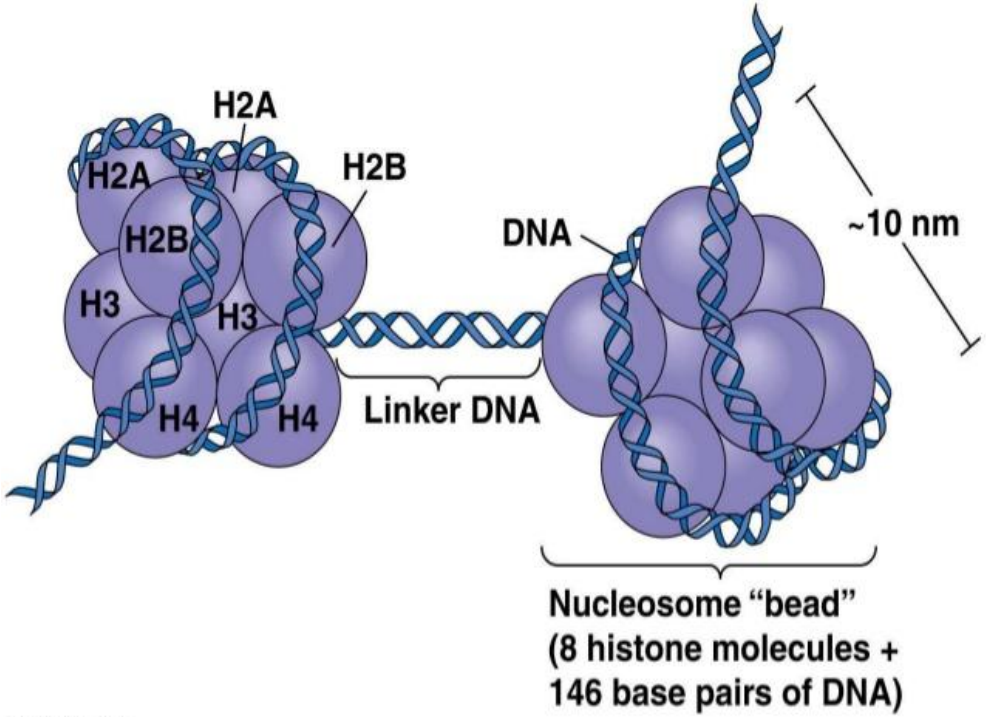


Ribose

Аденозинтрифосфат

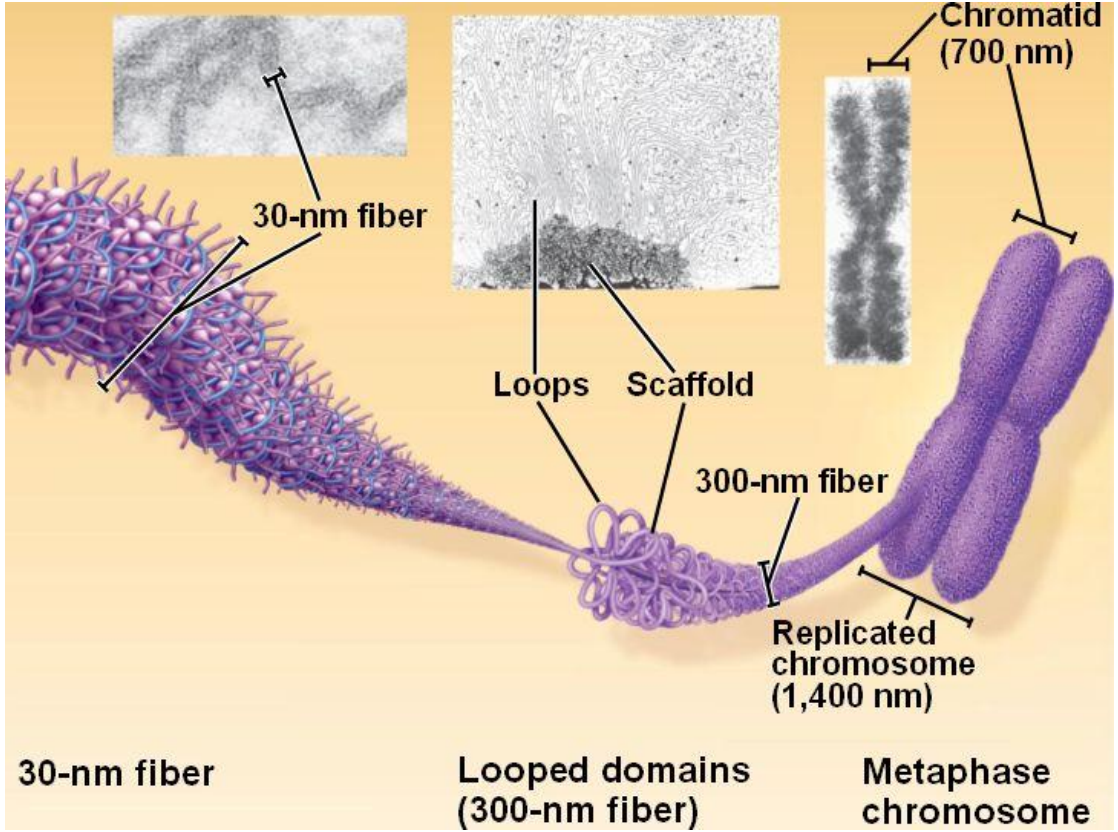


Упаковка ДНК

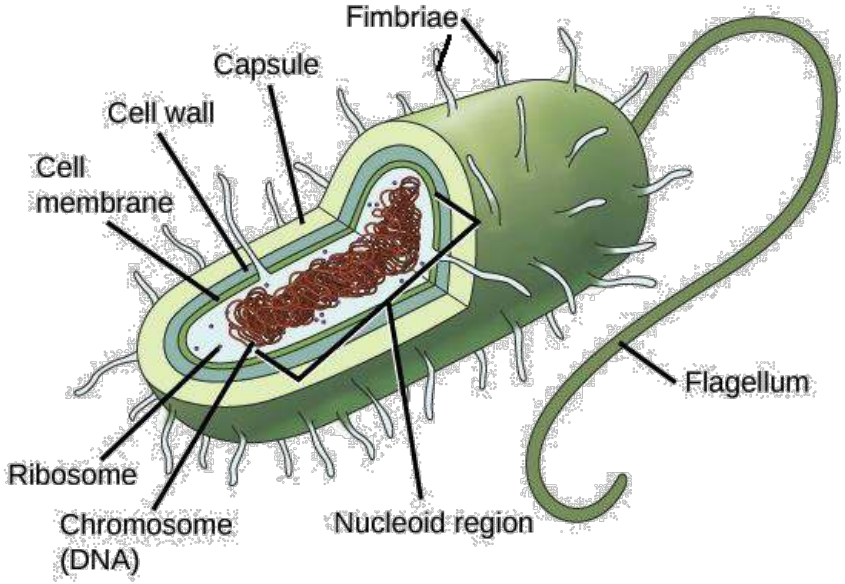


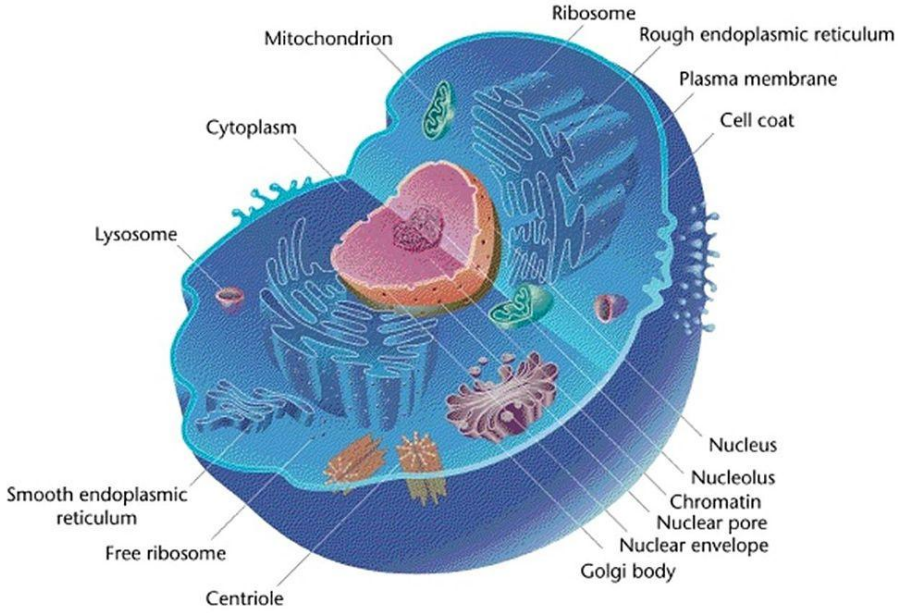
© 2012 Pearson Education, Inc.

Уровни упаковки хроматина

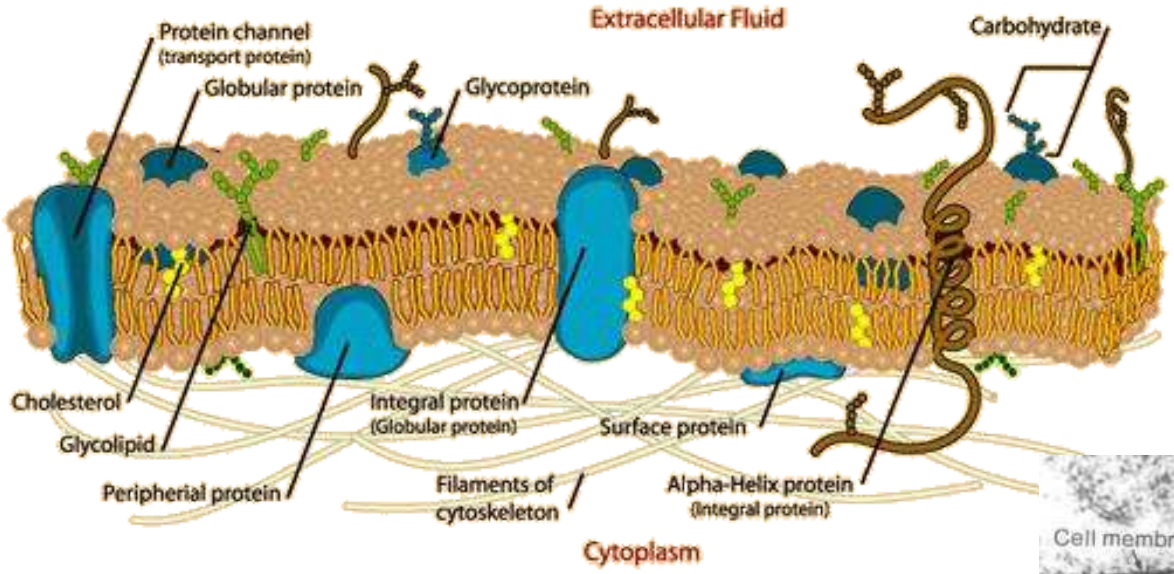


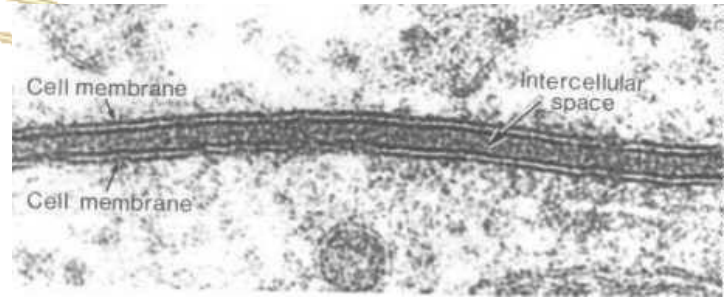
Строение клетки



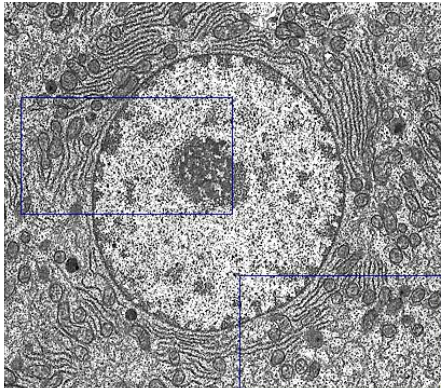


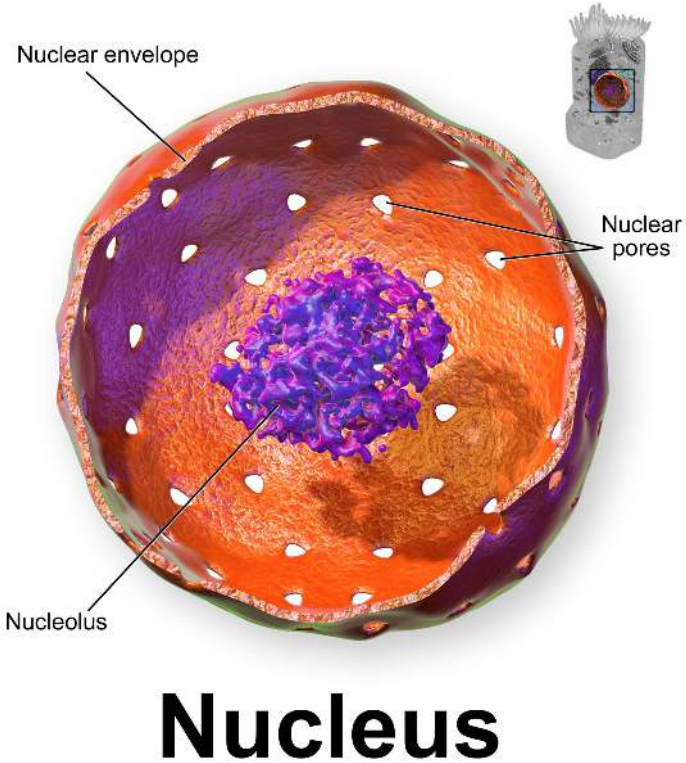
Строение клеточной мембраны

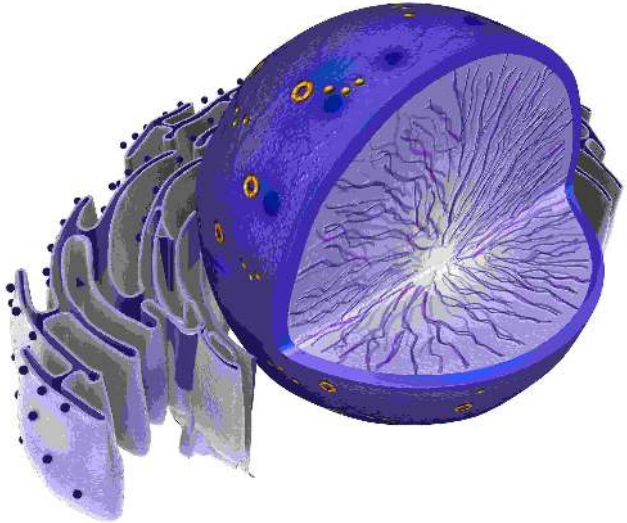




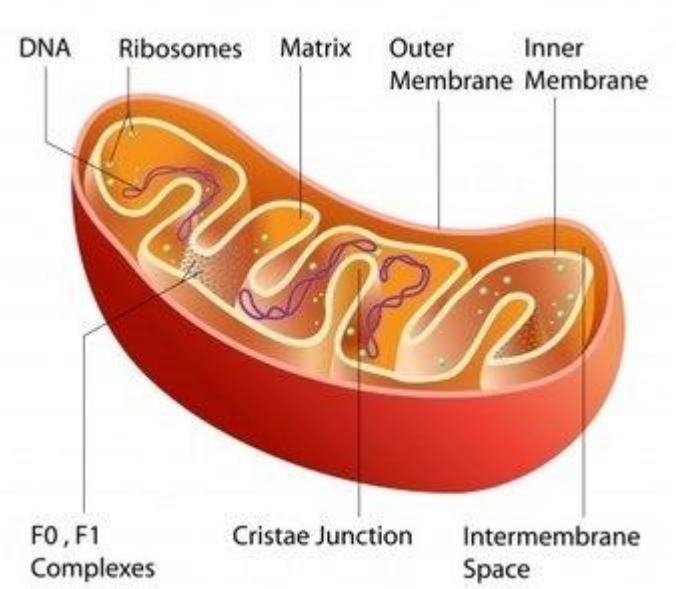
Ядро

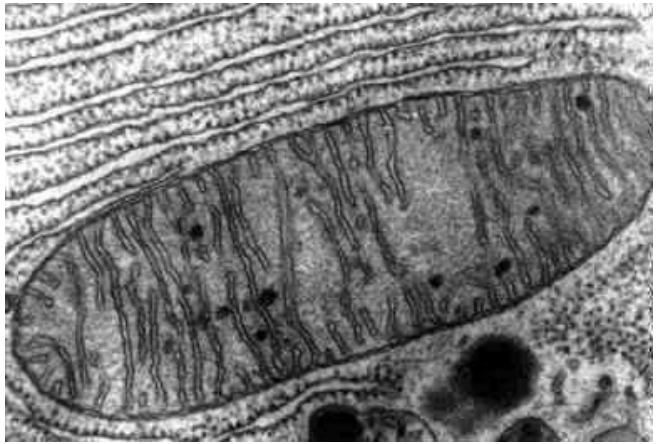




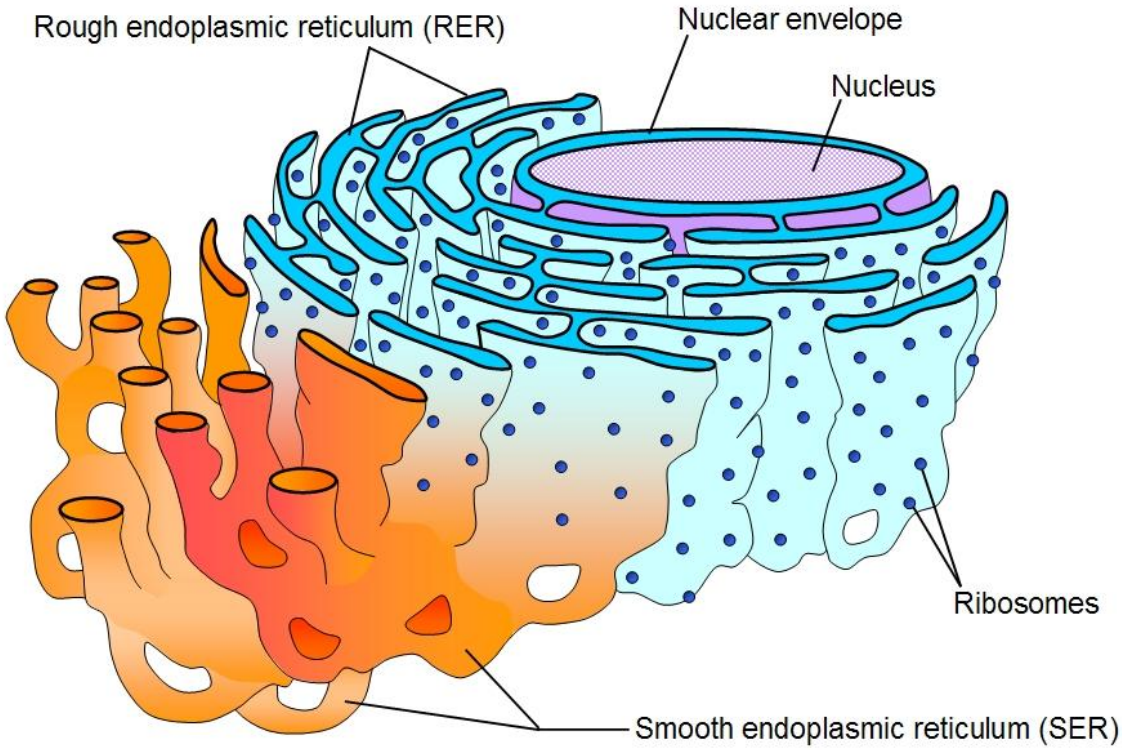


Митохондрии

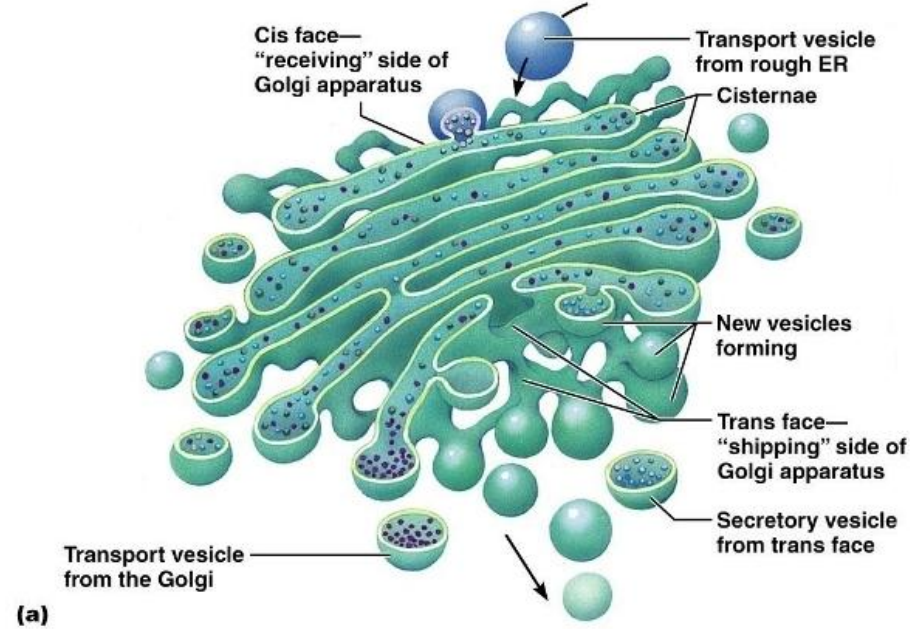




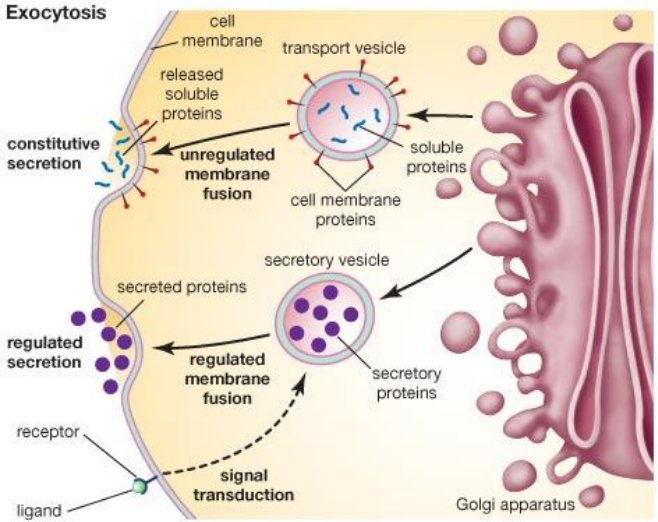
Эндоплазматическая сеть



Аппарат Гольджи

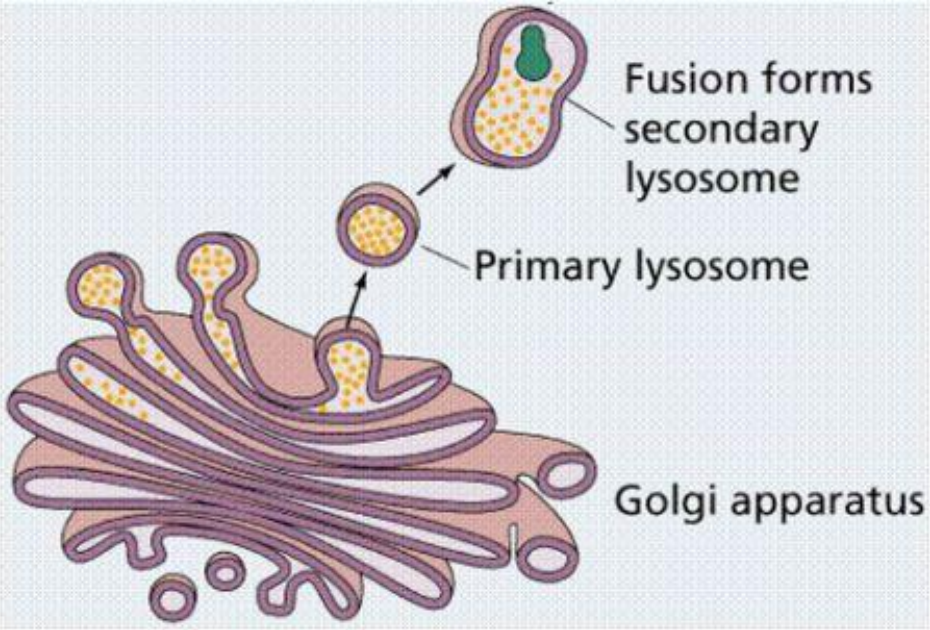


Copyright © 2008 Pearson Education, Inc., publishing as Benjamin Cummings.

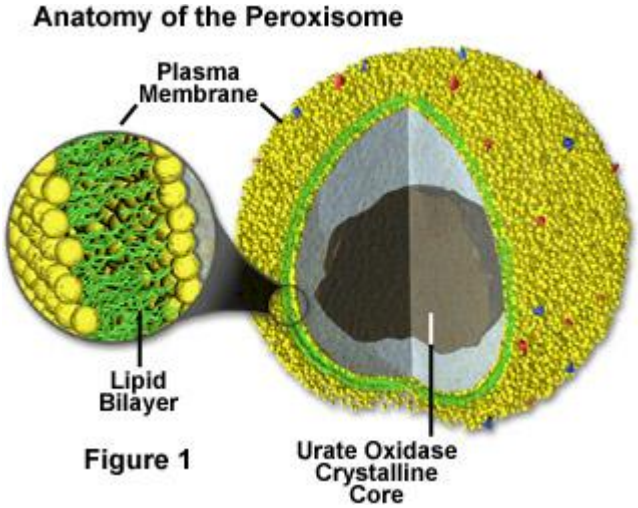


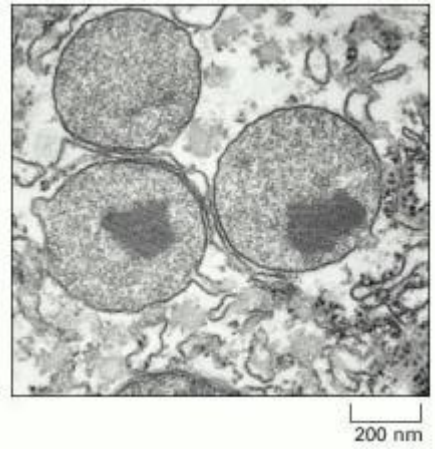
© 2008 Encyclopædia Britannica, Inc.

Лизосомы

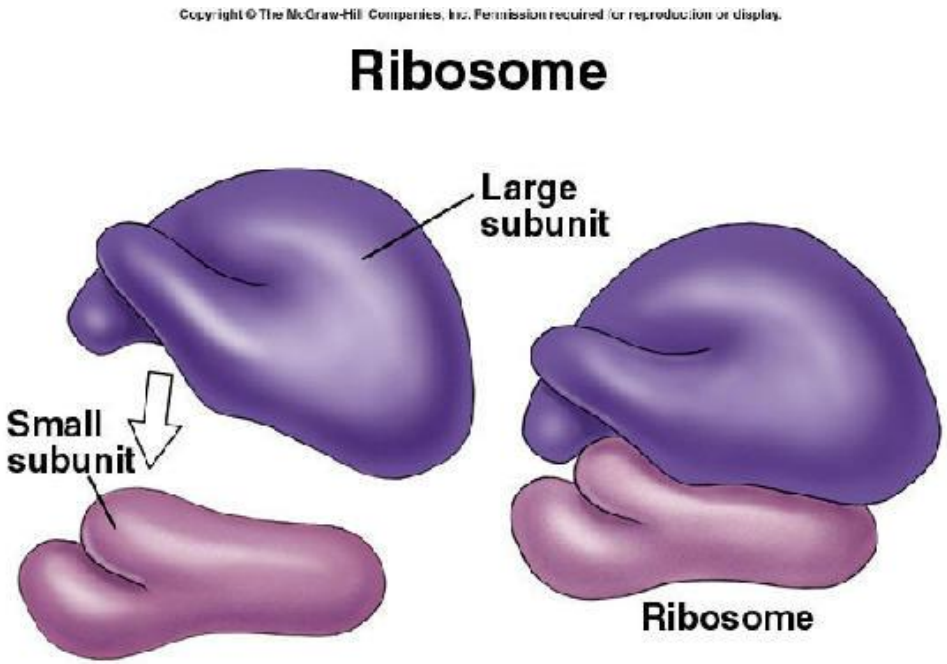

Fusion forms
secondary
lysosome
Primary lysosome
Golgi apparatus

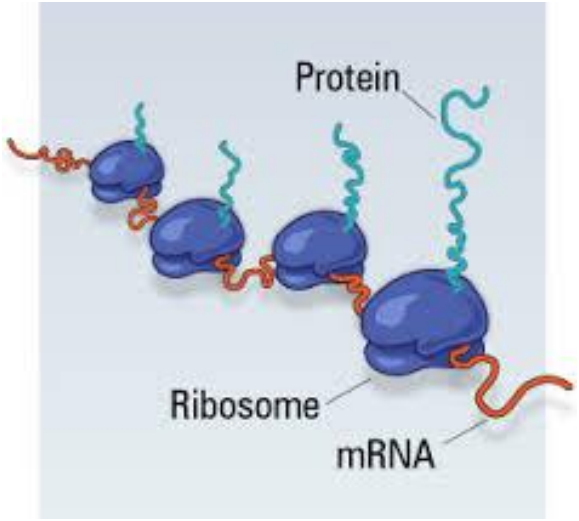
Пероксисомы



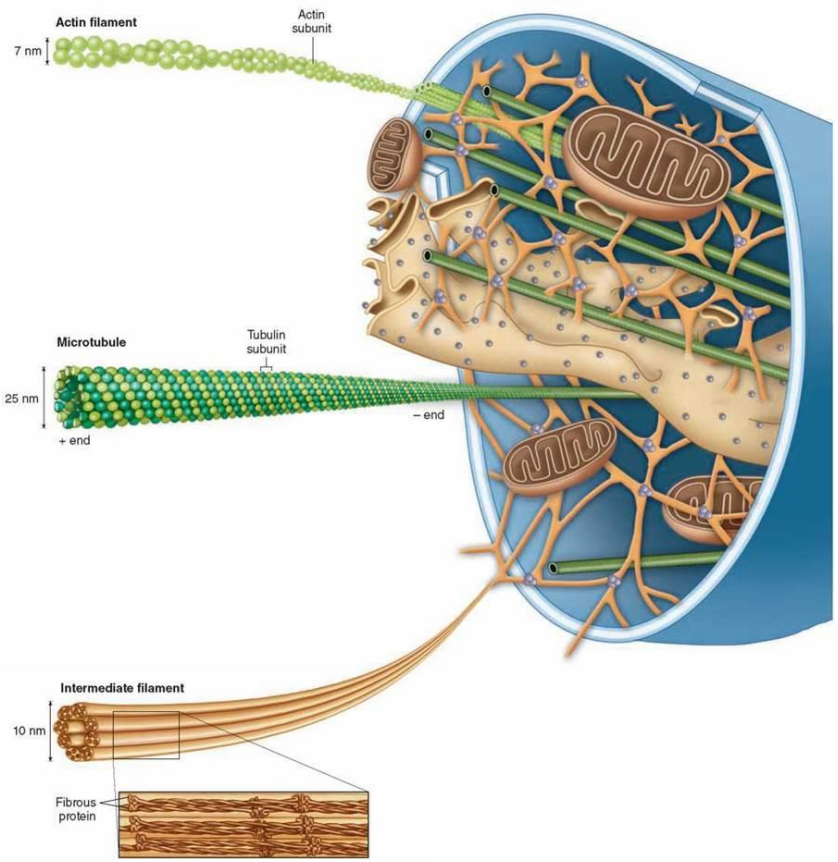


Рибосомы

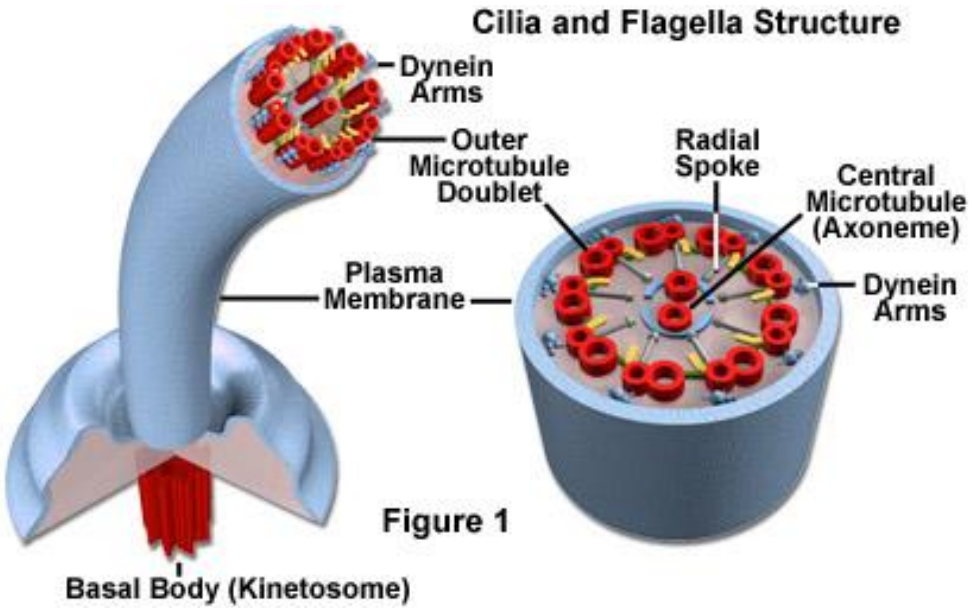

Copyright © The McGraw-Hill Companies, Inc. Permission required for reproduction or display.
Ribosome
Large subunit
Small subunit
Ribosome


Protein
Ribosome
mRNA

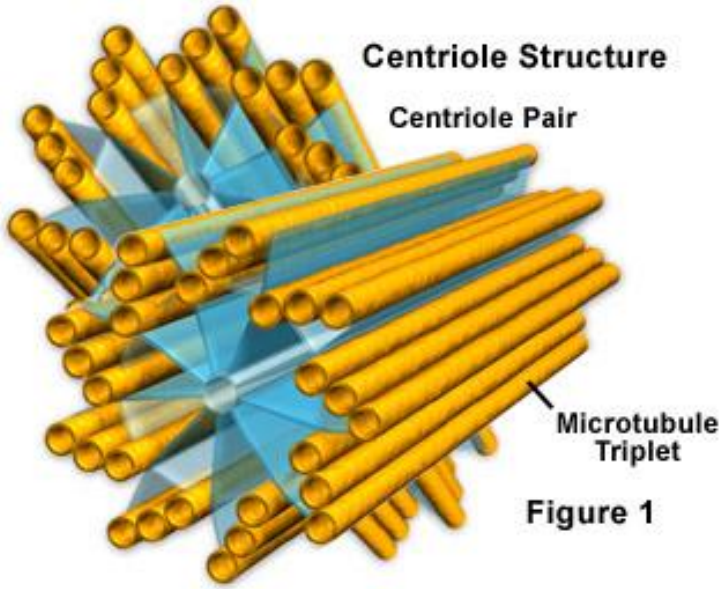
Цитоскелет


Actin filament
7 nm
Actin subunit
Microtubule
Tubulin subunit
25 nm
+ end
– end
Intermediate filament
10 nm
Fibrous protein

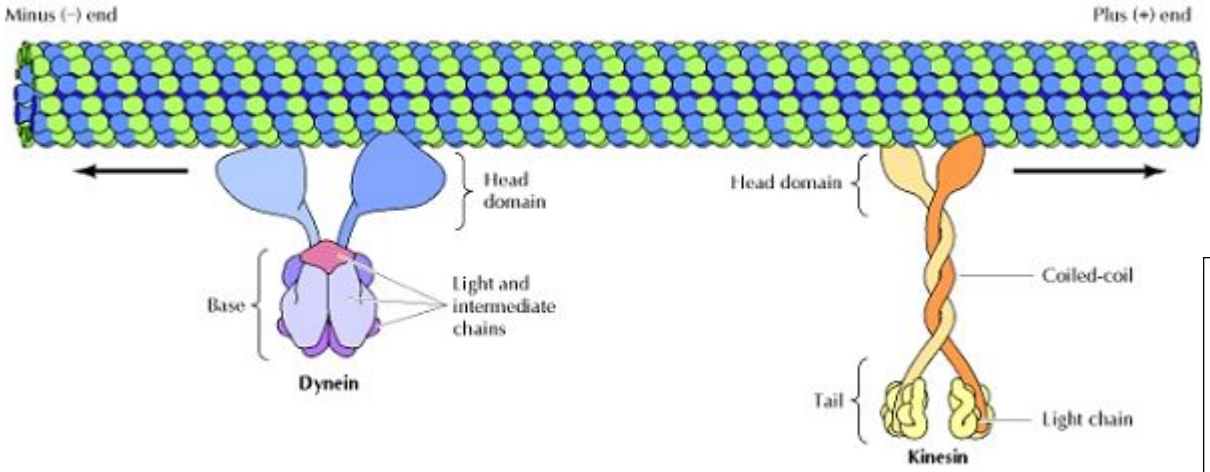
Реснички

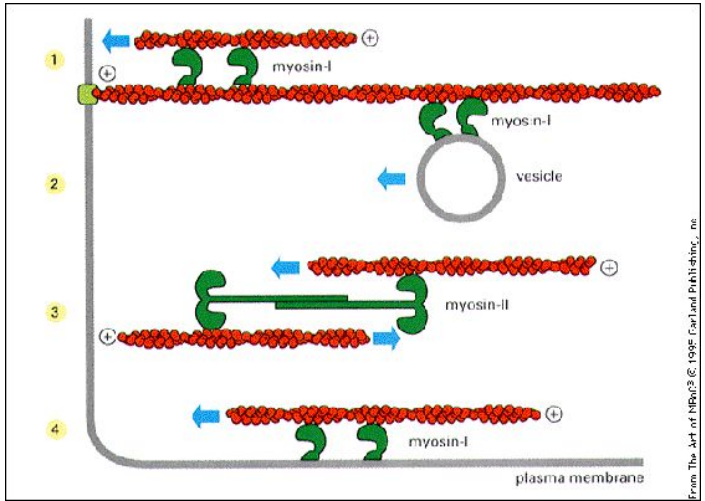

Cilia and Flagella Structure
Dynein Arms
Outer Microtubule Doublet
Radial Spoke
Central Microtubule (Axoneme)
Plasma Membrane
Dynein Arms
Figure 1
Basal Body (Kinetosome)

Центриоль

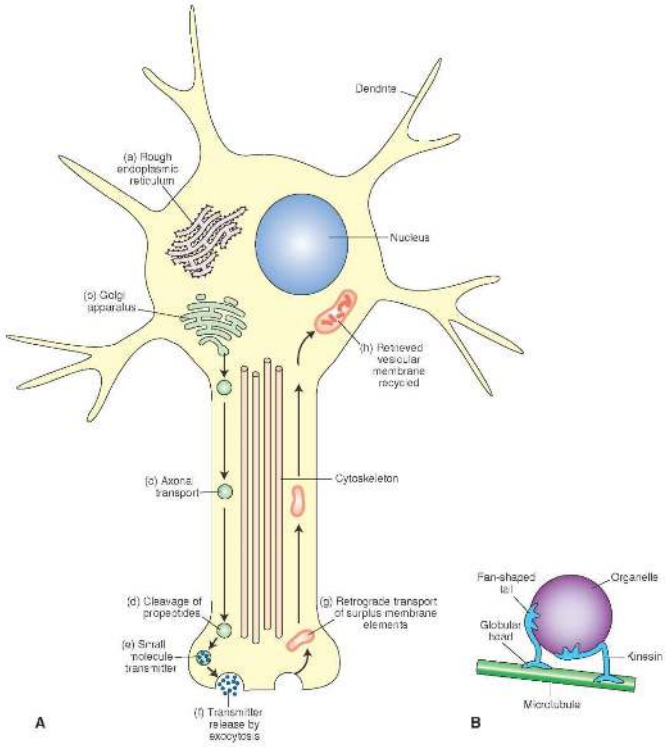

Centriole Structure
Centriole Pair
Microtubule
Triplet
Figure 1

Внутриклеточный транспорт

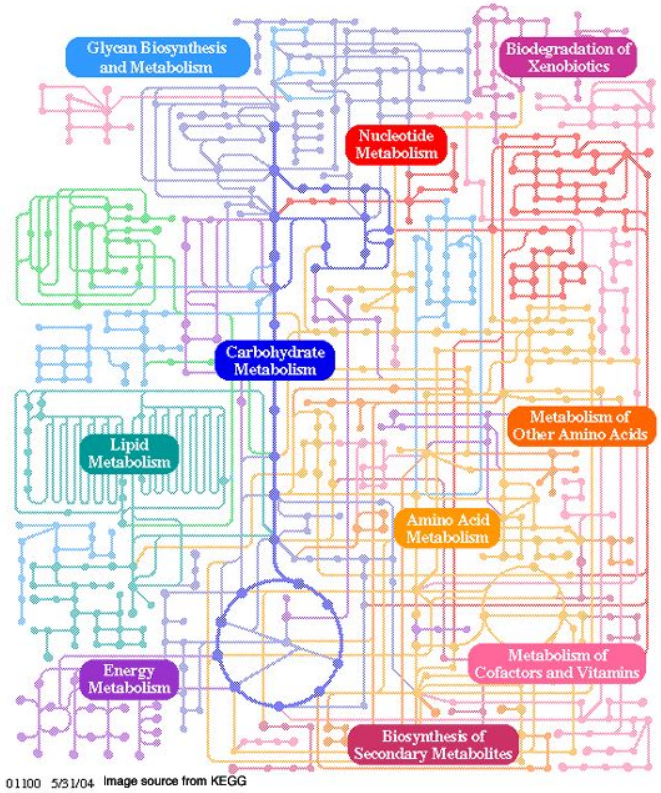




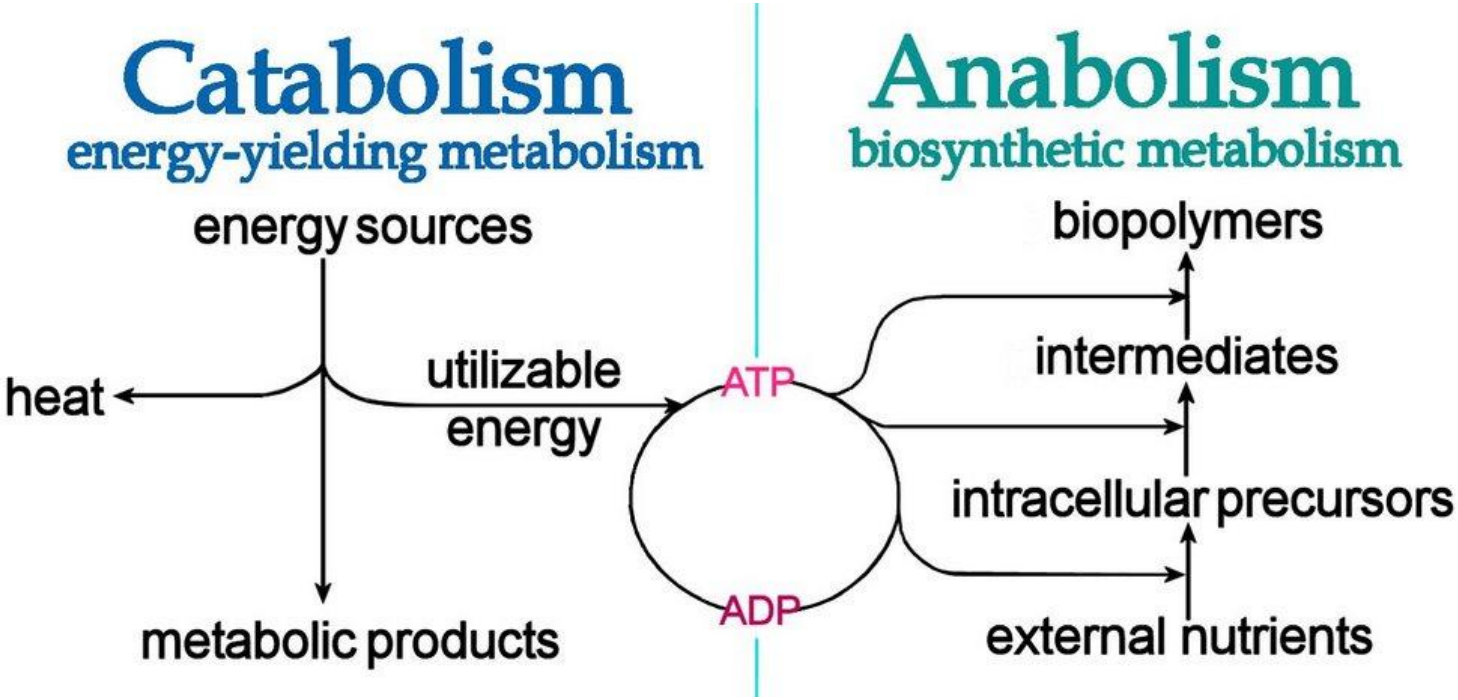
Внутриклеточный транспорт



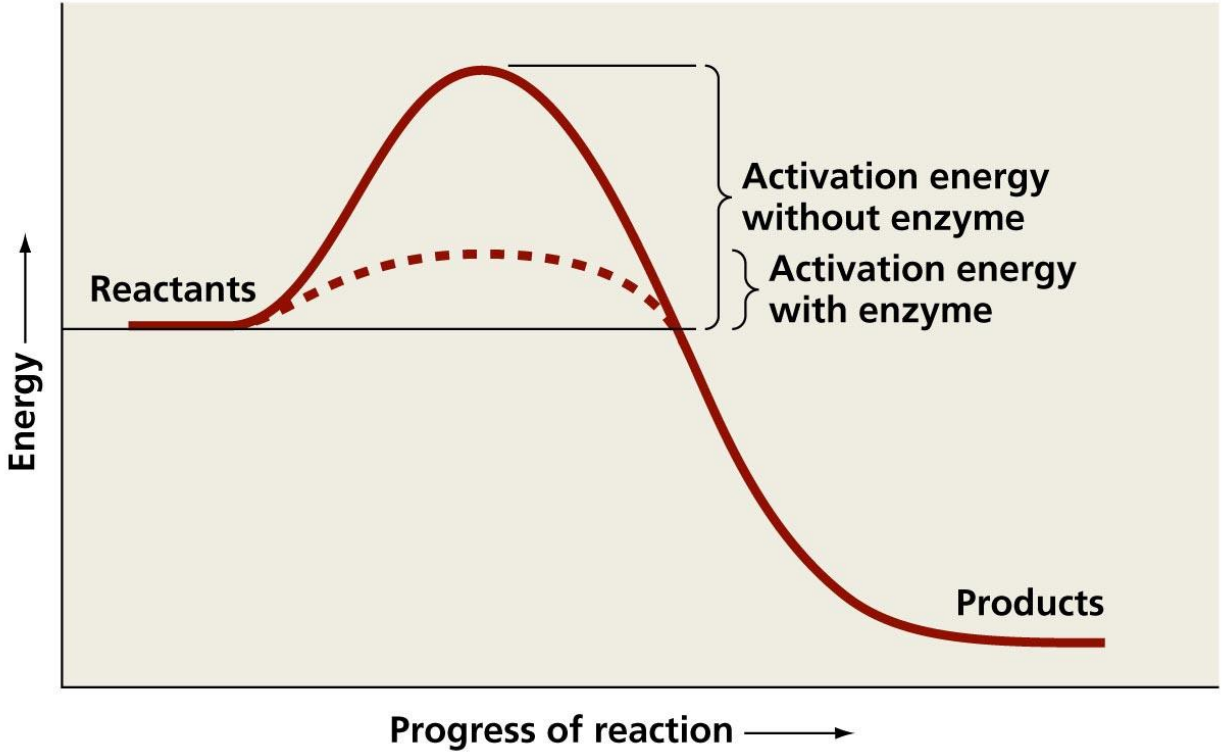
Метаболизм


Glycan Biosynthesis and Metabolism
Biodegradation of Xenobiotics
Nucleotide Metabolism
Carbohydrate Metabolism
Metabolism of Other Amino Acids
Lipid Metabolism
Amino Acid Metabolism
Metabolism of Cofactors and Vitamins
Energy Metabolism
Biosynthesis of Secondary Metabolites
01100 5/31/04 Image source from KEGG

Анаболизм и катаболизм

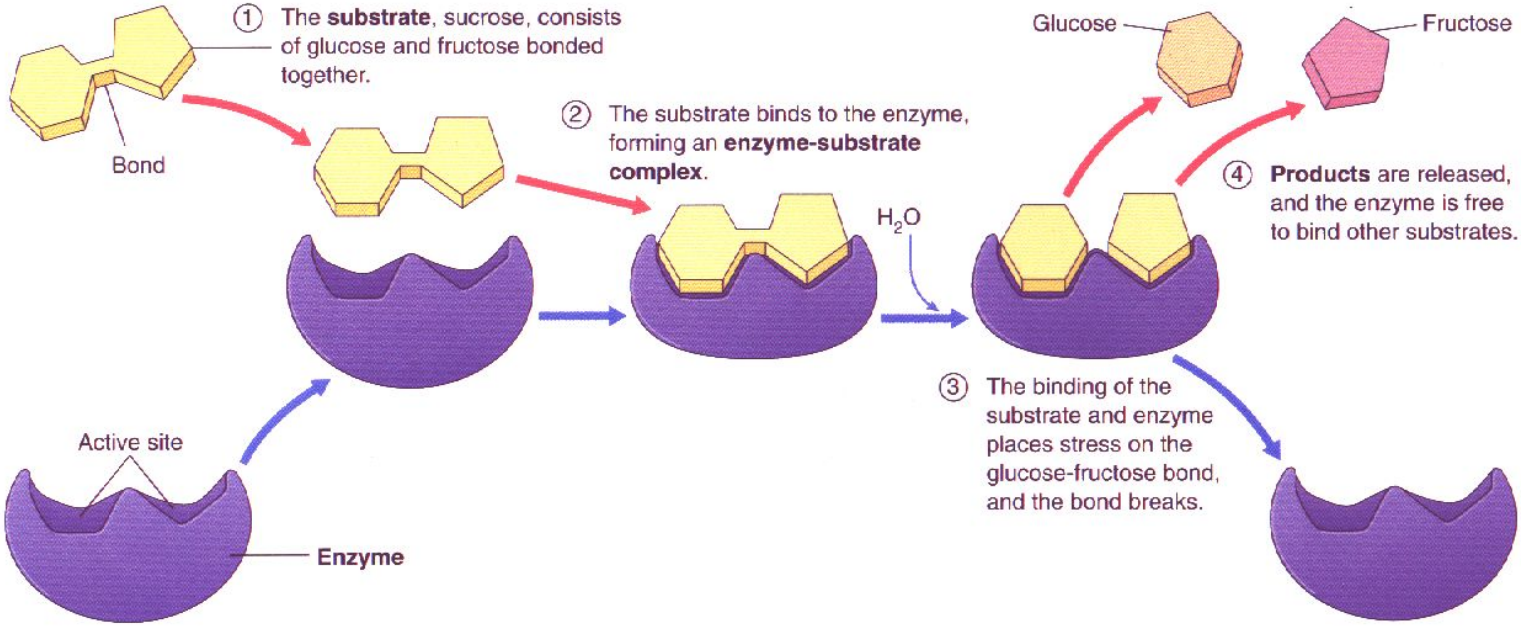


Ферменты

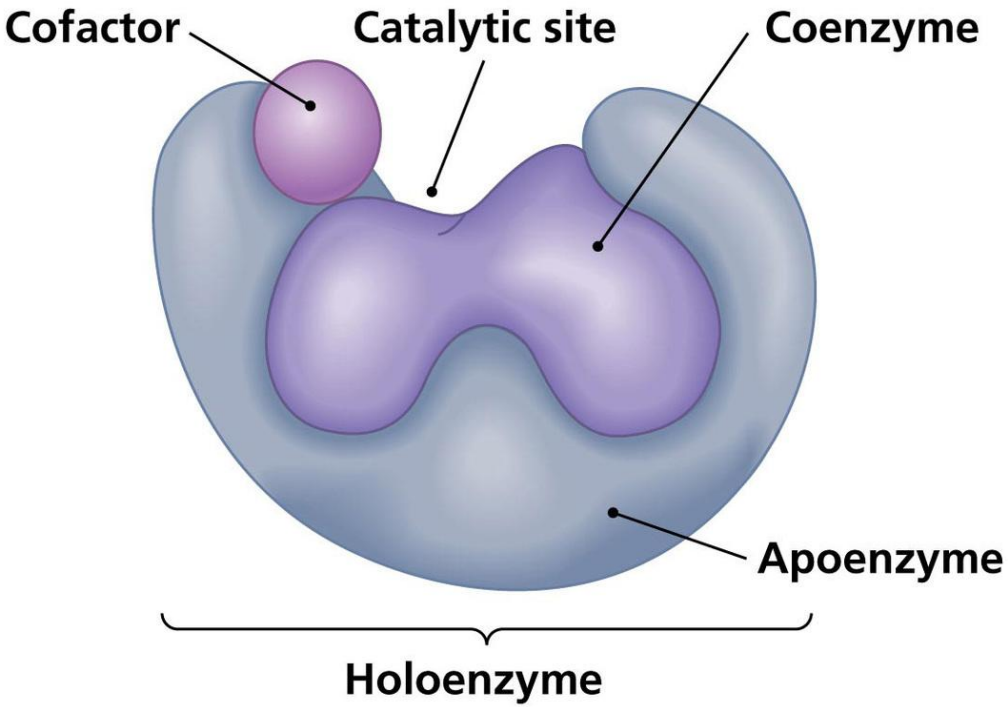


Copyright © 2006 Pearson Education, Inc., publishing as Benjamin Cummings.

Ферменты

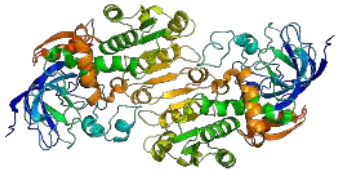

① The substrate, sucrose, consists of glucose and fructose bonded together.
Bond
② The substrate binds to the enzyme, forming an enzyme-substrate complex.
H_2O
③ The binding of the substrate and enzyme places stress on the glucose-fructose bond, and the bond breaks.
Glucose
Fructose
④ Products are released, and the enzyme is free to bind other substrates.
Active site
Enzyme

Структура фермента

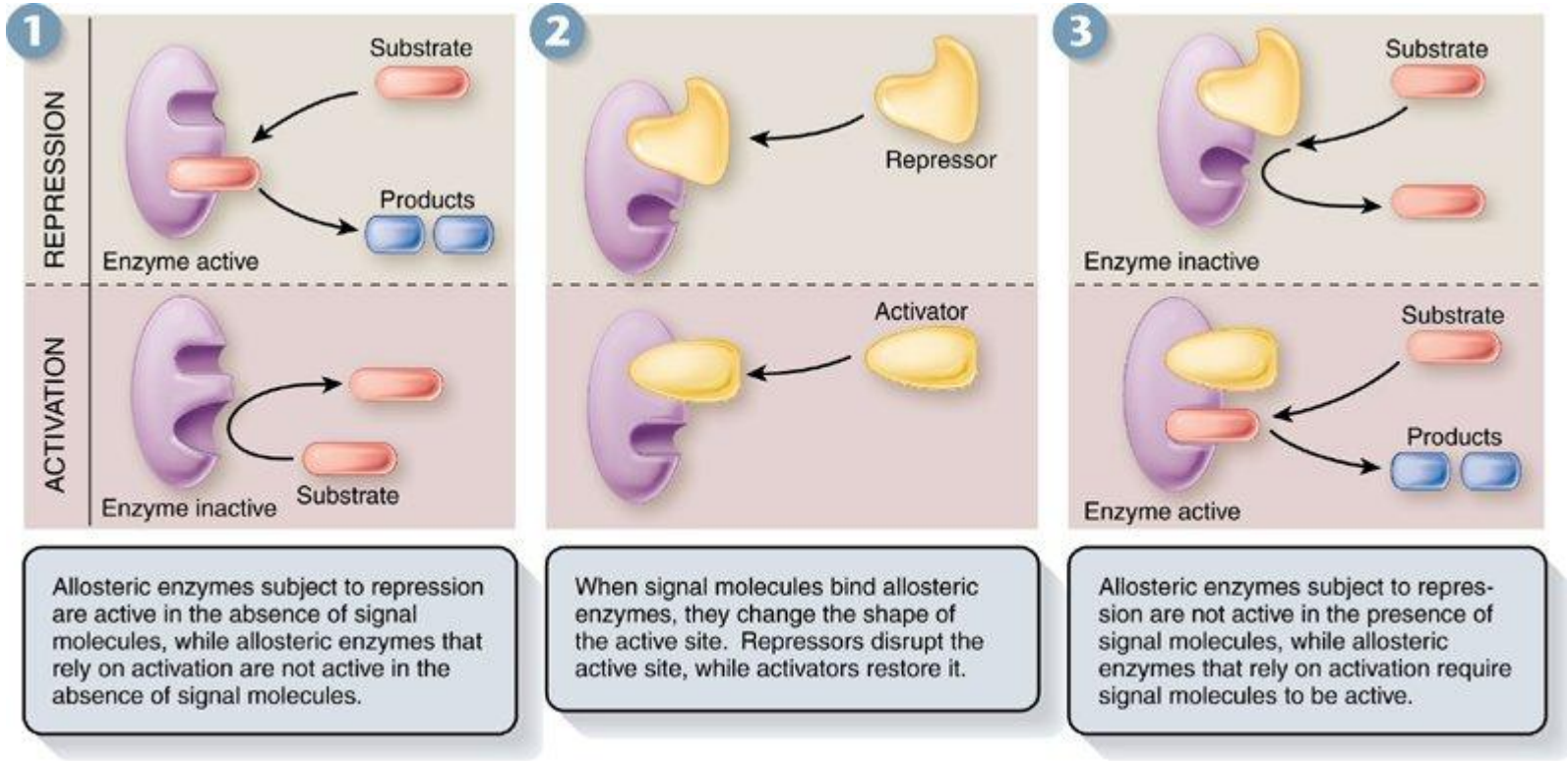


Классификация ферментов

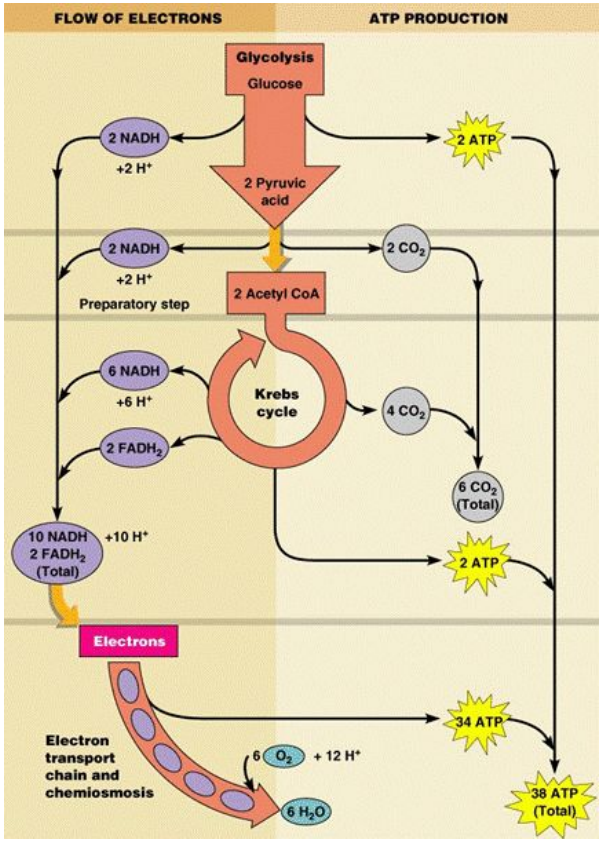
CLASSIFICATION OF ENZYMES		
Group of Enzyme	**Reaction Catalysed**	**Examples**
1. Oxidoreductases	Transfer of hydrogen and oxygen atoms or electrons from one substrate to another.	Dehydrogenases Oxidases
2. Transferases	Transfer of a specific group (a phosphate or methyl etc.) from one substrate to another.	Transaminase Kinases
3. Hydrolases	Hydrolysis of a substrate.	Estrases Digestive enzymes
4. Isomerases	Change of the molecular form of the substrate.	Phospho hexo isomerase, Fumarase
5. Lyases	Nonhydrolytic removal of a group or addition of a group to a substrate.	Decarboxylases Aldolases
6. Ligases (Synthetases)	Joining of two molecules by the formation of new bonds.	Citric acid synthetase



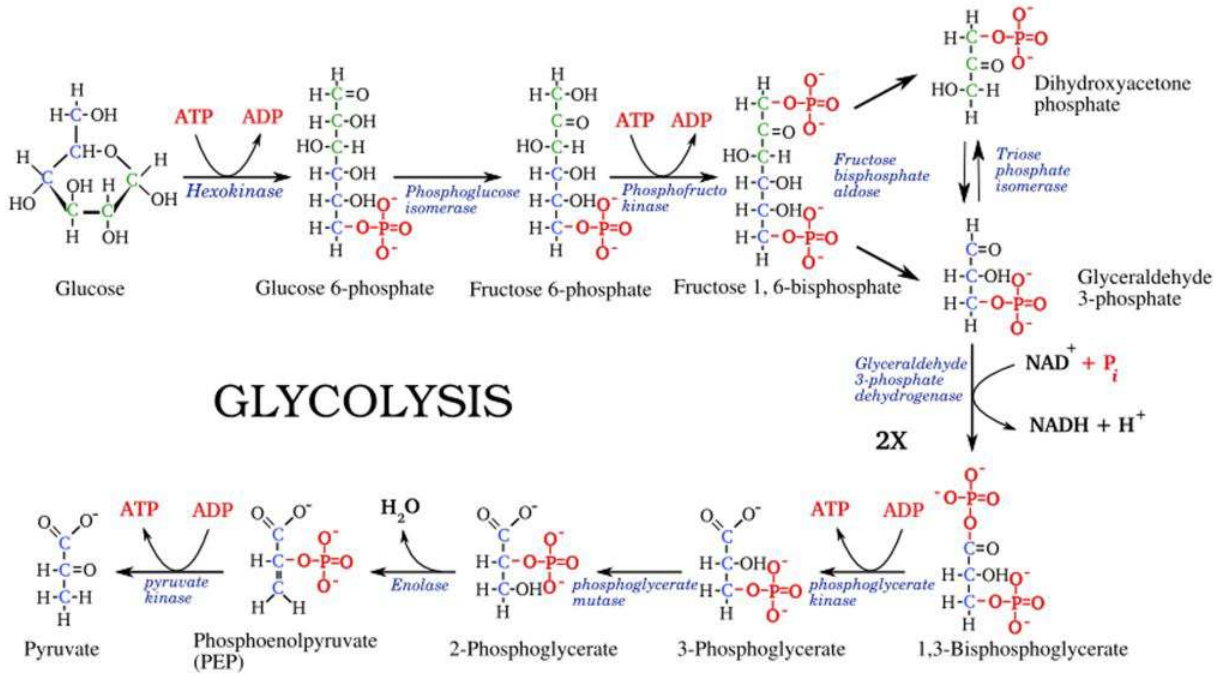
Регуляция работы ферментов



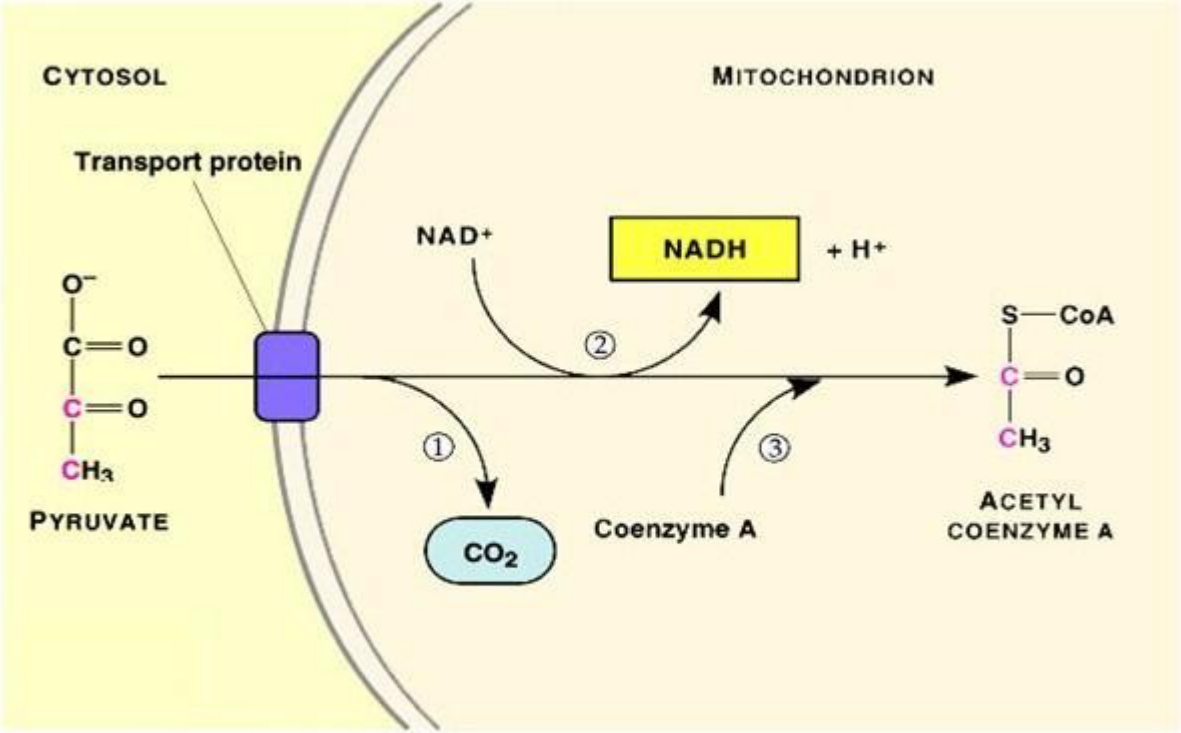
Катаболизм глюкозы



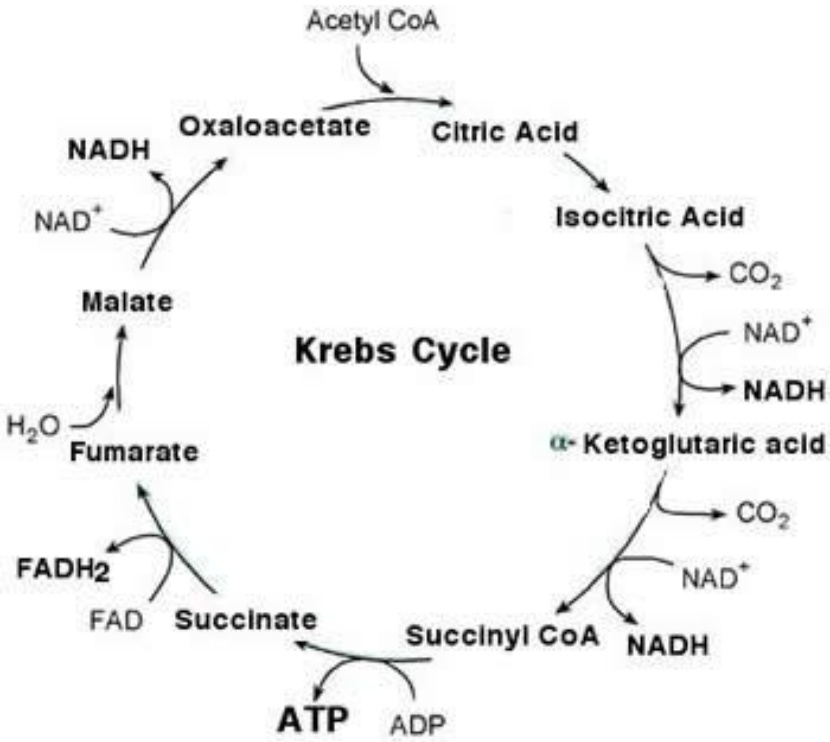
Гликолиз


GLYCOLYSIS
Glucose
ATP
ADP
Hexokinase
Glucose 6-phosphate
Phosphoglucose isomerase
Fructose 6-phosphate
ATP
ADP
Phosphofructo kinase
Fructose 1, 6-bisphosphate
Fructose bisphosphate aldose
Dihydroxyacetone phosphate
Triose phosphate isomerase
Glyceraldehyde 3-phosphate
Glyceraldehyde 3-phosphate dehydrogenase
NAD+ + Pi
NADH + H+
2X
1,3-Bisphosphoglycerate
ATP
ADP
phosphoglycerate kinase
3-Phosphoglycerate
phosphoglycerate mutase
2-Phosphoglycerate
Enolase
H2O
Phosphoenolpyruvate (PEP)
ATP
ADP
pyruvate kinase
Pyruvate

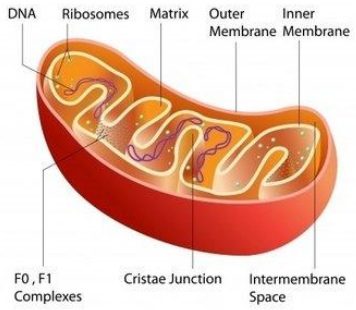
Образование ацетил-КоА

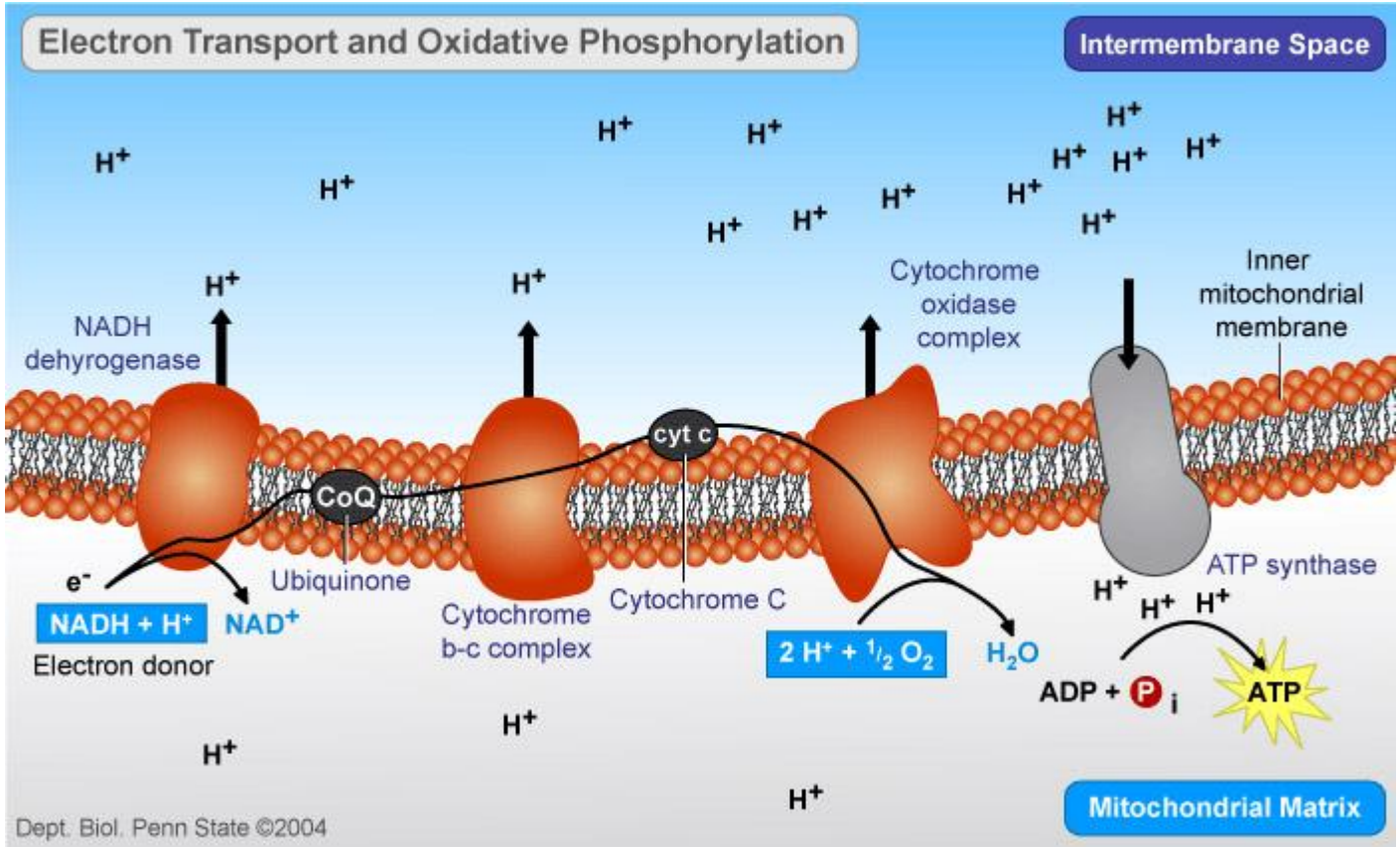


Цикл Кребса

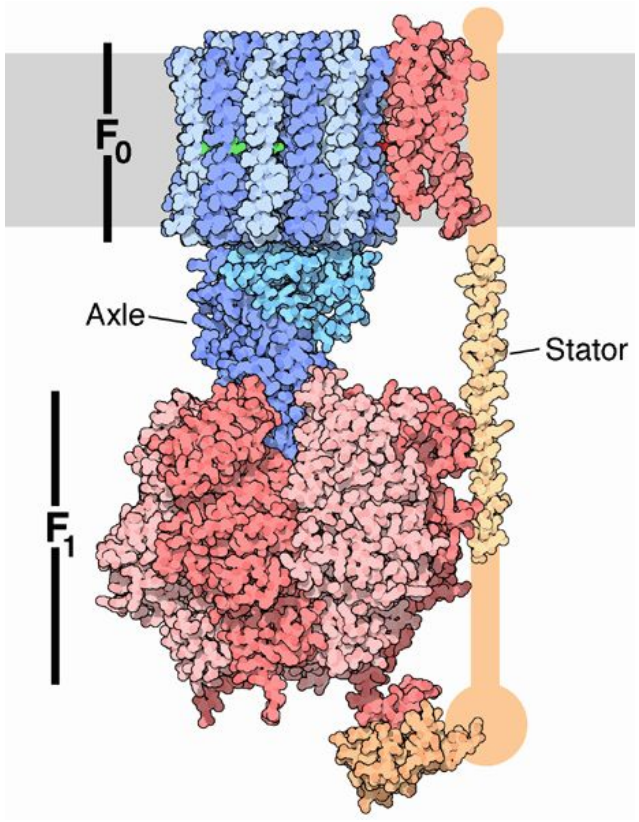

Acetyl CoA
Citric Acid
Isocitric Acid
CO_2
NAD^+
NADH
α- Ketoglutaric acid
CO_2
NAD^+
NADH
Succinyl CoA
ADP
ATP
Succinate
FAD
$FADH_2$
Fumarate
H_2O
Malate
NAD^+
NADH
Oxaloacetate
Krebs Cycle

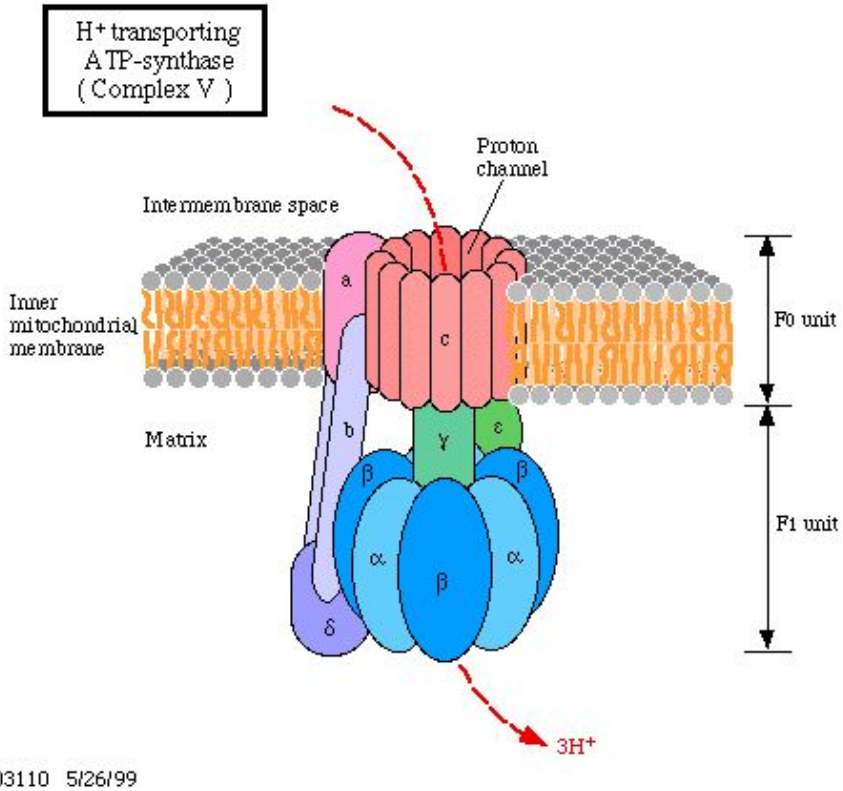
Окислительное фосфорилирование





АТФ-синтаза


F0
Axle
Stator
F1


H+ transporting
ATP-synthase
(Complex V)
Proton
channel
Intermembrane space
Inner
mitochondrial
membrane
Matrix
a
c
b
γ
ε
β
β
α
β
α
δ
F0 unit
F1 unit
3H+
03110 5/26/99