Uvod v molekularno biologijo celice

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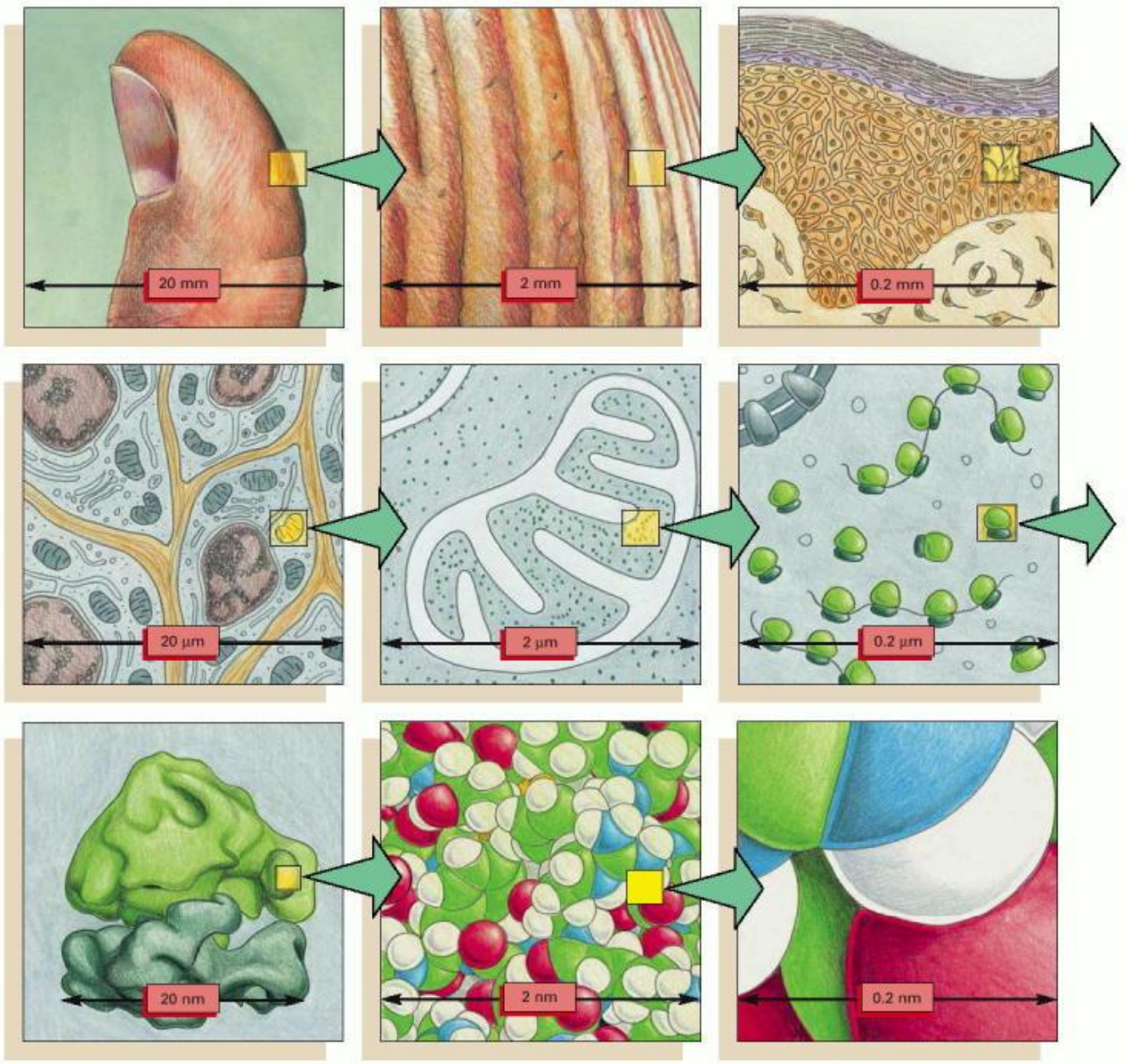
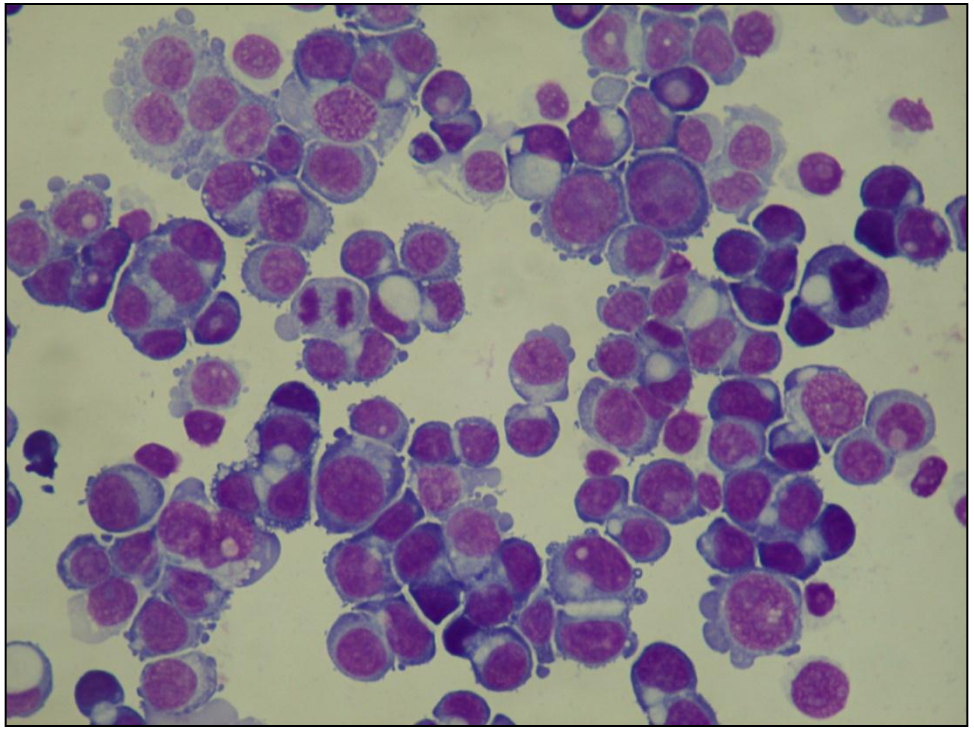


Lastnosti (znaki) živega

- Metabolizem
- Rast
- Razmnoževanje
- Odgovarjanje na dražljaje

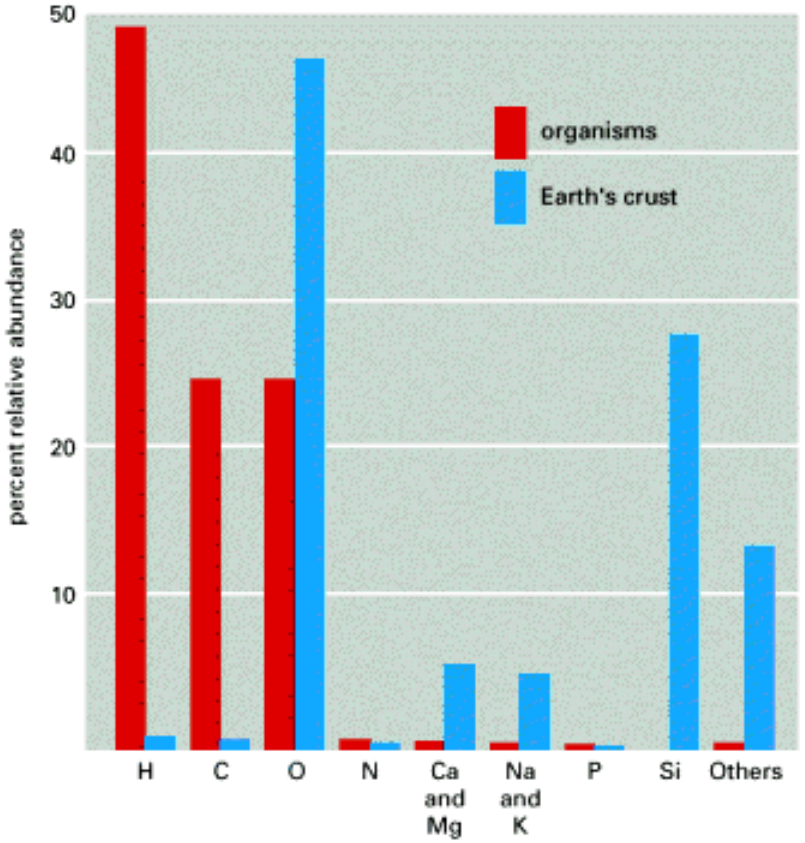


Lastnosti živega

- Visoko organizirani glede na neživo
- Homeostaza (vzdrževanje relativno konstantnega notranjega okolja)
- Razmnoževanje
- Rast in razvoj
- Jemanje energije od zunaj in njena transformacija
- Odgovarjajo na dražljaje
- Adaptacija na okolje

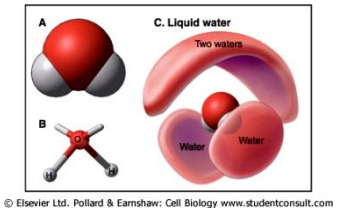
Sestavine celice -atomi

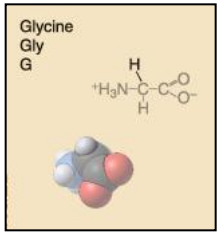
- Celice so zgrajene iz relativno majhnega števila različnih atomov

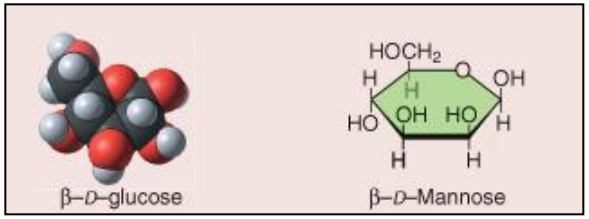


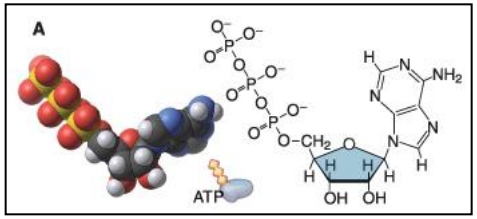
Gradniki celic

- Biogeni elementi: H, C, O, N, Ca, Mg, Na, K, P, drugi elementi
- Anorganske spojine: voda
- Organske molekule: sladkorji, maščobne kisline, aminokisline, nukleotidi







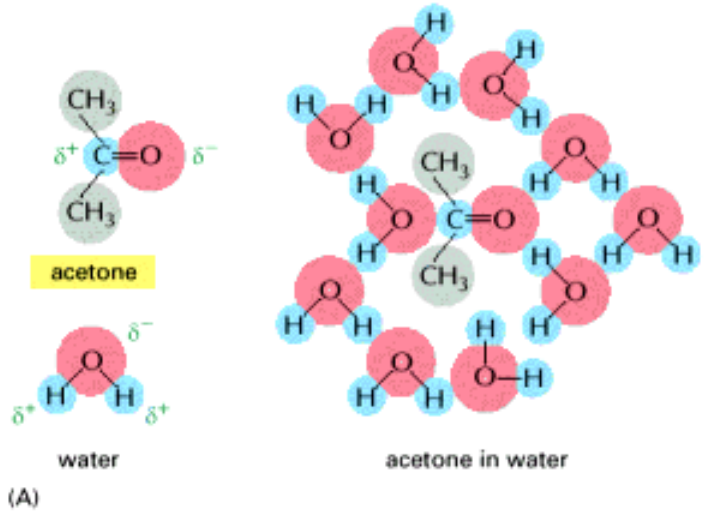


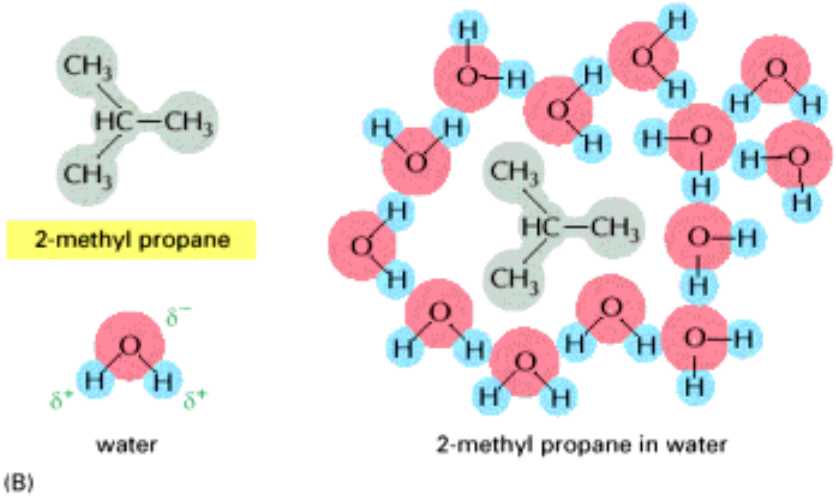
Sestavine celice-molekule

	%skupne teže celice
• Voda	70
• Anorganski ioni	1
• Sladkorji	1
• Aminokisline	0.4
• Nukleotidi	0.4
• Maščobne kisline	1
• Druge majhne mol.	0.2
• Makromolekule (proteini, nukleinske kisline, polisaharidi)	26

Voda

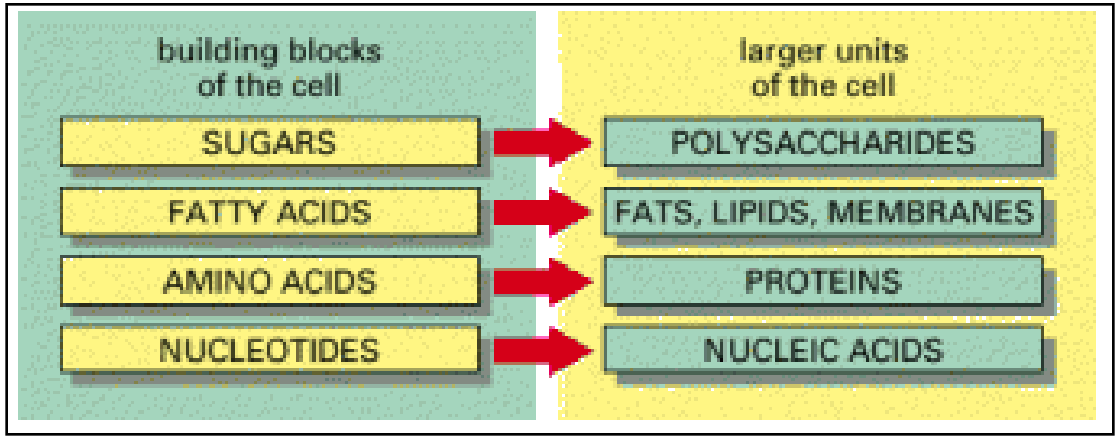
- Vodikova atoma sta povezana s kisikom s kovalentnimi vezmi – zelo polarna molekula
- Zato nastanejo med molekulami vode šibke vodikove vezi
- Glede na vezavo z vodo delimo molekule na:
  - Hidrofilne – topne v vodi (molekule sestavljene iz ionov ali polarne molekule)
  - Hidrofobne – netopne v vodi (molekule s pretežno nepolarnimi vezmi)





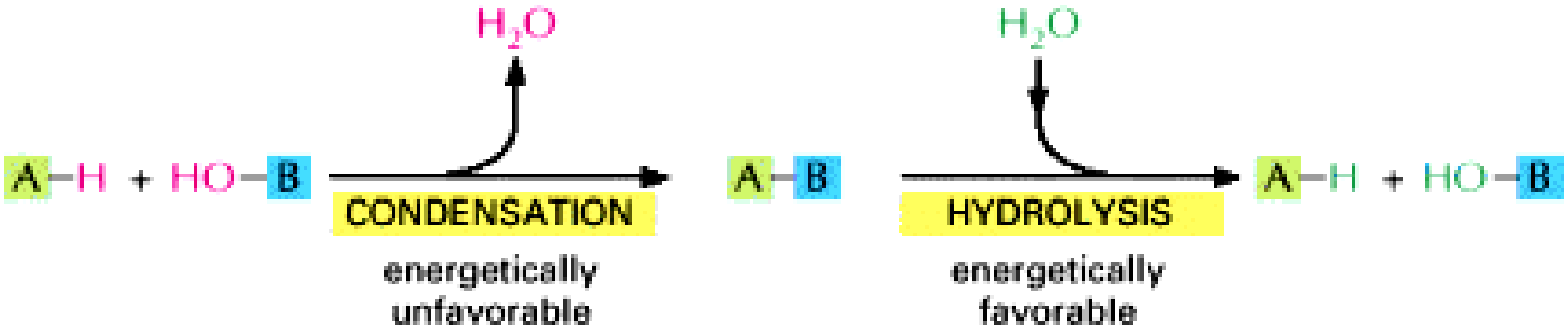
Organske snovi

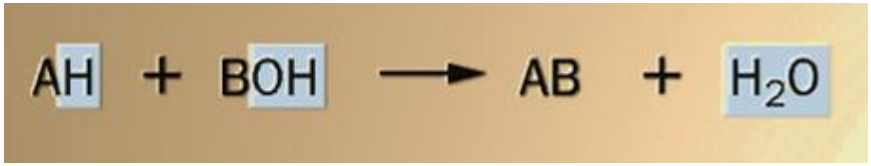
- Sestavljajo 80-90% suhe teže celice
- Poznamo štiri skupine molekul
  - ogljikovi hidrati
  - lipidi
  - proteini
  - nukleinske kisline

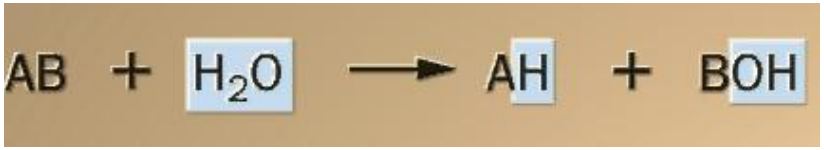


- Ogljikovi hidrati, proteini in nukleinske kisline so polimeri - makromolekule

Kondenzacija in hidroliza







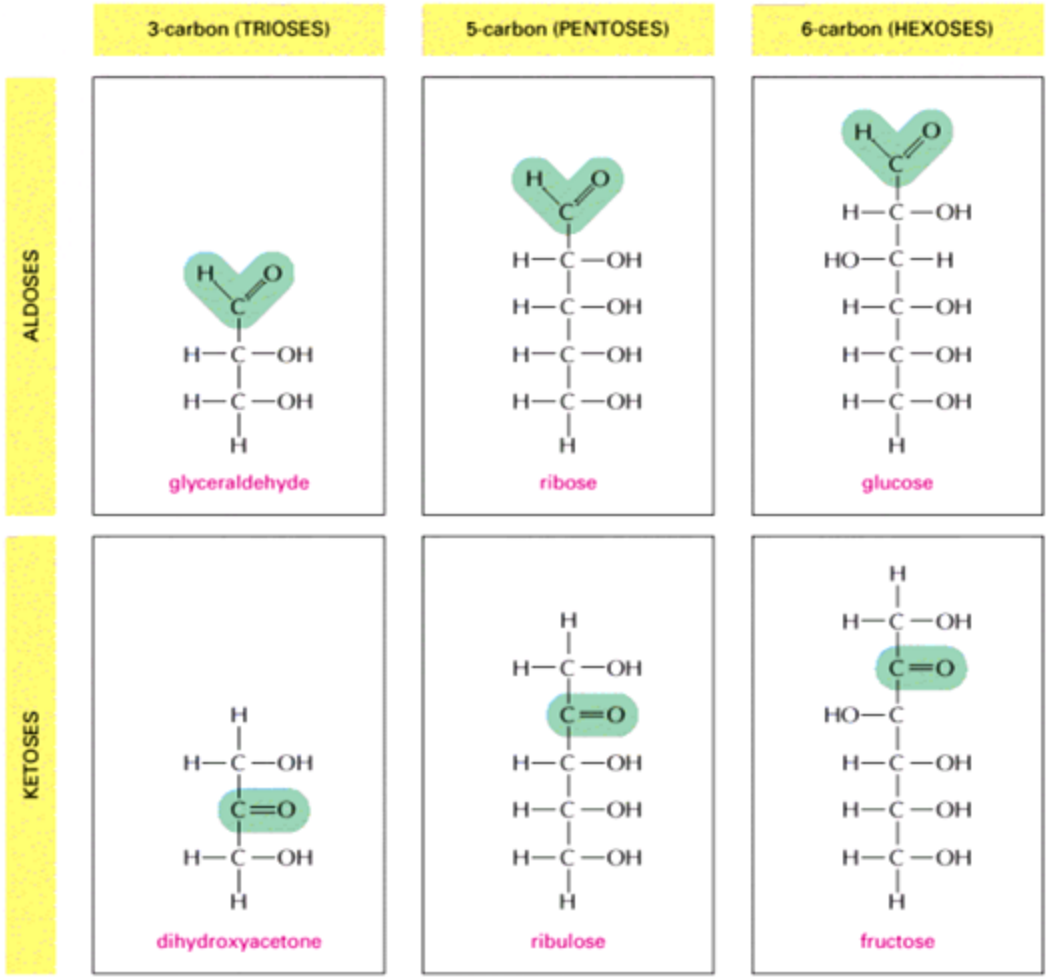
Podenote polisaharidov, nukleinskih kislin in proteinov se združujejo v polimere s kondenzacijo

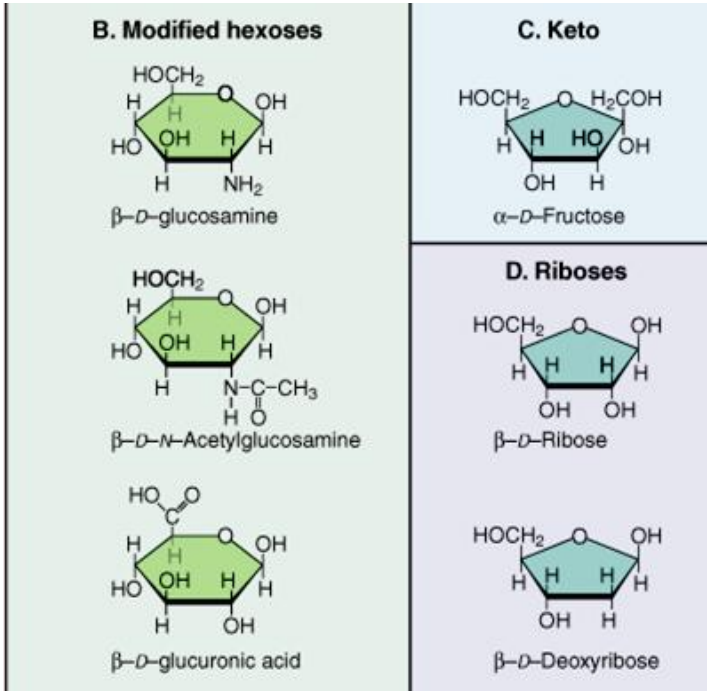
Ogljikovi hidrati

- Sladkorji, makromolekule sestavljene iz sladkorjev (CH_2O; monosaharidi, di, tri, n-saharidi)
- Založni ogljikovi hidrati: škrob, glikogen
- Strukturni ogljikovi hidrati: celuloza, hitin
- Transportni ogljikovi hidrati: saharoza

Ogljikovi hidrati

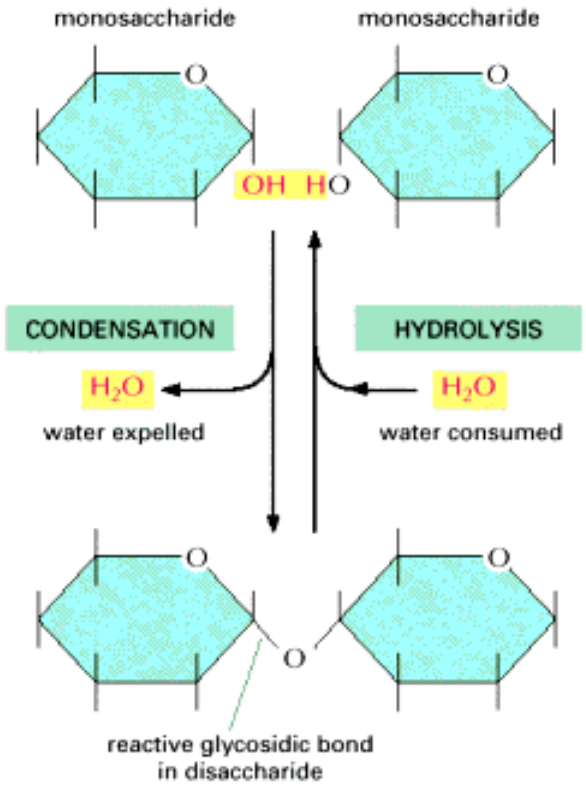
- Osnovne enote – monosaharidi$(CH_2O)_n$

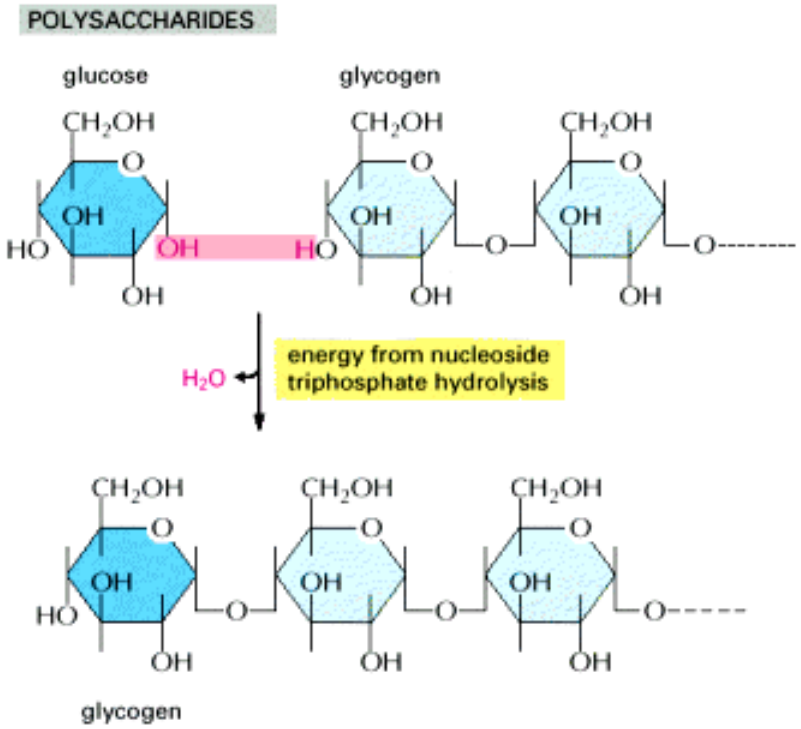




Glikozidna vez

- Disaharidi nastanejo s kondenzacijsko reakcijo med dvema monosaharidoma

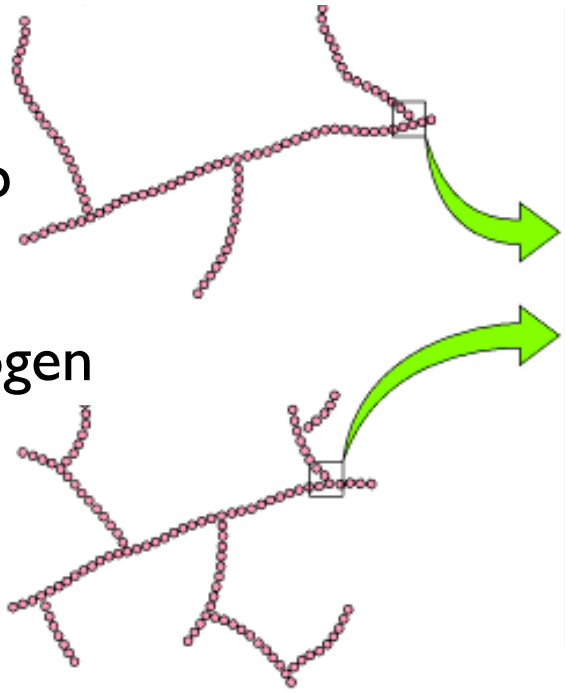


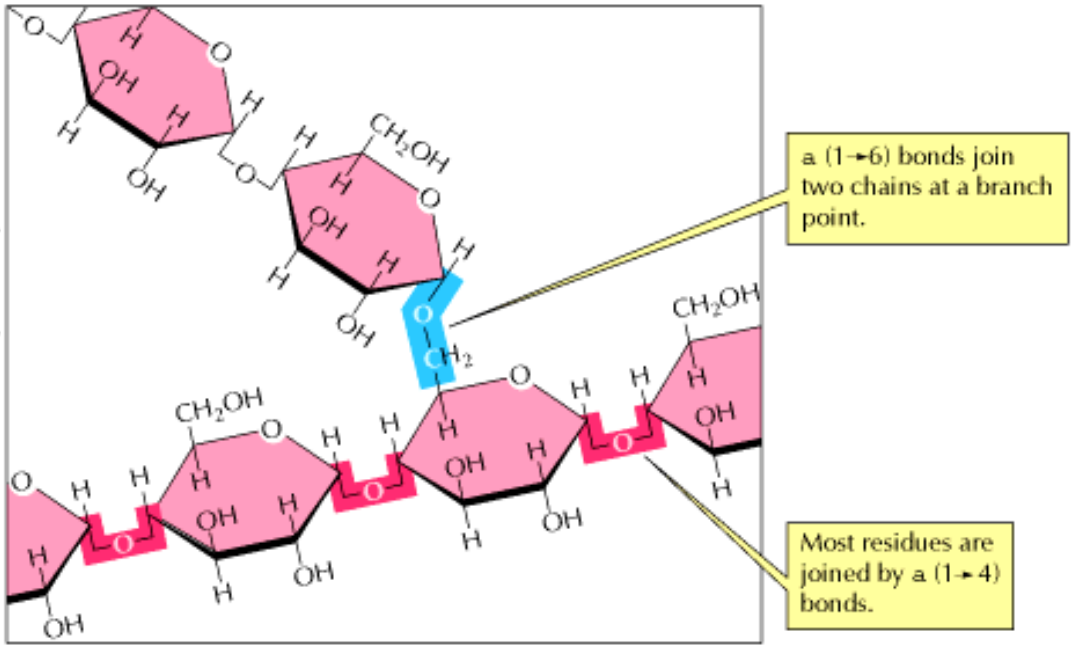


Polisaharidi

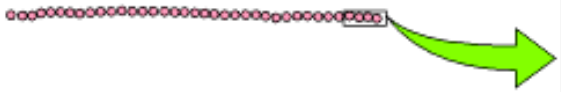
Škrob

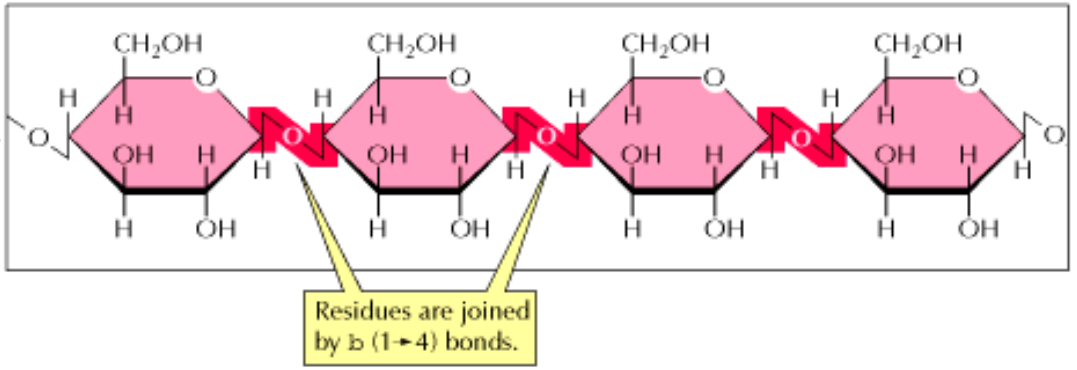
Glikogen





Celuloza



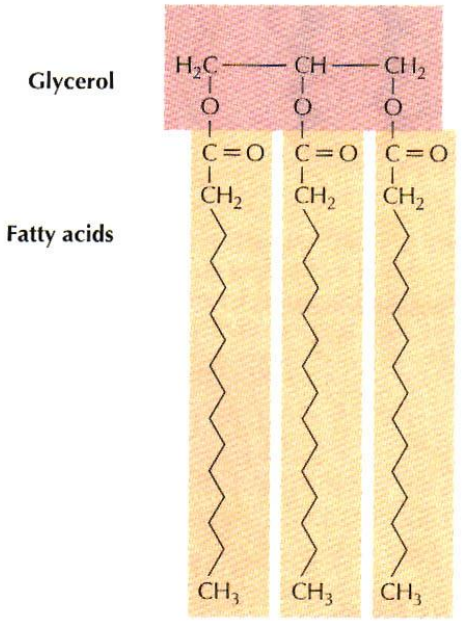


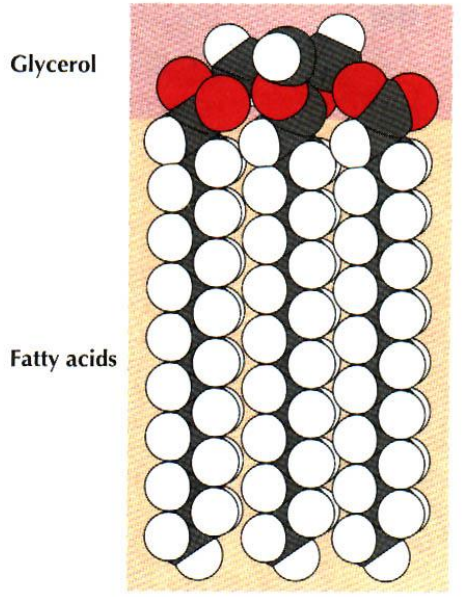
Lipidi

- Funkcije:
  - shramba energije
  - sestavni deli membran
  - medcelična komunikacija (hormoni)

Trigliceridi-maščobe

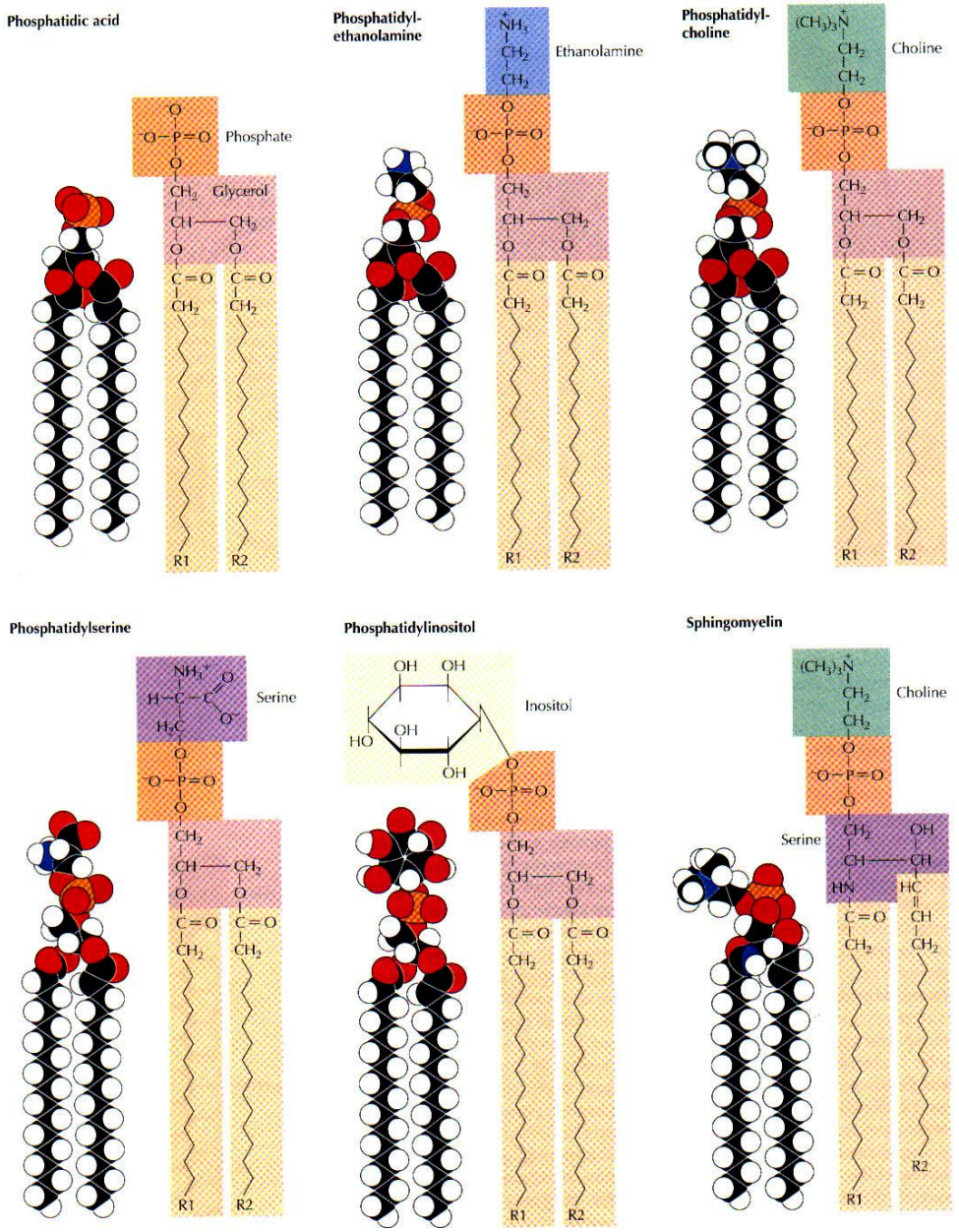
- Molekulo sestavljajo glicerol in tri maščobne kisline
- So netopni v vodi, zato se agregirajo kot kapljice v citoplazmi
- Glavni depo energije





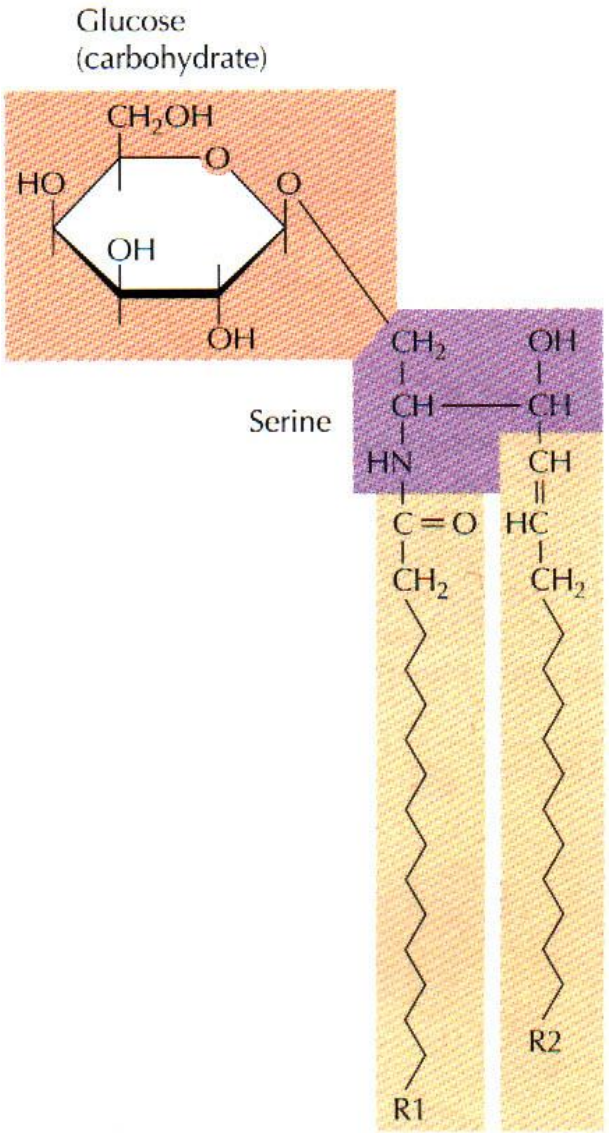
Fosfolipidi

- Molekulo sestavljajo glicerol, dve maščobni kislini in polarna skupina
- Glavna sestavina membran
- So amfipatske molekule - delno topne v vodi delno ne



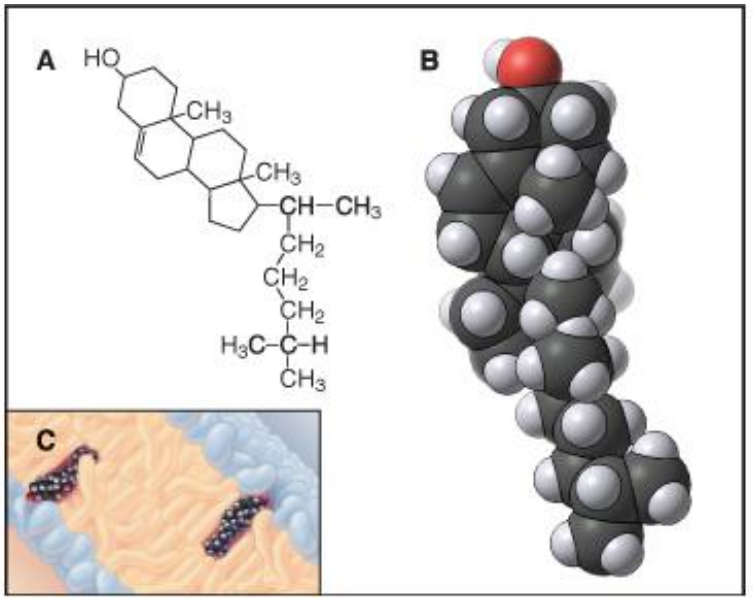
Glikolipidi

- Sestavni del membran
- Na glicerol je vezan sladkor
- Polarna molekula



Holesterol

- Štirje obroči ogljikovodikov (rigidnost) in ravna veriga ogljikovodikov
- Polarna molekula
- Membranam daje trdnost



Steroli – hormoni (testosteron, progesteron)

Beljakovine

- Različne vloge v celici:
  - encimi (DNA polimeraza)
  - hormoni (inzulin)
  - transportni (hemoglobin)
  - založni (jajčni beljak)
  - gibalni (miozin)
  - strukturni (kolagen)
  - obrambni (protitelesa)
  - signalni (G-proteini)
  - proteini s posebnimi nalogami (toksini)

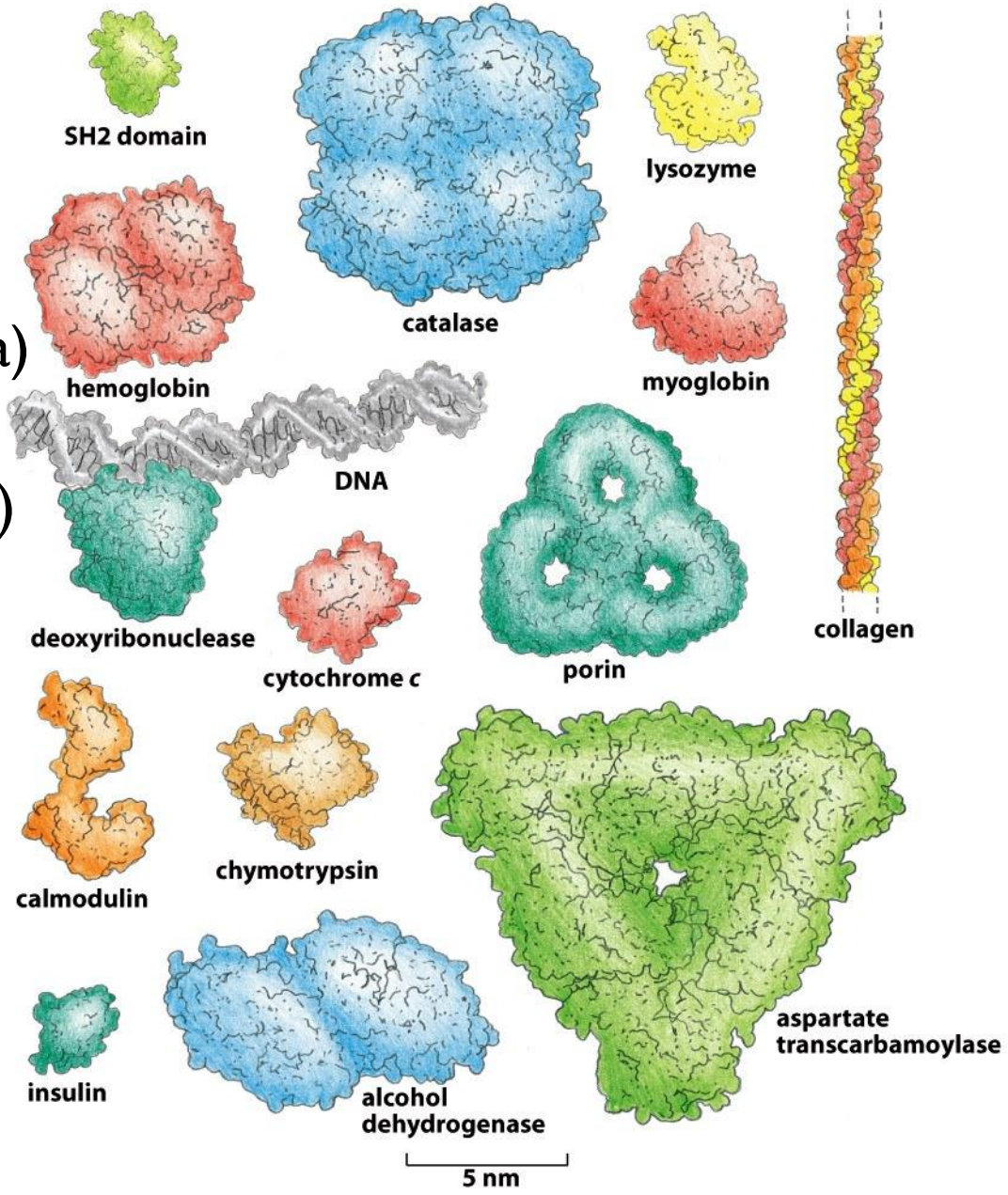


Figure 4-9 Essential Cell Biology 3/e (© Garland Science 2010)

Funkcije proteinov

ENZYME

function: Catalyzes covalent bond breakage or formation.

examples: Living cells contain thousands of different enzymes, each of which catalyzes (speeds up) one particular reaction. Examples include: *tryptophan synthetase*—makes the amino acid tryptophan; *pepsin*—degrades dietary proteins in the stomach; *ribulose bisphosphate carboxylase*—helps convert carbon dioxide into sugars in plants; *DNA polymerase*—copies DNA; *protein kinase*—adds a phosphate group to a protein molecule.

STRUCTURAL PROTEIN

function: Provides mechanical support to cells and tissues.

examples: Outside cells, *collagen* and *elastin* are common constituents of extracellular matrix and form fibers in tendons and ligaments. Inside cells, *tubulin* forms long, stiff microtubules and *actin* forms filaments that underlie and support the plasma membrane; *α-keratin* forms fibers that reinforce epithelial cells and is the major protein in hair and horn.

TRANSPORT PROTEIN

function: Carries small molecules or ions.

examples: In the bloodstream, serum albumin carries lipids, hemoglobin carries oxygen, and transferrin carries iron. Many proteins embedded in cell membranes transport ions or small molecules across the membrane. For example, the bacterial protein *bacteriorhodopsin* is a light-activated proton pump that transports H^+ ions out of the cell; the glucose carrier shuttles glucose into and out of liver cells; and a Ca^{2+} pump in muscle cells pumps the calcium ions needed to trigger muscle contraction into the endoplasmic reticulum, where they are stored.

MOTOR PROTEIN

function: Generates movement in cells and tissues.

examples: *Myosin* in skeletal muscle cells provides the motive force for humans to move; *kinesin* interacts with microtubules to move organelles around the cell; *dynein* enables eucaryotic cilia and flagella to beat.

STORAGE PROTEIN

function: Stores small molecules or ions.

examples: Iron is stored in the liver by binding to the small protein *ferritin*; ovalbumin in egg white is used as a source of amino acids for the developing bird embryo; *casein* in milk is a source of amino acids for baby mammals.

SIGNAL PROTEIN

function: Carries signals from cell to cell.

examples: Many of the hormones and growth factors that coordinate physiological function in animals are proteins: *insulin*, for example, is a small protein that controls glucose levels in the blood; *netrin* attracts growing nerve cells in a specific direction in a developing embryo; *nerve growth factor (NGF)* stimulates some types of nerve cells to grow axons; *epidermal growth factor (EGF)* stimulates the growth and division of epithelial cells.

RECEPTOR PROTEIN

function: Detects signals and transmits them to the cell's response machinery.

examples: *Rhodopsin* in the retina detects light; the *acetylcholine receptor* in the membrane of a muscle cell receives chemical signals released from a nerve ending; the *insulin receptor* allows a liver cell to respond to the hormone insulin by taking up glucose; the *adrenergic receptor* on heart muscle increases the rate of heartbeat when it binds to adrenaline.

GENE REGULATORY PROTEIN

function: Binds to DNA to switch genes on or off.

examples: The *lactose repressor* in bacteria silences the genes for the enzymes that degrade the sugar lactose; many different *homeodomain proteins* act as genetic switches to control development in multicellular organisms, including humans.

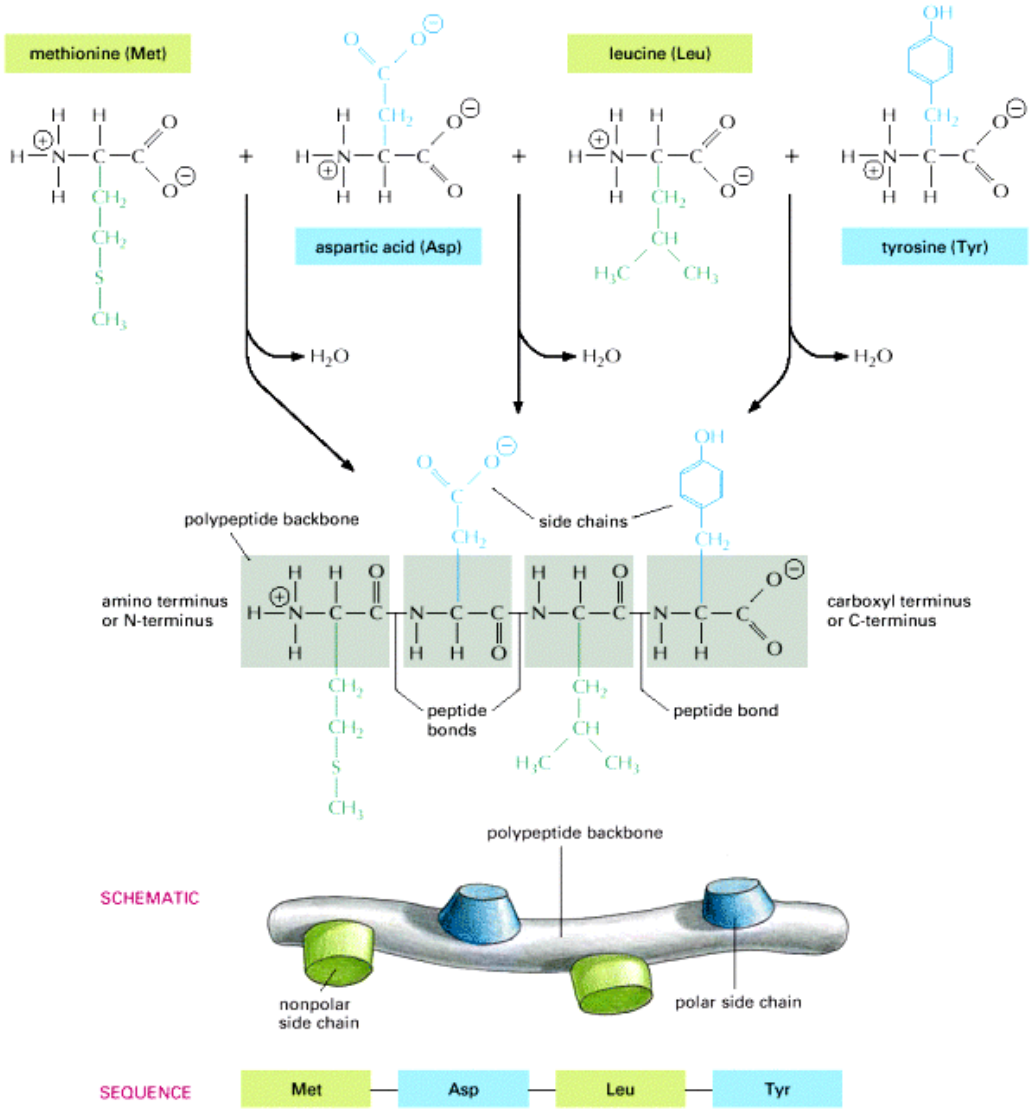
SPECIAL-PURPOSE PROTEIN

function: Highly variable.

examples: Organisms make many proteins with highly specialized properties. These molecules illustrate the amazing range of functions that proteins can perform. The *antifreeze proteins* of Arctic and Antarctic fishes protect their blood against freezing; *green fluorescent protein* from jellyfish emits a green light; *monellin*, a protein found in an African plant, has an intensely sweet taste; mussels and other marine organisms secrete glue proteins that attach them firmly to rocks, even when immersed in seawater.

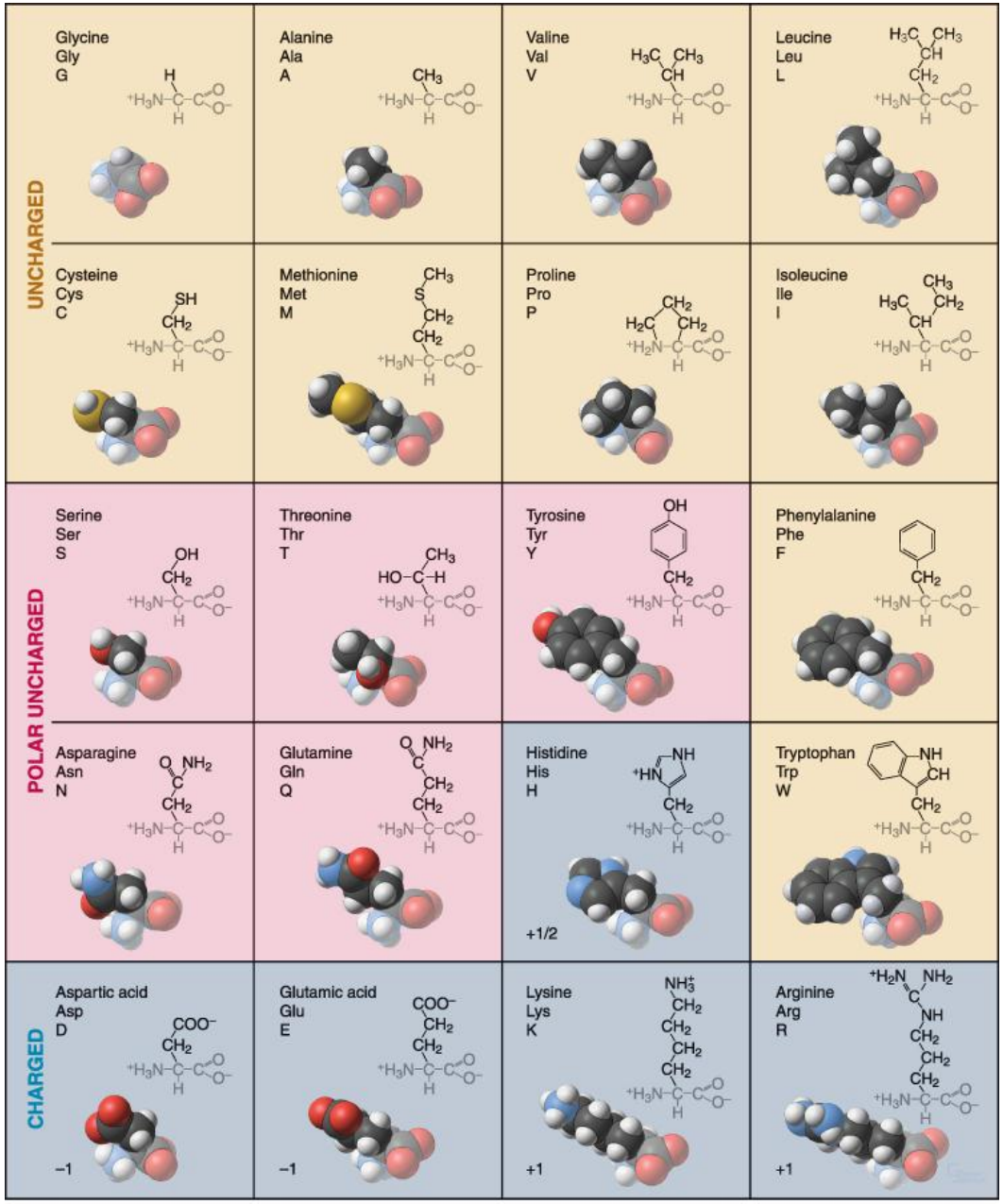
Proteini - beljakovine

- Sestavljeni iz enega ali več polimerov – polipeptidov
- Polipeptidi sestavljeni iz aminokislin



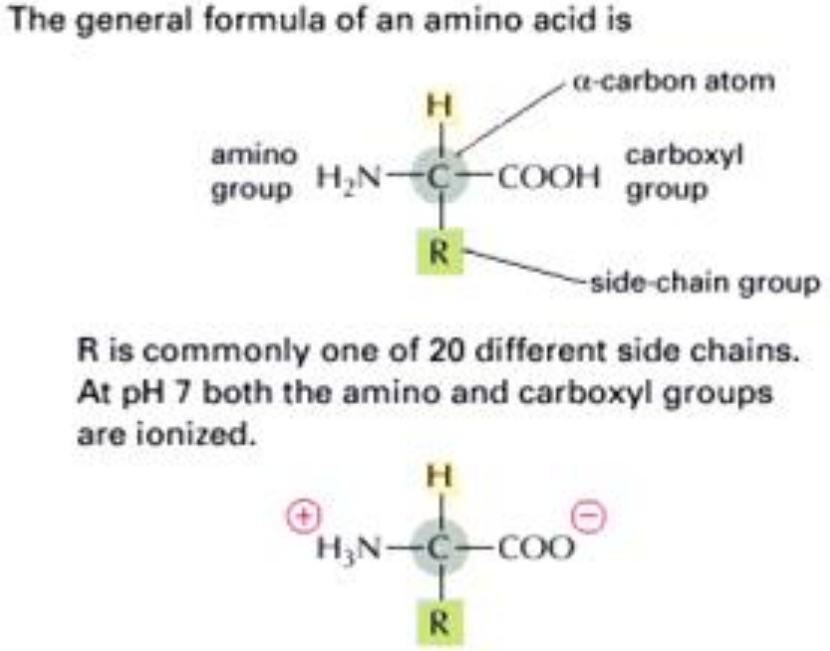
Beljakovine

- Aminokisline povezane s peptidno vezjo
- 20 aminokislin



Aminokisline

- 20 znanih
- Glede na stransko verigo jih razdelimo na:
  - kisle
  - bazične
  - nenabite polarne
  - nepolarne



Lastnosti aminokislin

AMINO ACID			SIDE CHAIN	
Aspartic acid	Asp	D	negative	Kisle
Glutamic acid	Glu	E	negative	
Arginine	Arg	R	positive	Bazične
Lysine	Lys	K	positive	
Histidine	His	H	positive	
Asparagine	Asn	N	uncharged polar	
Glutamine	Gln	Q	uncharged polar	
Serine	Ser	S	uncharged polar	
Threonine	Thr	T	uncharged polar	
Tyrosine	Tyr	Y	uncharged polar	

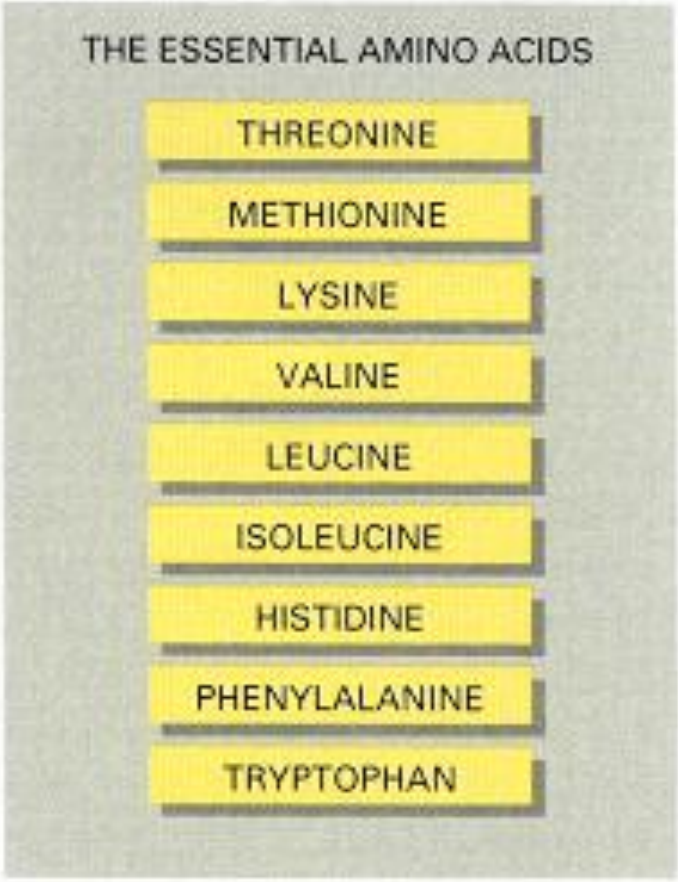
POLAR AMINO ACIDS

AMINO ACID			SIDE CHAIN
Alanine	Ala	A	nonpolar
Glycine	Gly	G	nonpolar
Valine	Val	V	nonpolar
Leucine	Leu	L	nonpolar
Isoleucine	Ile	I	nonpolar
Proline	Pro	P	nonpolar
Phenylalanine	Phe	F	nonpolar
Methionine	Met	M	nonpolar
Tryptophan	Trp	W	nonpolar
Cysteine	Cys	C	nonpolar

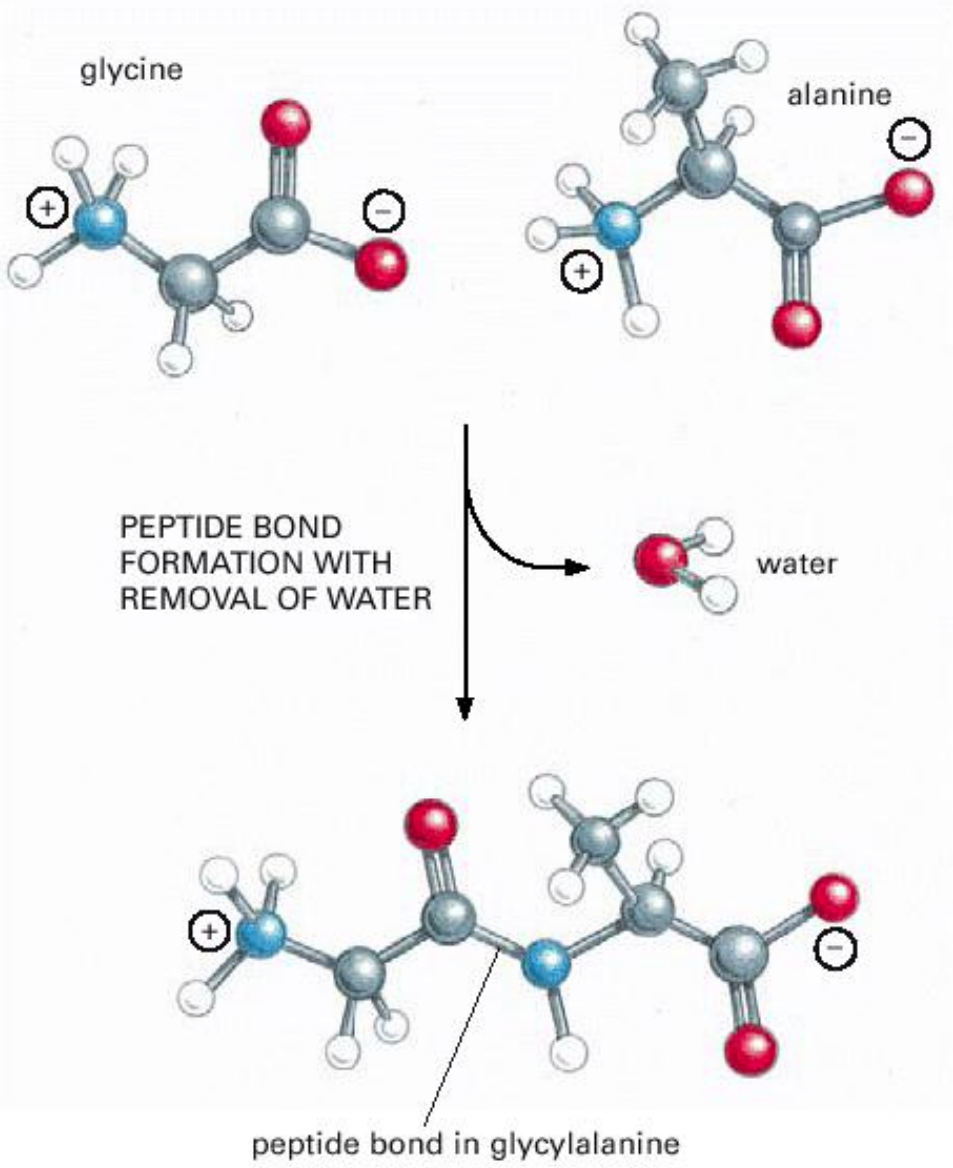
NONPOLAR AMINO ACIDS

Esencialne aminokisline

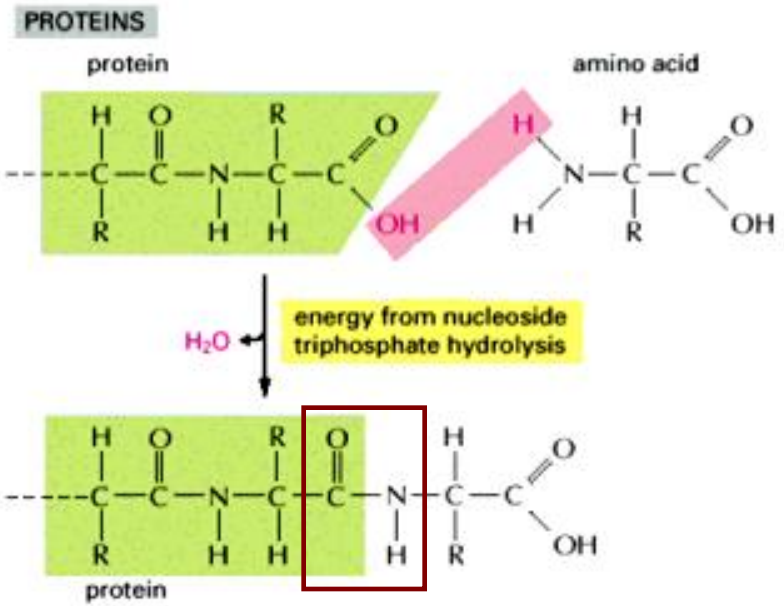
- 9 esencialnih – organizem jih ne more sintetizirati sam in jih torej mora dobiti s hrano



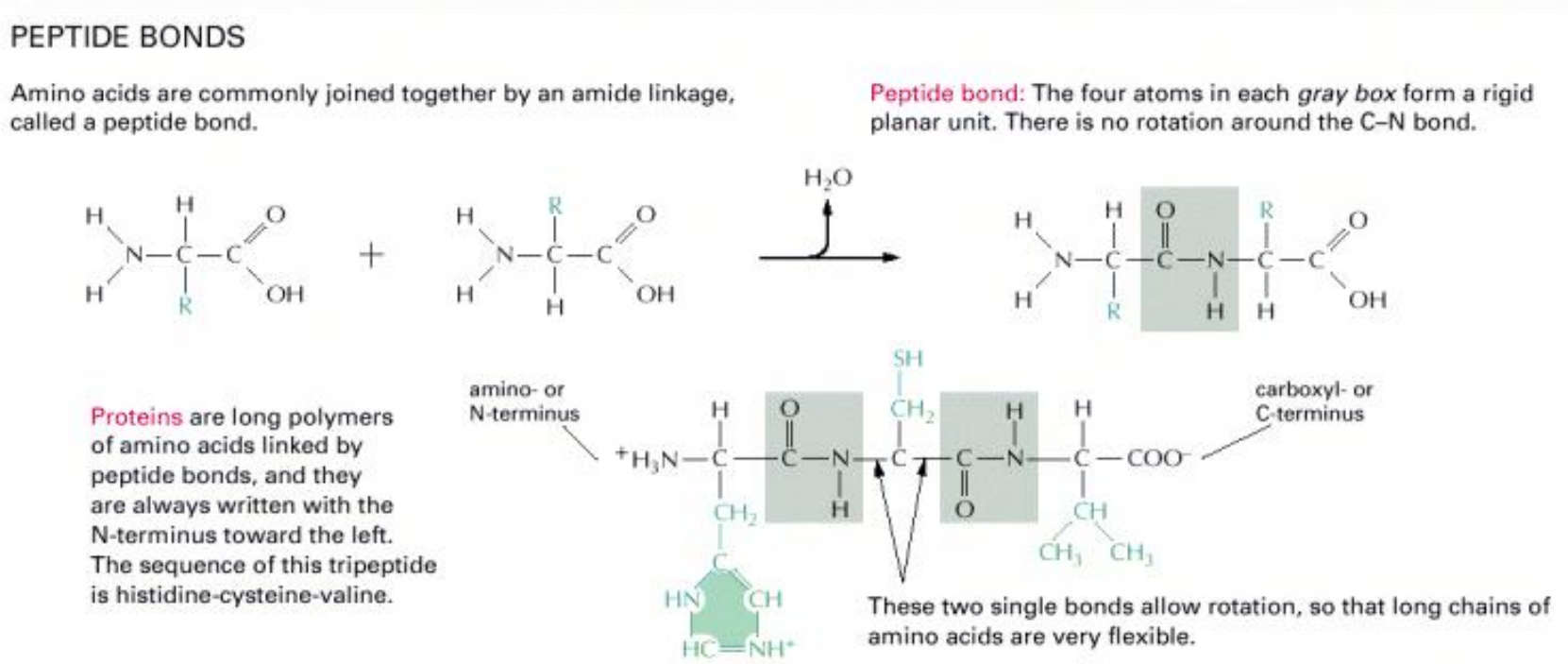
Peptidna vez



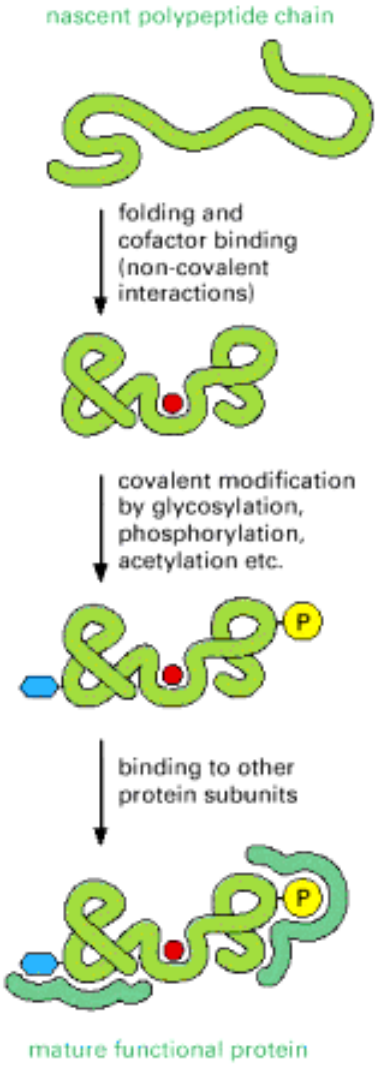
- Peptidna vez se tvori med amino in karboksilno skupino dveh aminokislin



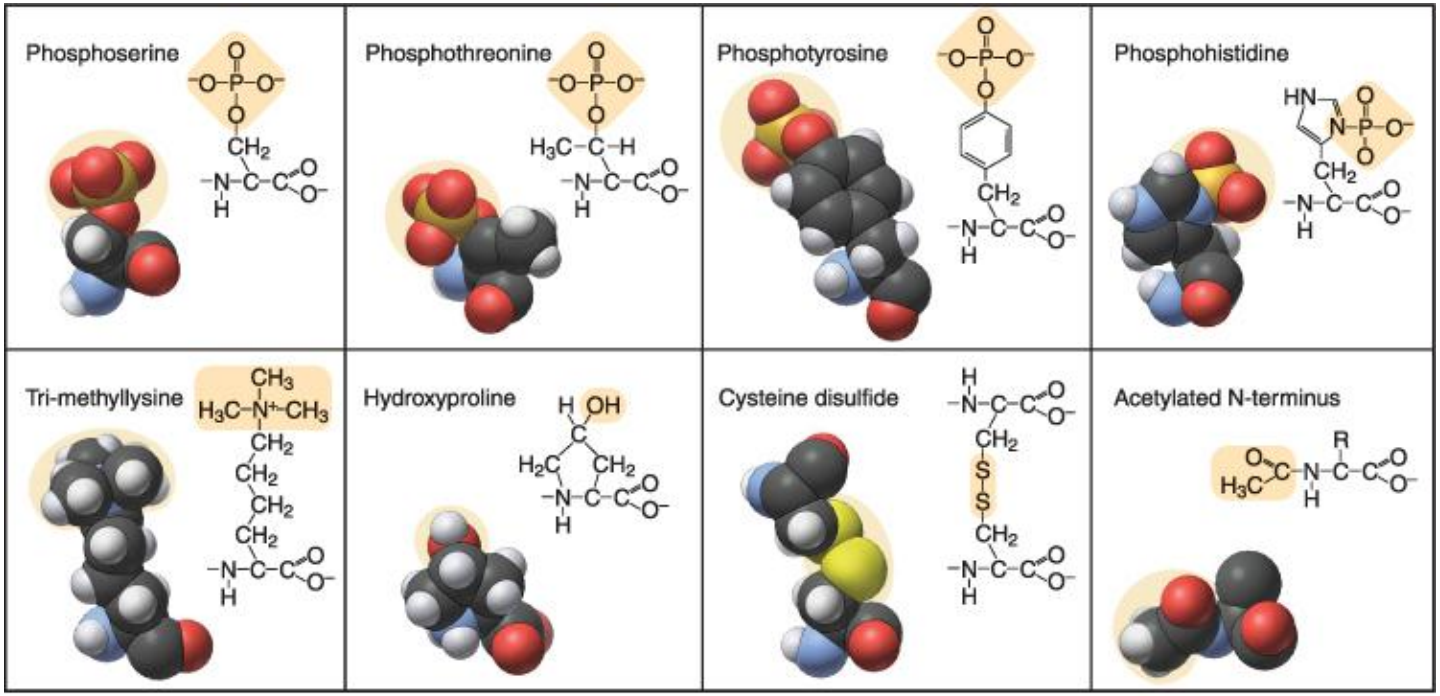
Peptidna vez



Post-translacijske modifikacije



Fosforilacija, Acetilacija, Metilacija
Hidroksilacija, Tvorba disulfidnih mostičkov

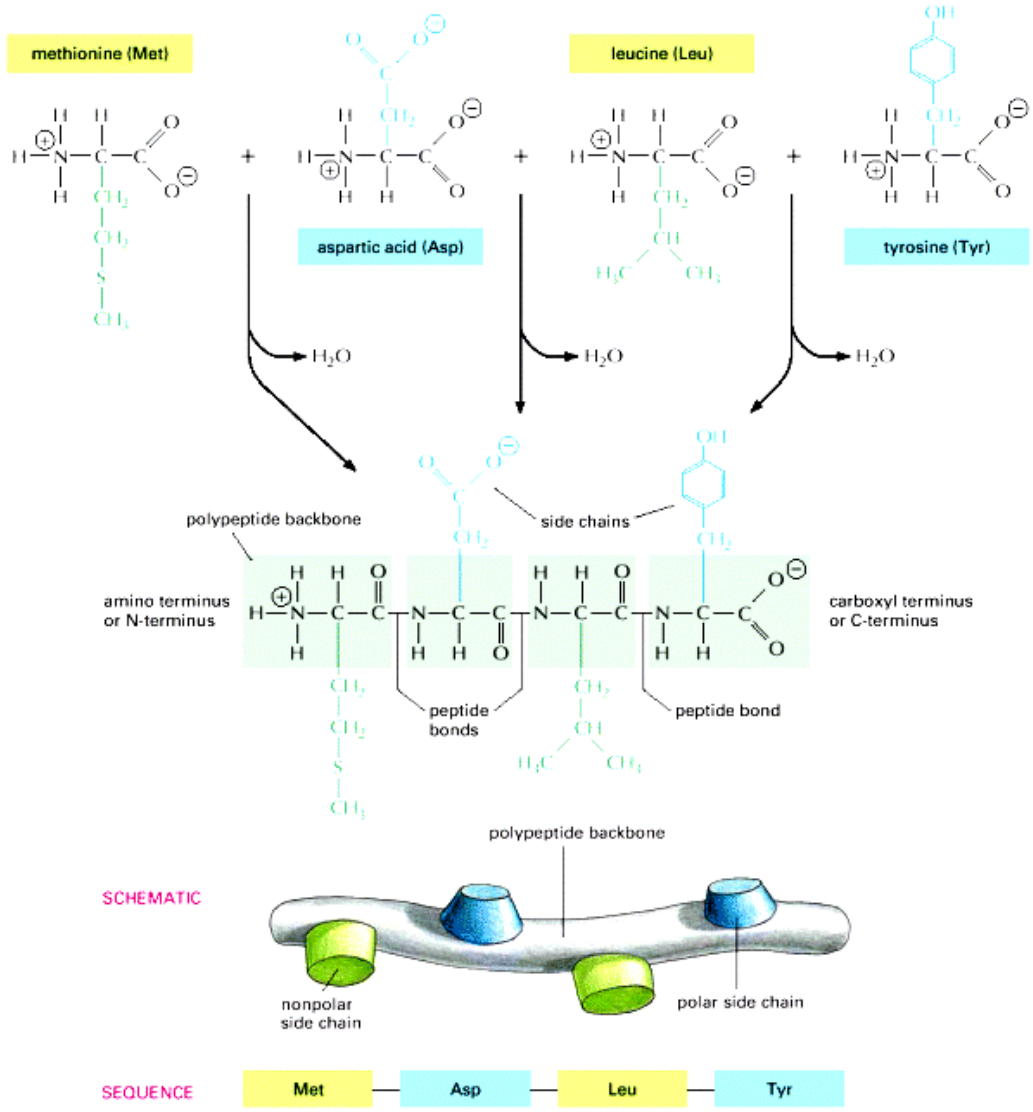


Struktura polipetidov

- Vsak protein ima tridimenzionalno konformacijsko strukturo, ki je oblika z najmanjšo energijo
- Denaturacija – če protein obdelamo s topili, ki raztrgajo nekovalentne vezi , se protein razvije (razpre - denaturira).
- Renaturacija – ko odstranimo topilo se protein povrne v svojo prvotno konformacijo

Primarna struktura proteinov

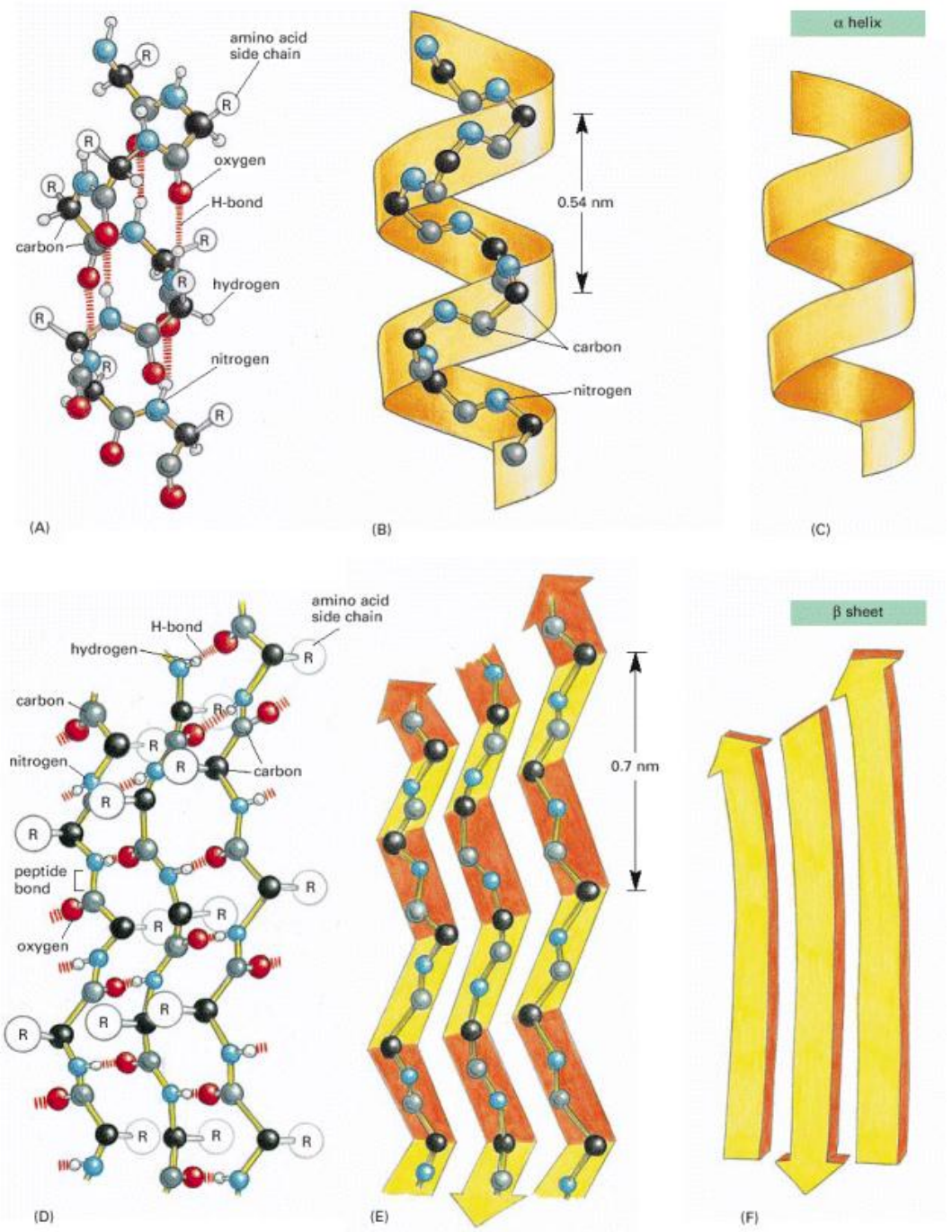
- Določa jo zaporedje aminokislin
- Od primarnega zaporedja AK v polipeptidni verigi je odvisno kako se bo veriga zvijala ali zlagala v prostoru



Sekundarna struktura proteinov

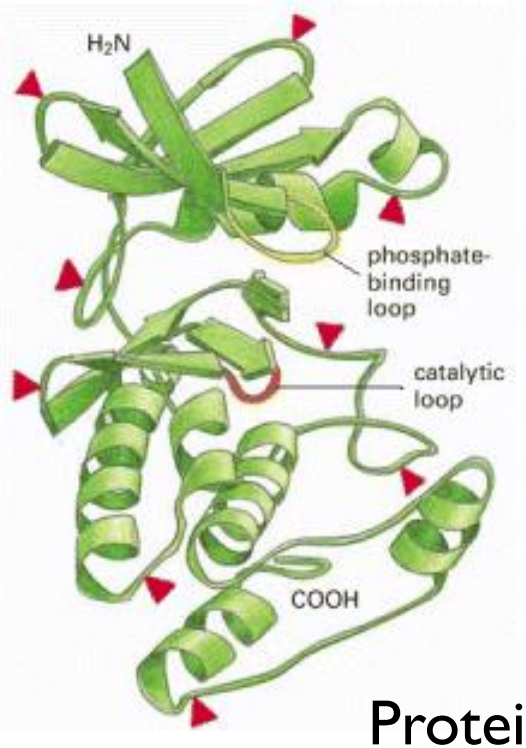
- α-heliks – zavijanje polipeptidne verige okoli svoje osi
- β-trak – cikcakasto gubanje v obliki vzporednih ali nasprotno potekajočih trakov

  Za sekundarno strukturo so pomembne vodikove in ionske vezi

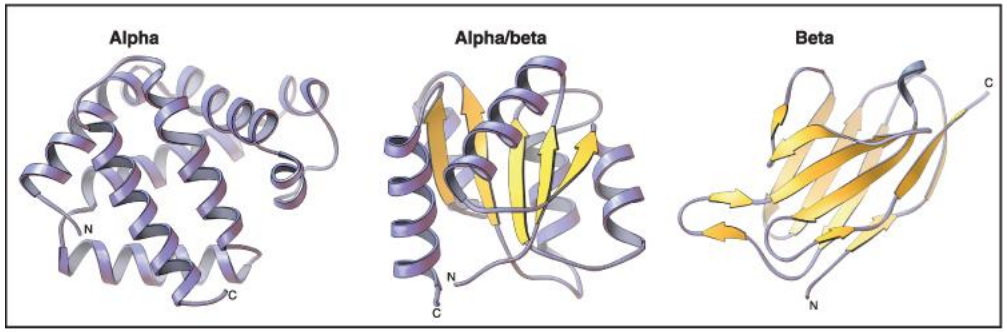


Tercirana struktura proteinov

Kovalentne vezi dodatno zvijejo polipeptidno verigo v tridimenzijsko prostorsko zgradbo beljakovine – klobčiči, kroglice, snopi, nitke

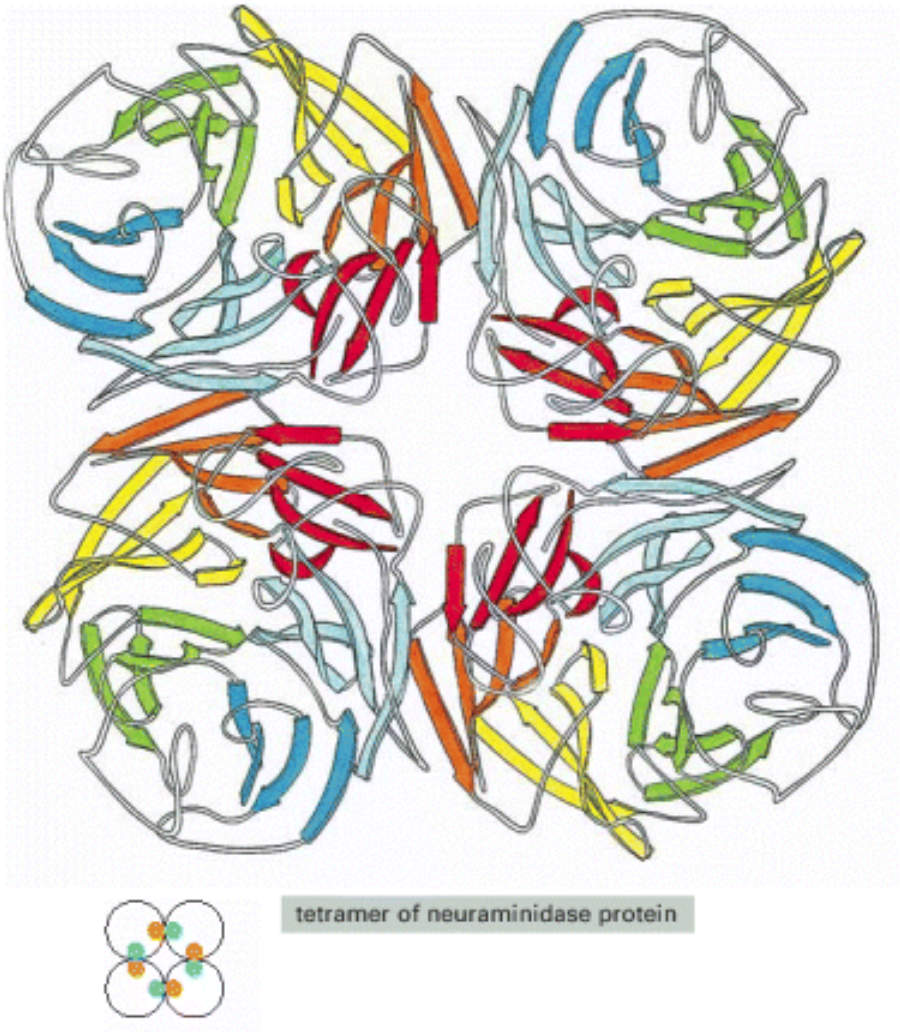


Proteinska kinaza



Kvartarna struktura proteinov

- Kadar se podenote proteinov povezujejo med seboj



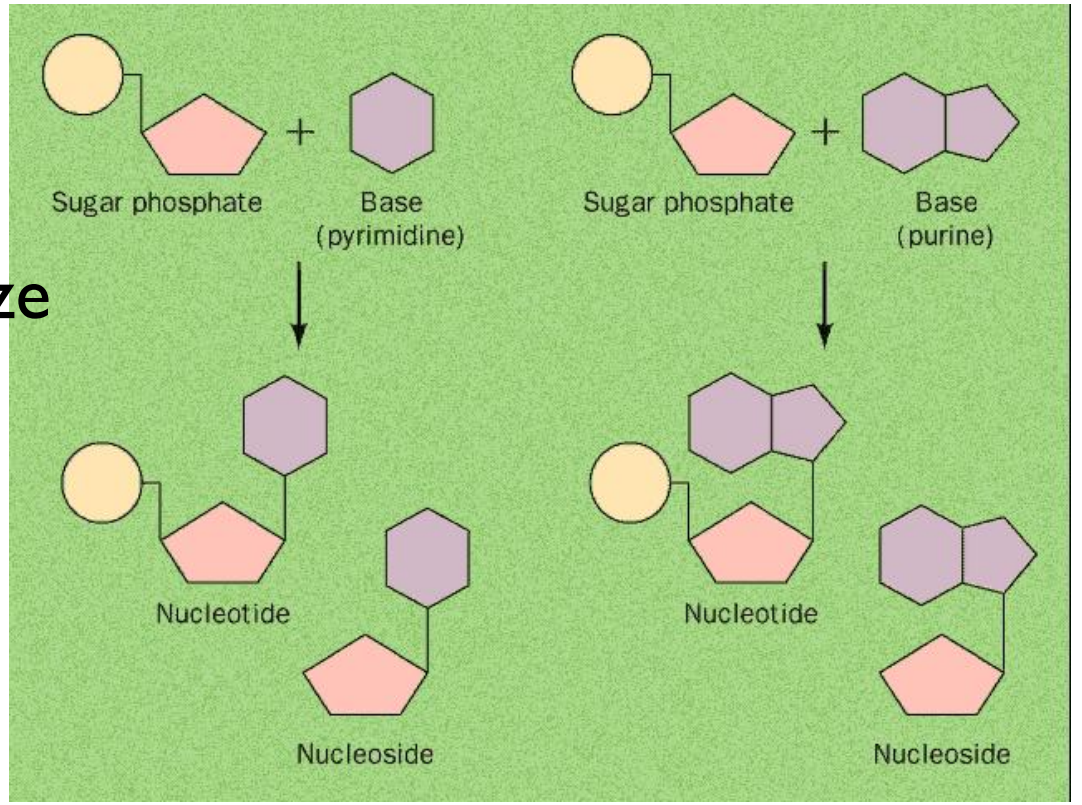
Nukleinske kisline

- Nukleotidi:
- gradniki nukleinskih kislin
  - Fosfatna skupina
  - Enostavni sladkor: pentozi: riboza, deoksiriboza
  - Dušikova baza: **pirimidinski bazi**: citozin, timin (v DNA), uracil (v RNA)

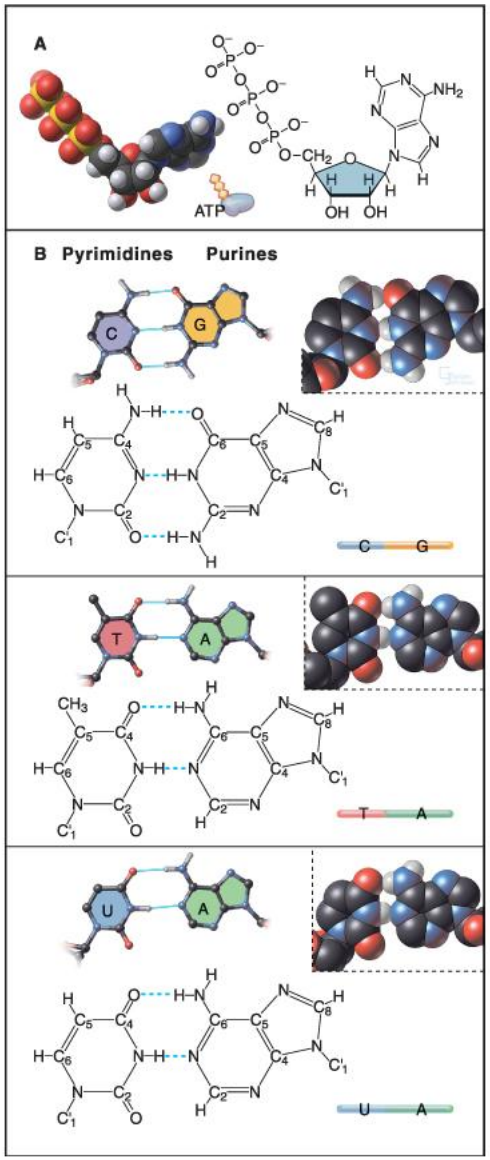
    purinski bazi: adenin, gvanin
- energijsko bogate snovi (ATP), koencimi

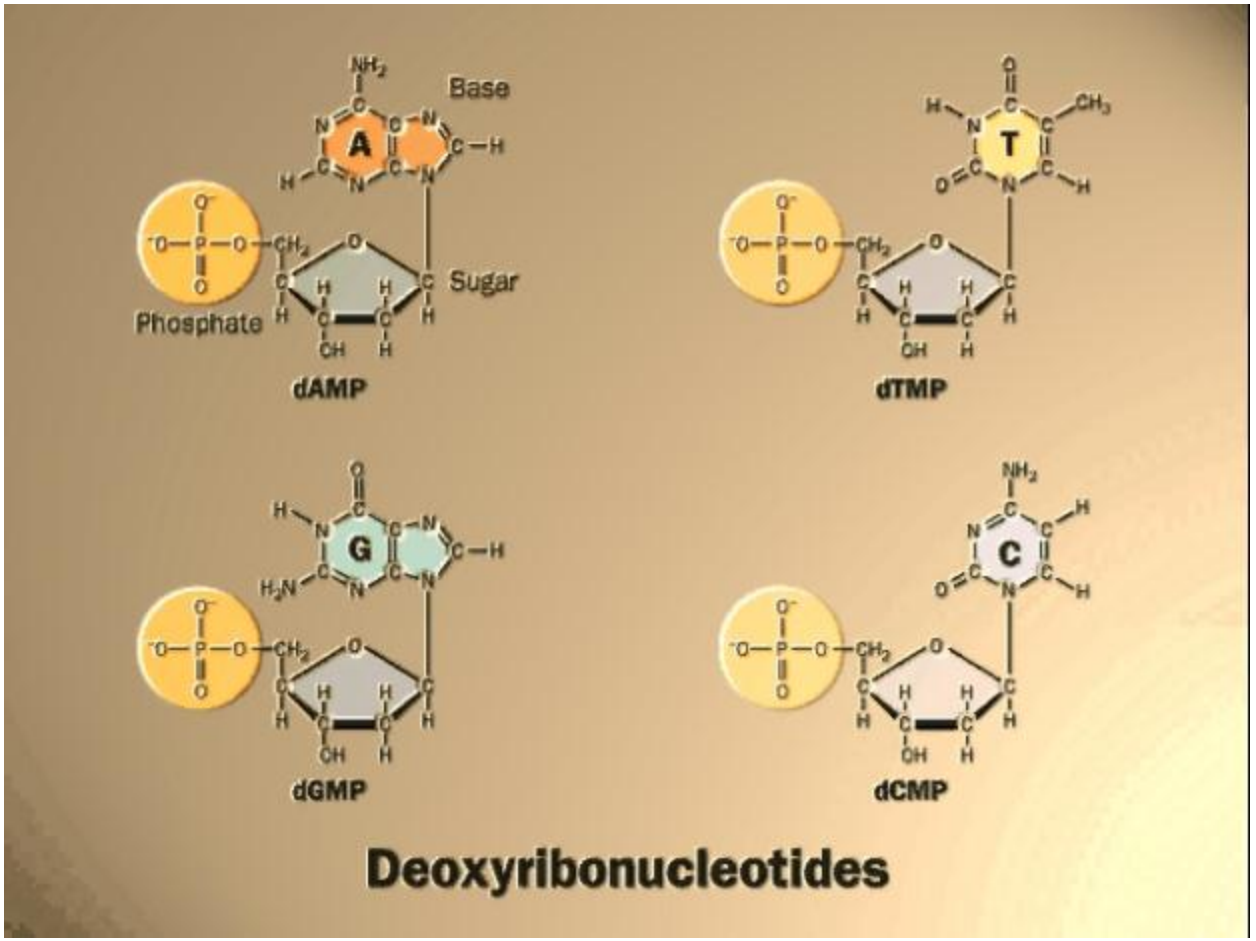
Nukleotidi

- Nukleotid je sestavljen iz treh delov:
  - Ostanka fosforne kisline
  - sladkorja pentoze
    - riboza
    - deoksiriboza
  - organske dušikove baze
    - Purin gvanin, adenin
    - Pirimidin citozin, timin



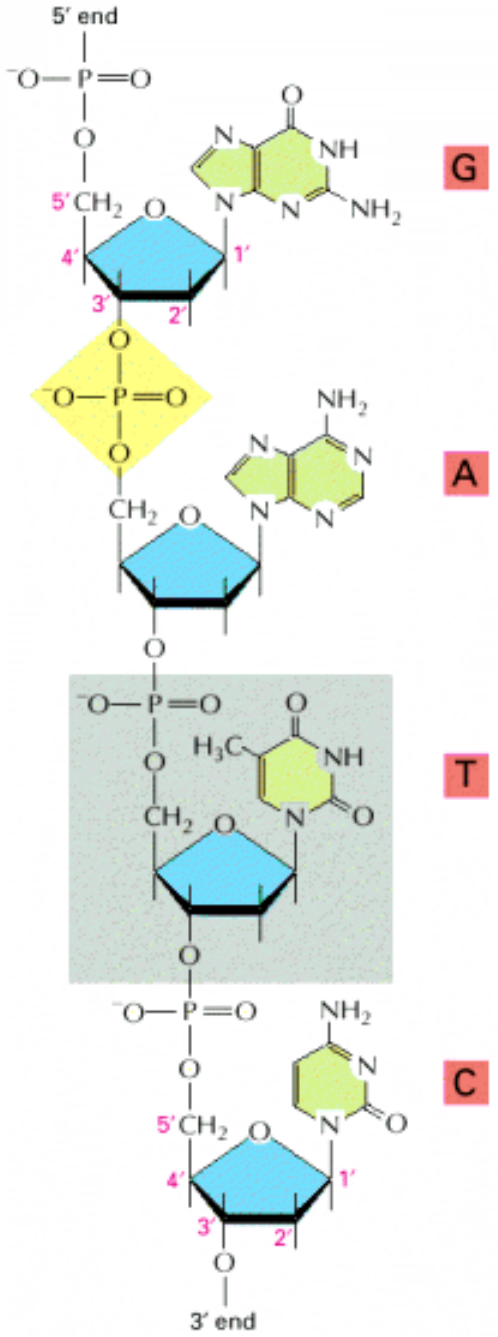
DNA -deoksiribonukleotidi





Nukleinske kisline

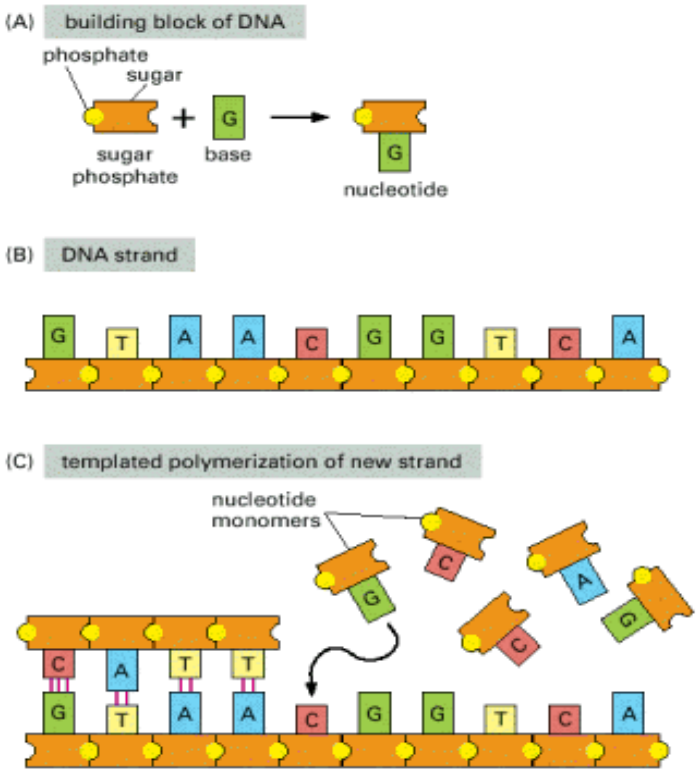
- Polimeri nukleotidov
- Nastanejo s kondenzacijsko reakcijo med sladkorjem enega nukleotida in fosfatno skupino drugega nukleotida- fosfodiesterska vez

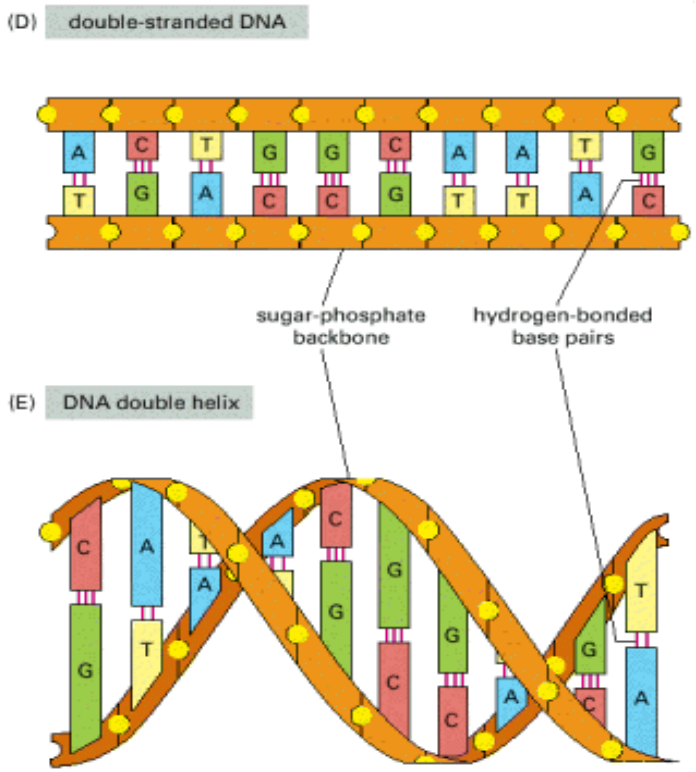


DNA

- Vodikove vezi povezujejo baze nukleotidov: A - T ; C - G

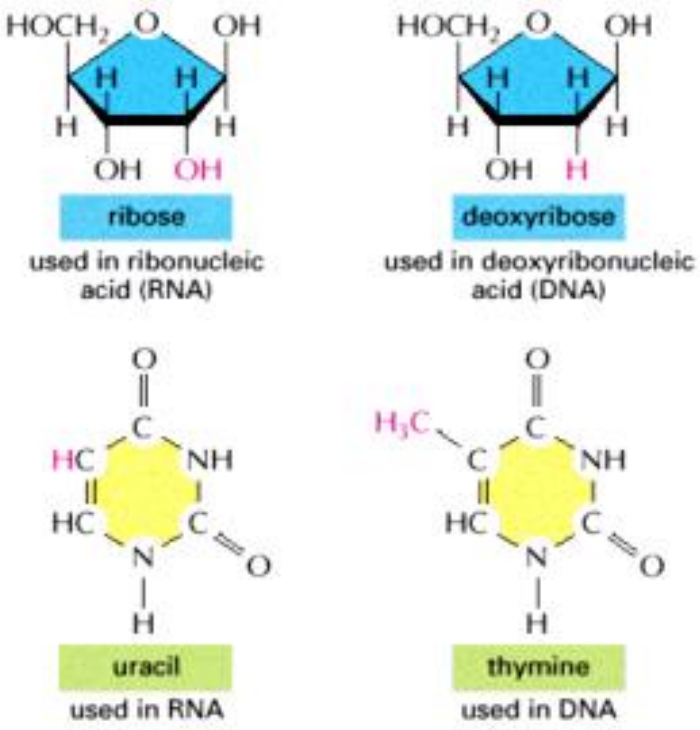
- Dvojna vijačnica
- Verigi DNA sta usmerjeni v nasprotni smeri- antiparalelni verigi
- Sinteza DNA je semikonzervativna

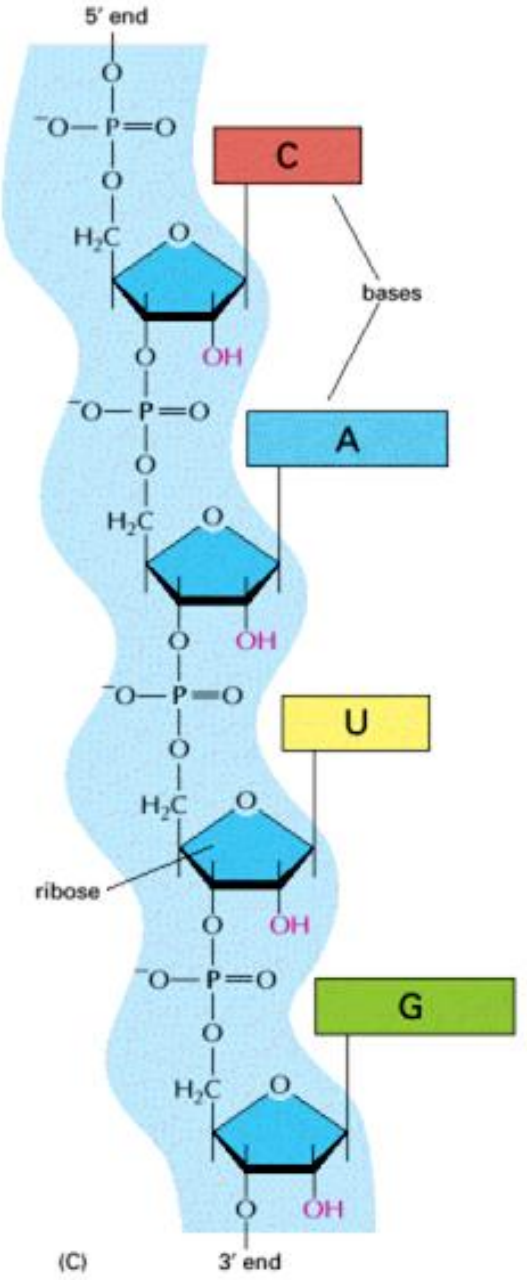




RNA

- Enojne verige





Osnovni pojmi

- Žive celice sledijo enakim kemijskim in fizikalnim zakonom kot neživa narava.
- Žive celice so sestavljene iz določenega stevila elementov, 4 – C, H, N, O sestavljajo 96,5% teže celice.
- Celice vsebujejo 4 tipe glavnih organskih molekul: sladkorji, maščobne kisline, amino kisline in nukleotidi

Osnovni pojmi

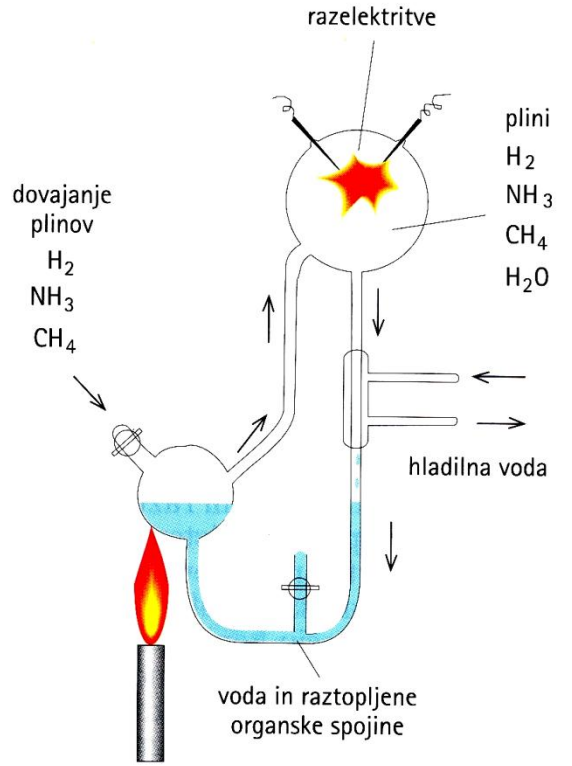
- Sladkorji so primarni vir energije za celice in se lahko združujejo v polisaharide, ki so skladišče energije.
- Maščobne kisline so tudi vir energije, najihova glavna funkcija pa je sestavljanje celičnih membran.
- Makromolekule so polimeri sladkorjev, aminokislin in nukleotidov

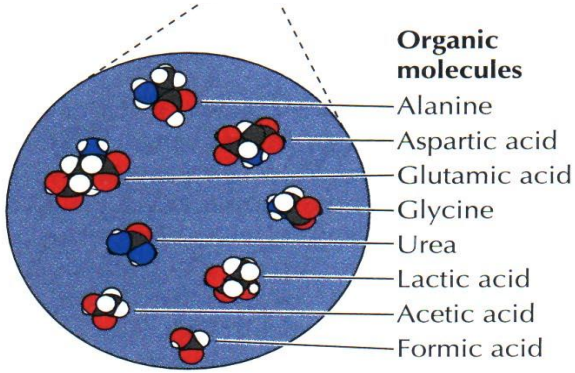
Osnovni pojmi

- Proteini-beljakovine so polimeri aminokislin
- Nukleotidi igrajo pomembno vlogo pri prenosu energije in sestavljajo informacijske markomolekule – DNA in RNA
- Šibke nekovalentne vezi se tvorijo med različnimi deli makromolekul, kar omogoča makromolekula, da se zvijajo v različne tridimenzionalne strukture.

Nastanek življenja

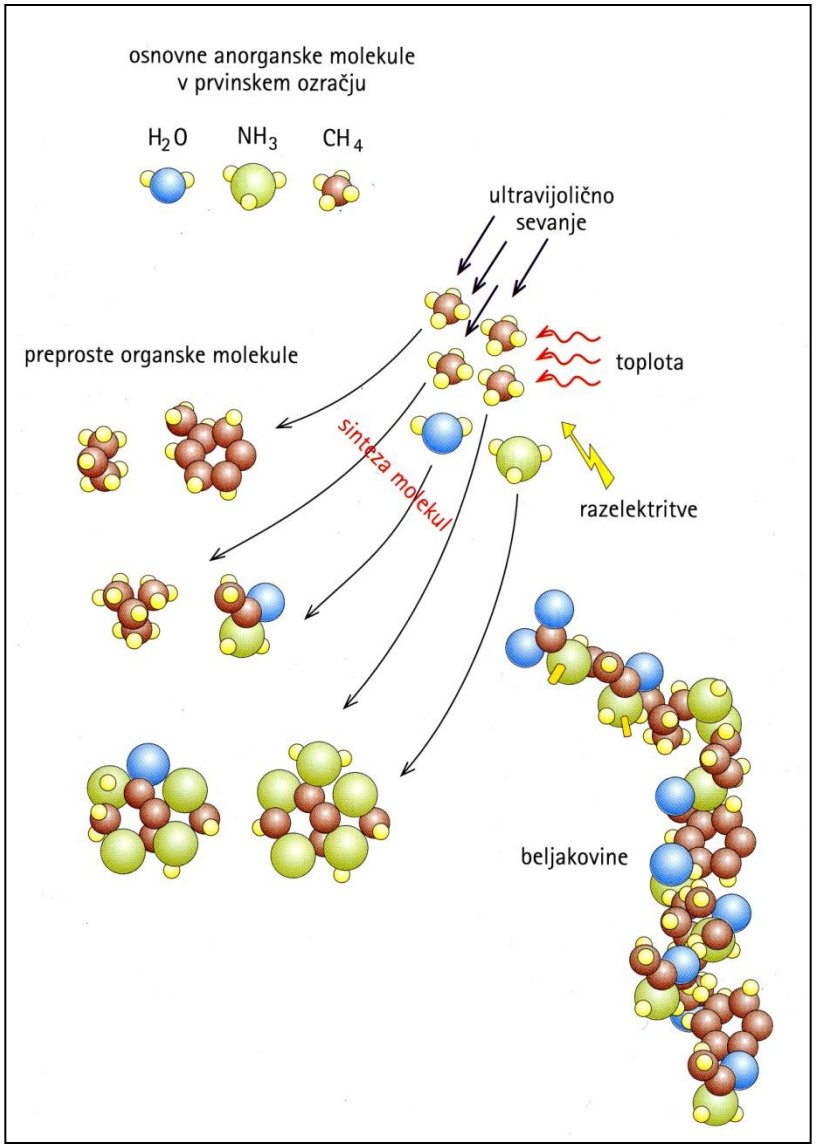
- Nastanek organskih molekul
  - Stanley Miller - 1950
  - Prvi dokaz o nastanku organskih molekul





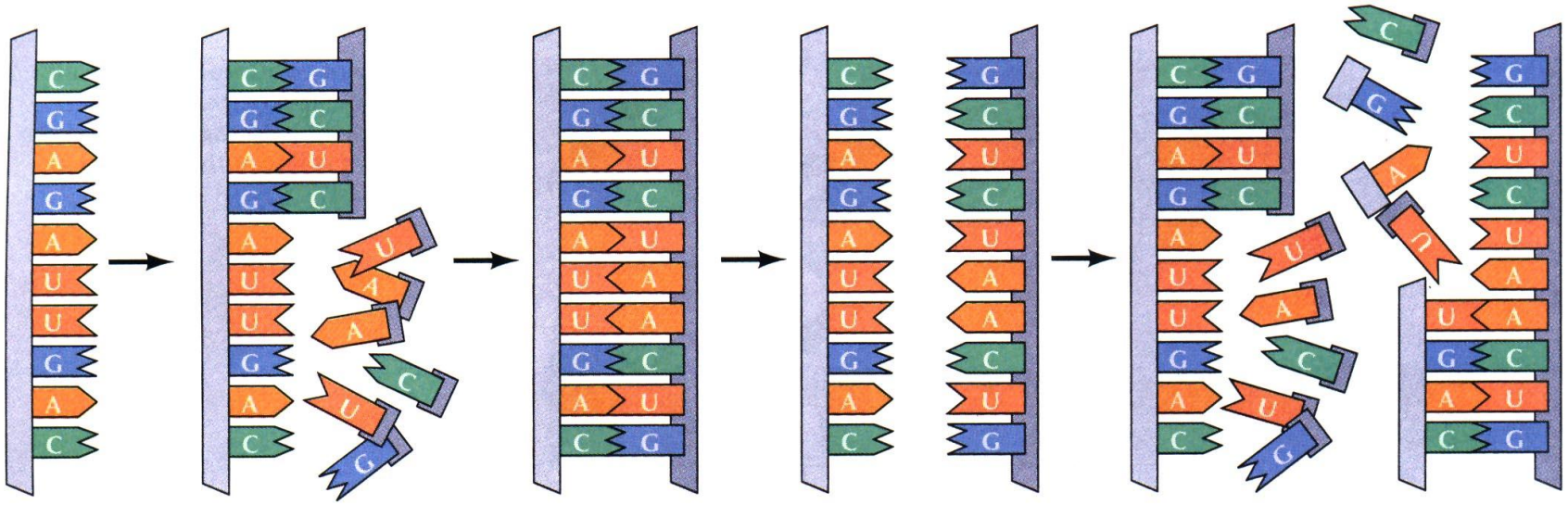
Nastanek življenja

- Nastanek makromolekul
  - Makromolekule lahko polimerizirajo spontano v primernih okoliščinah
  - Kritično za nastanek življenja pa je samoreplikacija (samopodvajanje) makromolekul



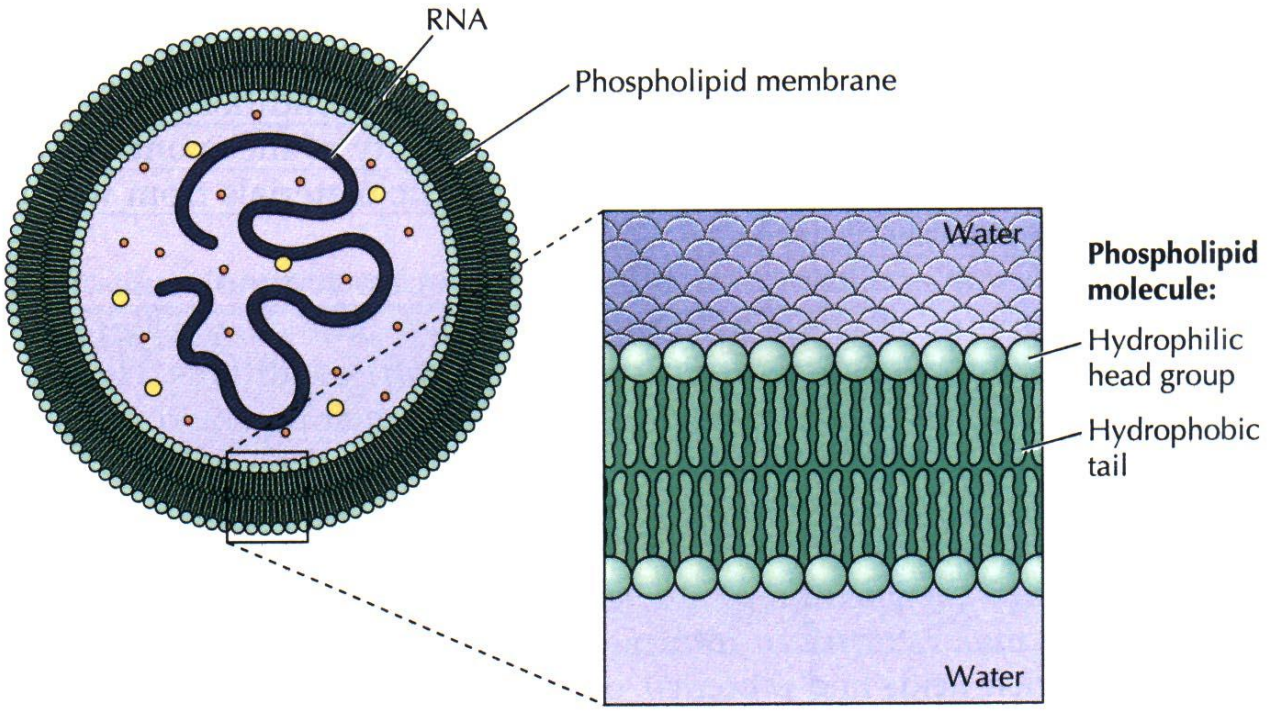
Nastanek življenja

- Samoreplikacija – samopodvajanje
- RNA molekula (1980) – makromolekula, ki je sposobna samopodvajanja in daje zapis za nastanek proteinov



Nastanek življenja

- Nastanek prve celice
- RNA molekula obdana z lipidnim ovojem



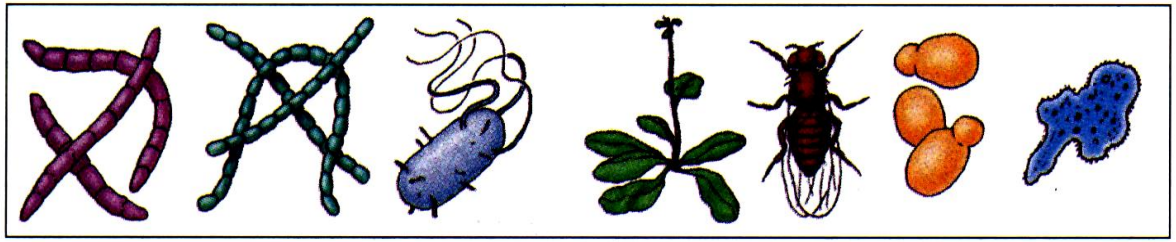
Evolucija metabolizma celic

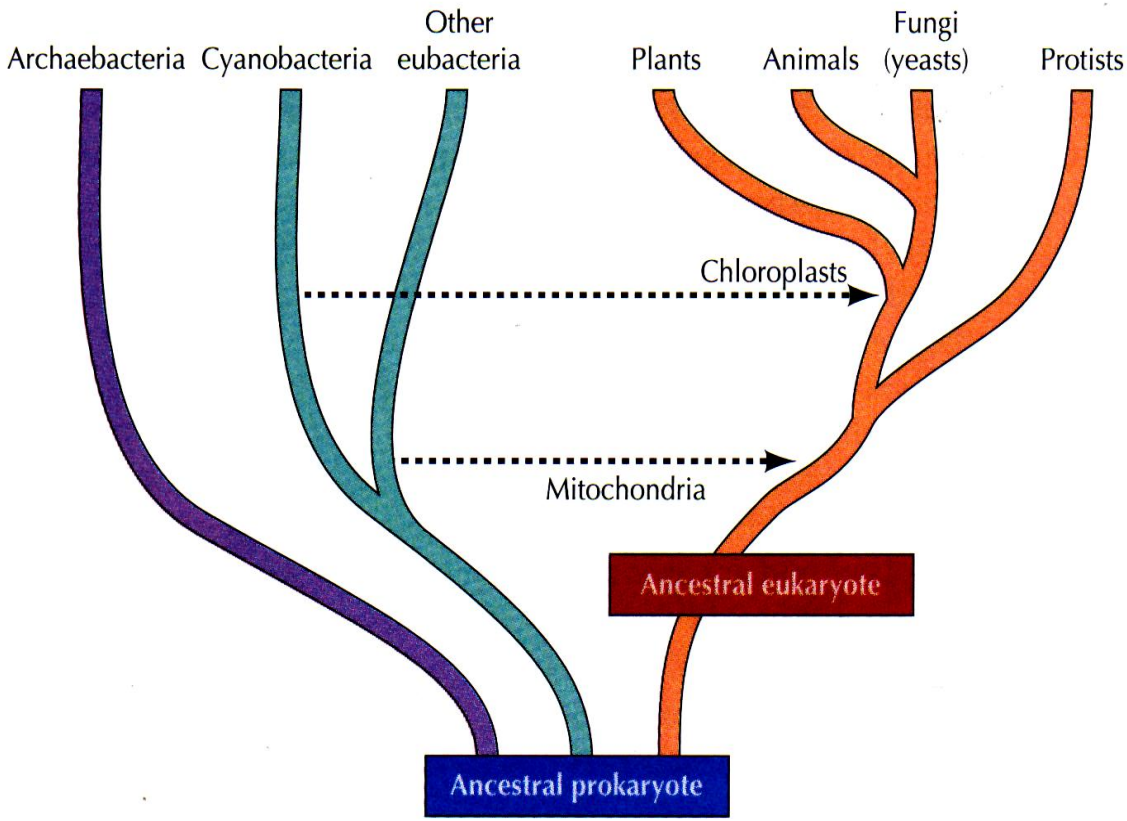
- Prve celice so dobivale hrano in energijo iz morja z organskimi molekulami
- Za nadaljni razvoj je bil potreben razvoj sistema za tvorbo in uporabo metabolne energije (3 sistemi: glikoliza, fotosinteza, oksidativni fosforilacija (celično dihanje) ATP)

Celice

- Protobionti – makromolekule obdane z lipidnim ovojem, ki so se sposobne podvajati
- Prokarionti – bakterijske celice
- Evkarionti – celice praživali, gliv, rastlin in živali

Evolucija




Archaebacteria
Cyanobacteria
Other eubacteria
Plants
Animals
Fungi (yeasts)
Protists
Chloroplasts
Mitochondria
Ancestral eukaryote
Ancestral prokaryote

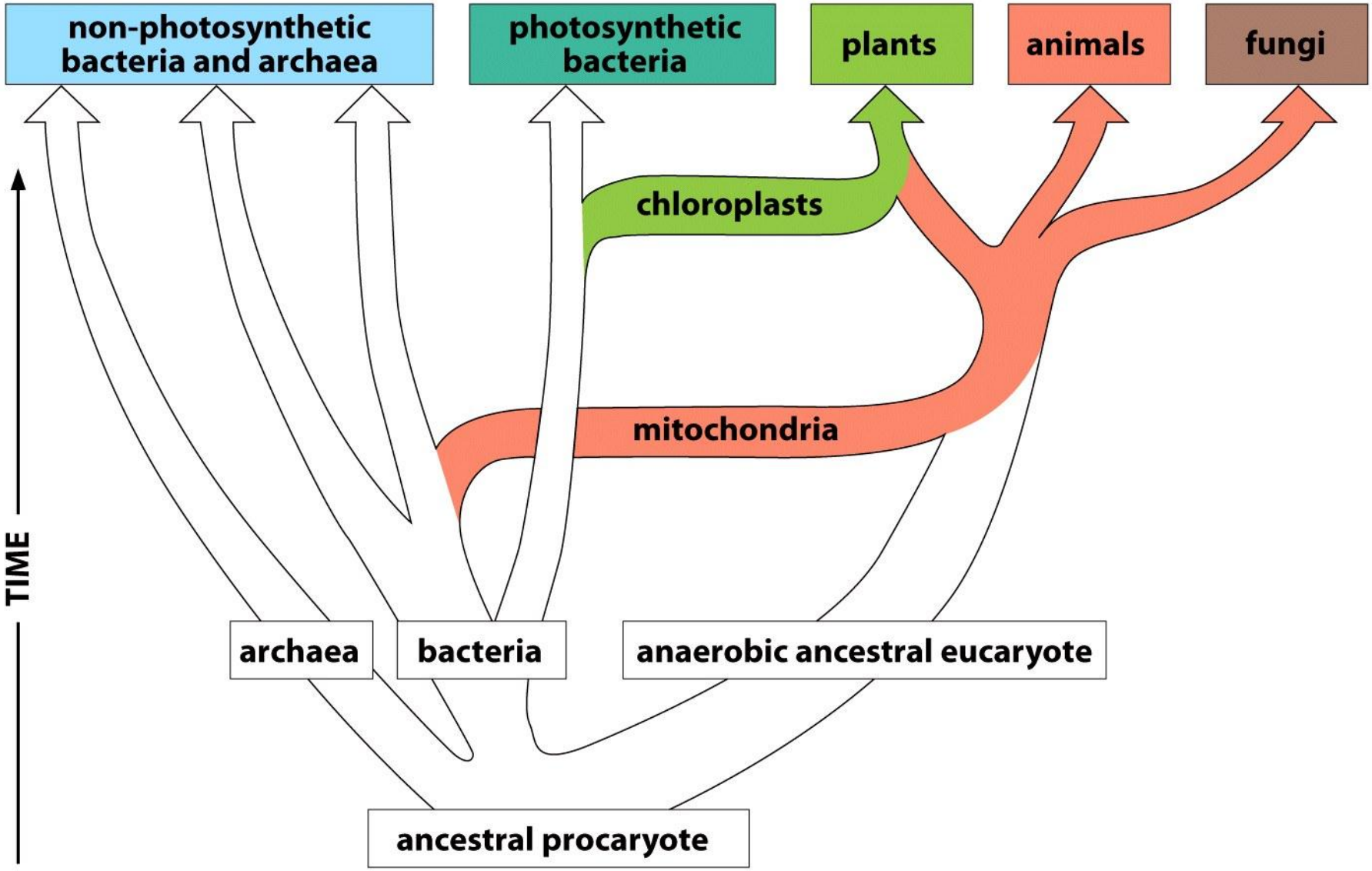
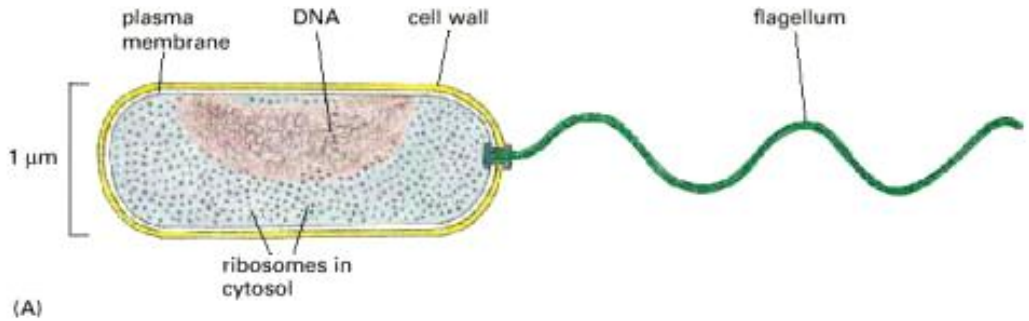
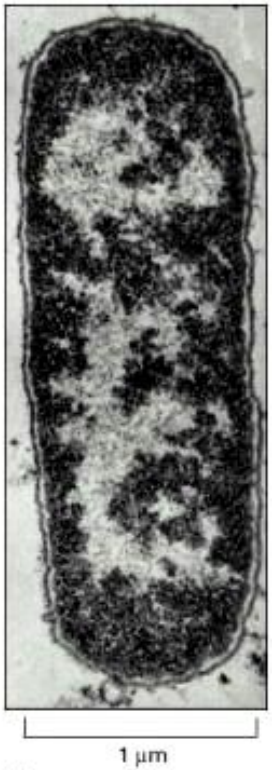


Figure 1-29 Essential Cell Biology 3/e (© Garland Science 2010)

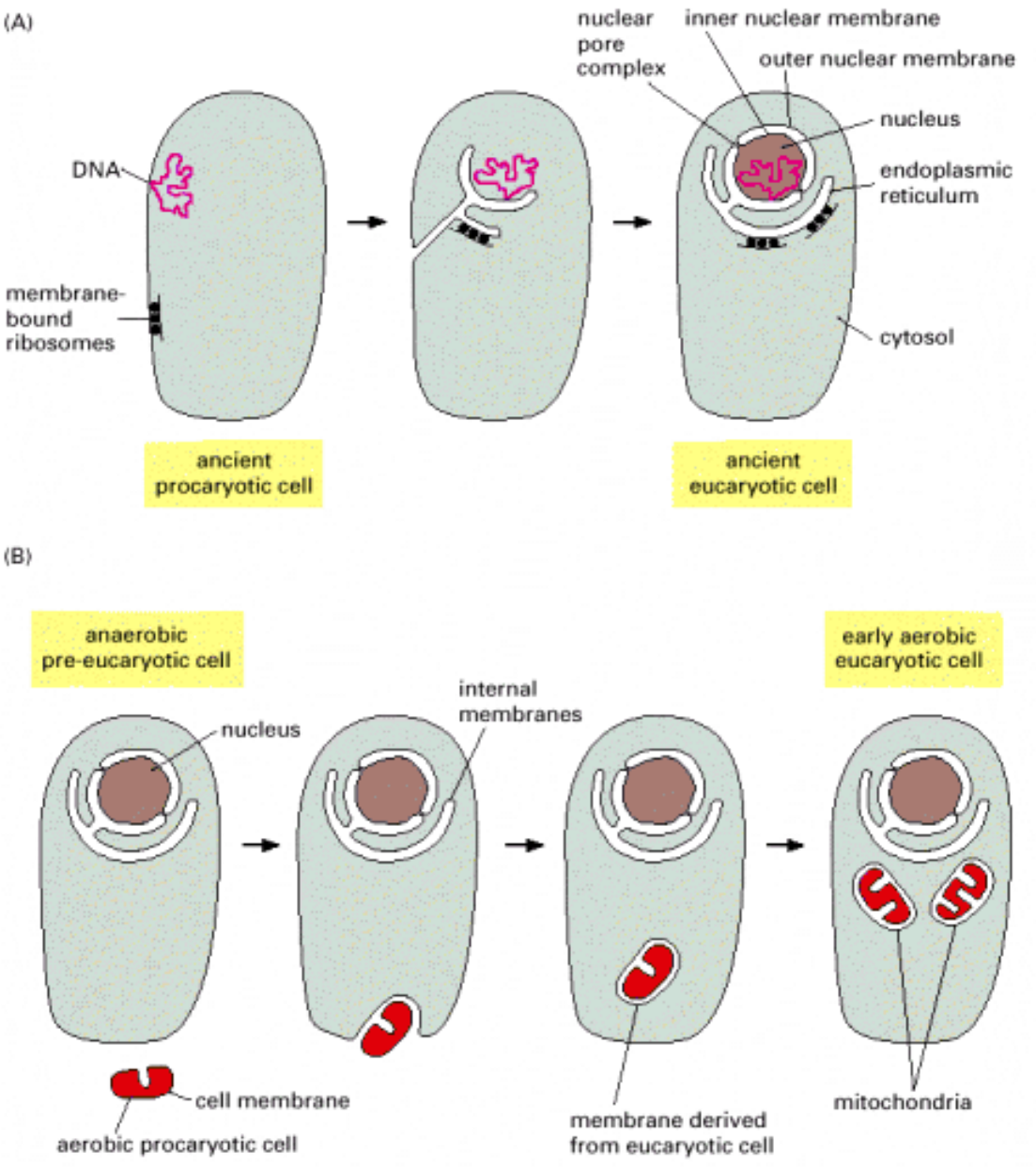
Prokarionti

- Celična stena: peptidoglikani
- Zrnata citoplazma
- Brez organelov
- Brez jedra
- Dedni material je krožna DNA
- Nimajo citoskeleta





Nastanek evkariontske celice



Nastanek kloroplastov

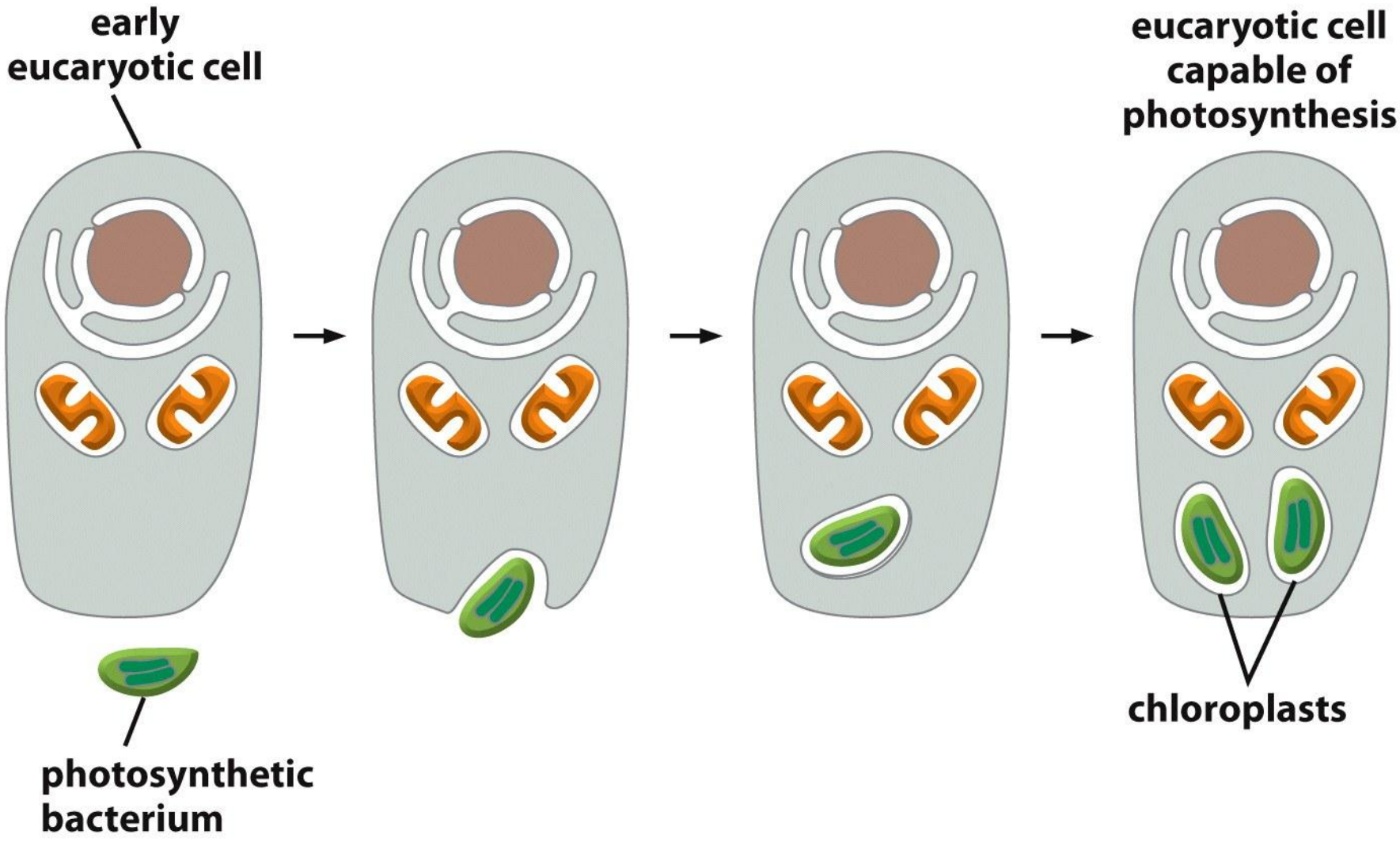
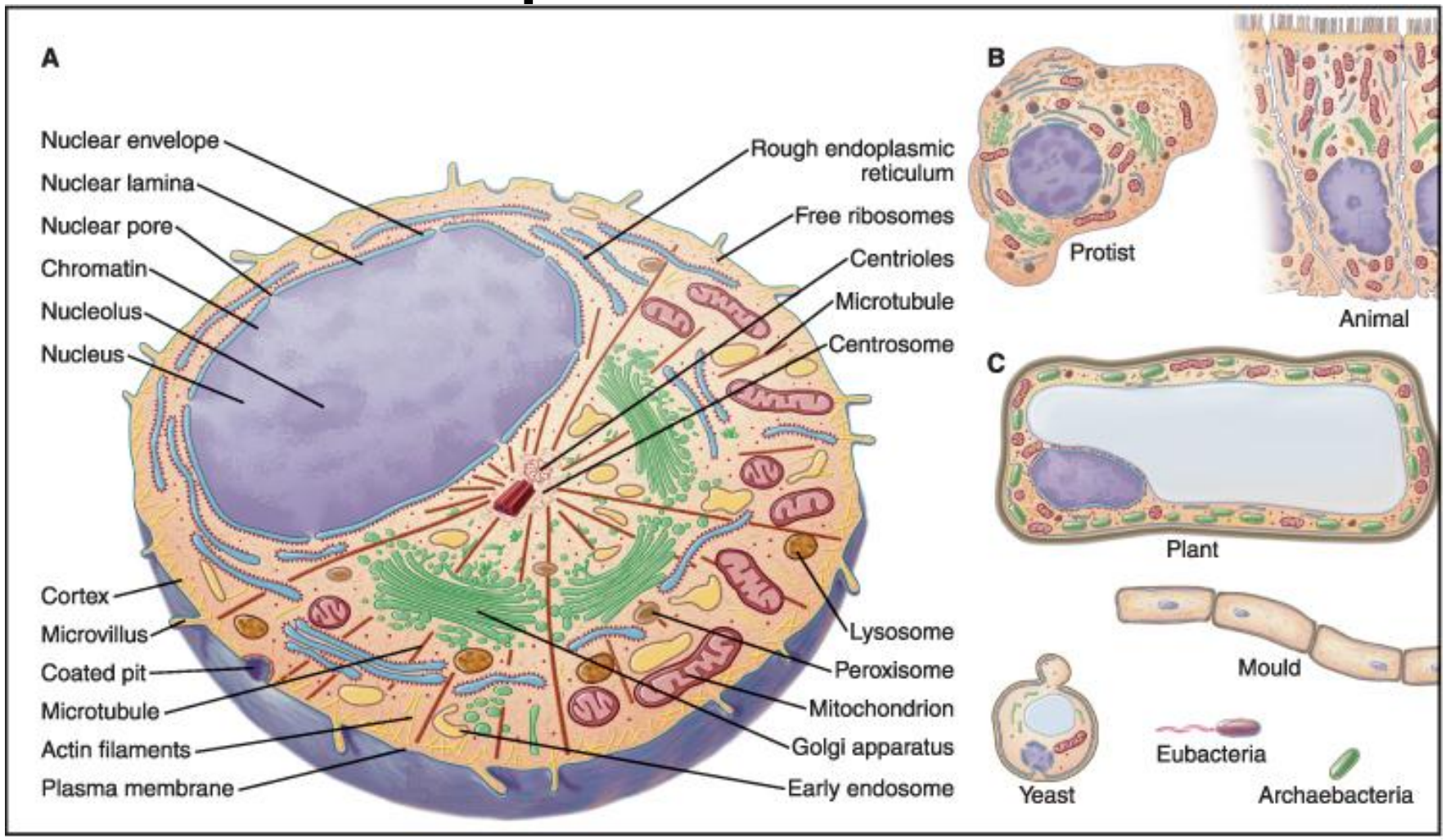


Figure 1-21 Essential Cell Biology 3/e (© Garland Science 2010)

Evkarionti

- Celična snov ali protoplazma je diferencirana v:
  - Jedro
  - Citoplazmo:
    - Citoskelet
    - Citosol
    - Celični organeli
- Živalska celica je obdana s plazmalemo
- Rastlinska celica ima poleg plazmaleme še celulozno celično steno

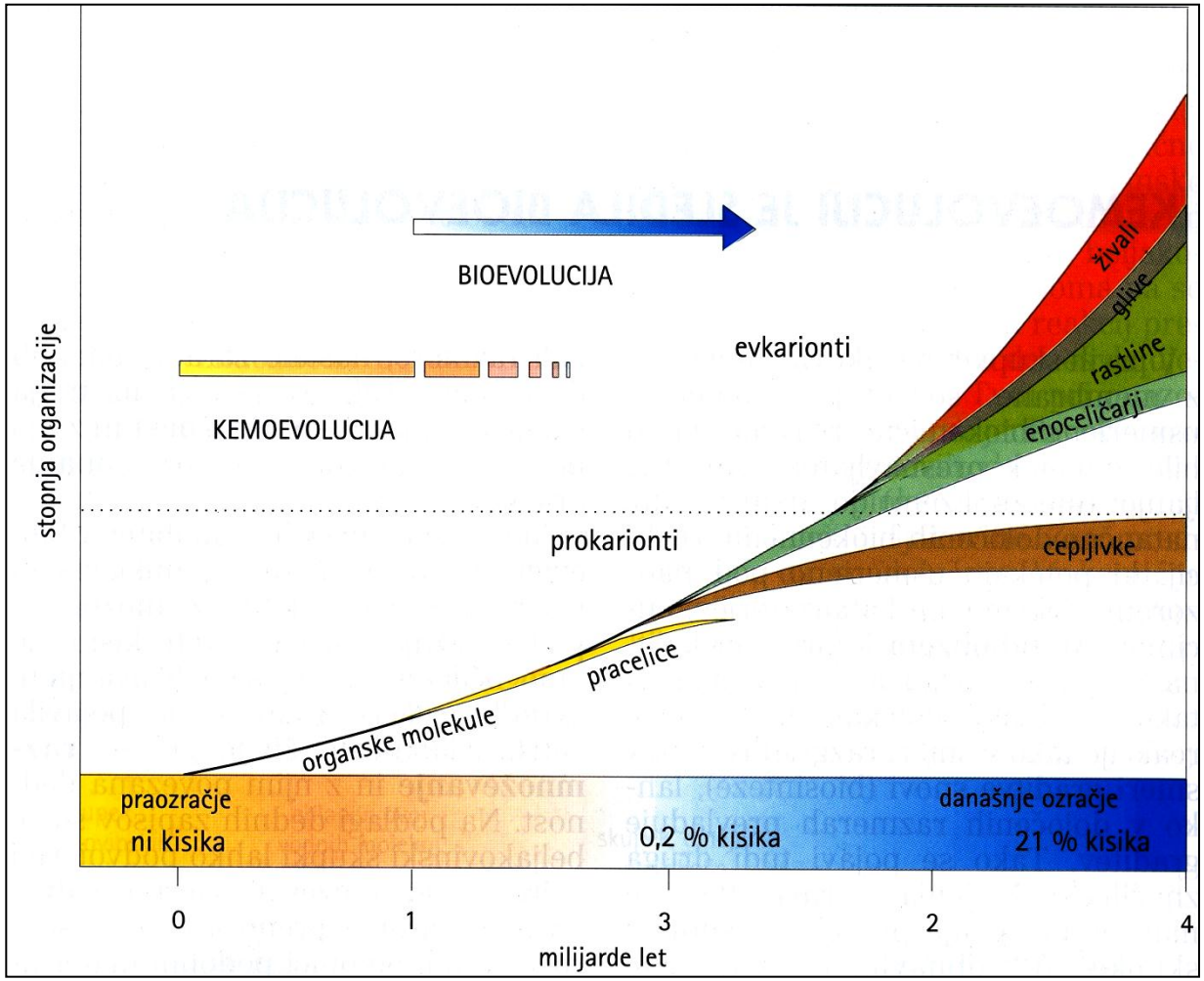
Primerjava med evkarionti in prokarionti



Evkraionti in prokarionti

Značilnost	Celice evkariontov	Celice prokariontov
Velikost	med 10 – 100 um	med 1-10 um
Dedni material	jedro z ovojem	ni jedra
Organizacija DNA	linearni kromosomi	krožni kromosom
Citoplazma	vsebuje cel. organele	nediferencirana
Citoskelet	filamenti in mikrotubuli	ni citoskeleta
Metabolizem	večinoma aerobne	več. anaerobne
Razmnoževanje	mitoza, mejoza	cepitev

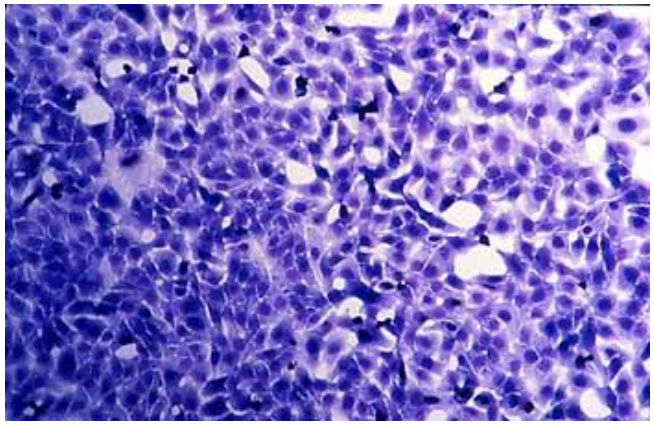
Evolucija


stopnja organizacije
BIOEVOLUCIJA
KEMOEVOLUCIJA
evkarionti
prokarionti
živali
glive
rastline
enoceličarji
cepljivke
pracelice
organske molekule
praozračje
ni kisika
0,2 % kisika
današnje ozračje
21 % kisika
0
1
3
2
4
milijarde let

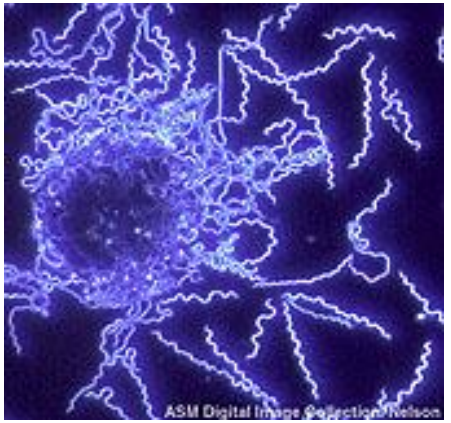
Celica

- Osnovna enota življenja
- Ogromne razlike v obliki in funkciji
- Kemijski procesi v celicah enaki ne glede na vrsto celic oz. njihovo funkcijo
- Makromolekule v različnih celicah enake in sodelujejo pri istih tipih kemijskih reakcij

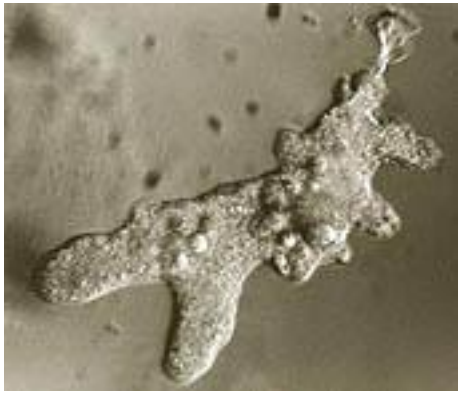
Vrste celic



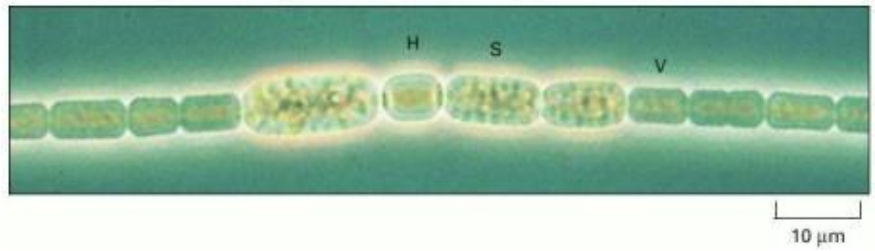
Jetrne celice v kulturi



Borelia spp.



Ameba



Fotosintetska bakterija

Celice

- Skupni prednik (analiza genoma)
- Mutacije
- Geni – navodila za obliko, funkcijo in obnašanje

Zgodovina

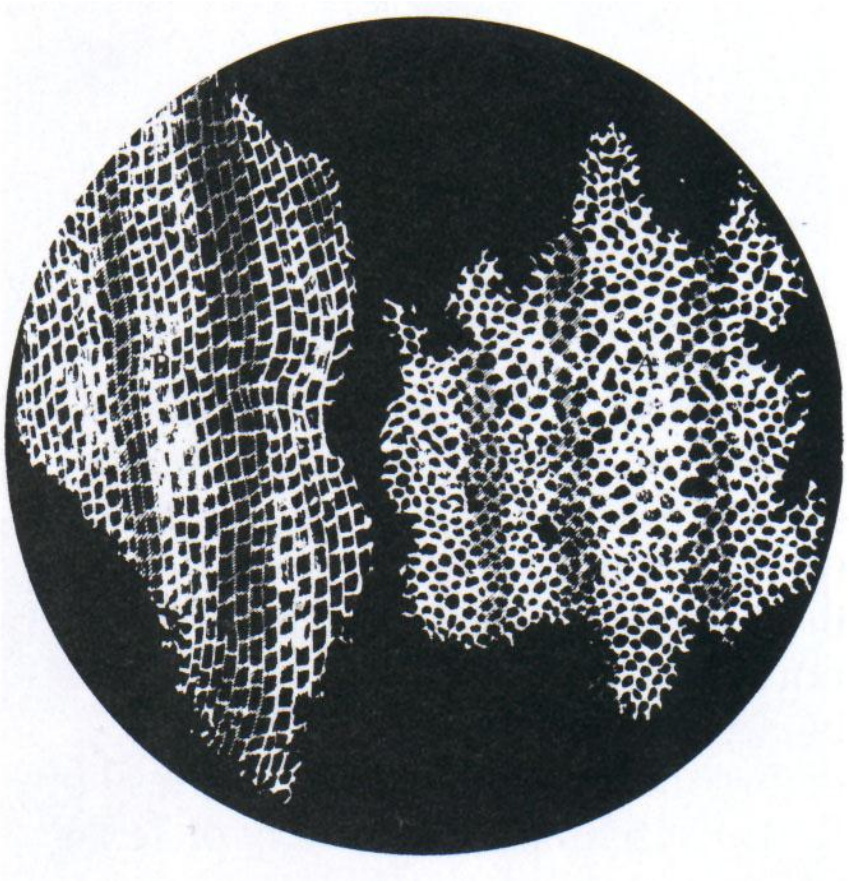
- Mikroskop – 17 stoletje
- Svetlobni mikroskop – odkritje celic Robert Hooke (košček plute 1665)-prvi uporabil izraz celica
- 1837 –Purkyne – definicija protoplazme
- 1838 – botanik Matthias Schleiden
- 1839 – zoolog Theodor Schwann
- Celična teorija: organizmi ne nastajajo spontano, ampak lahko nastanejo samo iz obstoječih – to je potem nedvoumno dokazal Louis Pasteur 1860.

TABLE 1–1 HISTORICAL LANDMARKS IN DETERMINING CELL STRUCTURE	
1665	Hooke uses a primitive microscope to describe small pores in sections of cork that he calls "**cells**."
1674	Leeuwenhoek reports his discovery of **protozoa**. Nine years later, he sees **bacteria** for the first time.
1833	Brown publishes his microscopic observations of orchids, clearly describing the cell **nucleus**.
1838	Schleiden and Schwann propose the **cell theory**, stating that the nucleated cell is the universal building block of plant and animal tissues.
1857	Kölliker describes **mitochondria** in muscle cells.
1879	Flemming describes with great clarity **chromosome behavior during mitosis** in animal cells.
1881	Cajal and other histologists develop staining methods that reveal the structure of **nerve cells** and the organization of neural tissue.
1898	Golgi first sees and describes the **Golgi apparatus** by staining cells with silver nitrate.
1902	Boveri links **chromosomes and heredity** by observing chromosome behavior during sexual reproduction.
1952	Palade, Porter, and Sjöstrand develop methods of **electron microscopy** that enable many intracellular structures to be seen for the first time. In one of the first applications of these techniques, Huxley shows that muscle contains arrays of protein filaments—the first evidence of a **cytoskeleton**.
1957	Robertson describes the bilayer structure of the **cell membrane**, seen for the first time in the electron microscope.
1960	Kendrew describes the first detailed **protein structure** (sperm whale **myoglobin**) to a resolution of 0.2 nm using **X-ray crystallography**. Perutz proposes a lower-resolution structure for **hemoglobin**.
1965	Christian de Duve and his colleagues use a **cell fractionation** technique to separate **peroxisomes**, **mitochondria**, and **lysosomes** from a preparation of rat liver.
1968	Petran and collaborators make the first **confocal microscope**.
1974	Lazarides and Weber use **fluorescent antibodies** to stain the cytoskeleton.
1994	Chalfie and collaborators introduce **green fluorescent protein** (**GFP**) as a marker to follow the behavior of proteins in living cells.

Table 1-1 Essential Cell Biology 3/e (© Garland Science 2010)

Odkritje celic

- 1665 - Robert Hook
- Prva slika celic plute



Kaj lahko vidimo z različnimi mikroskopi

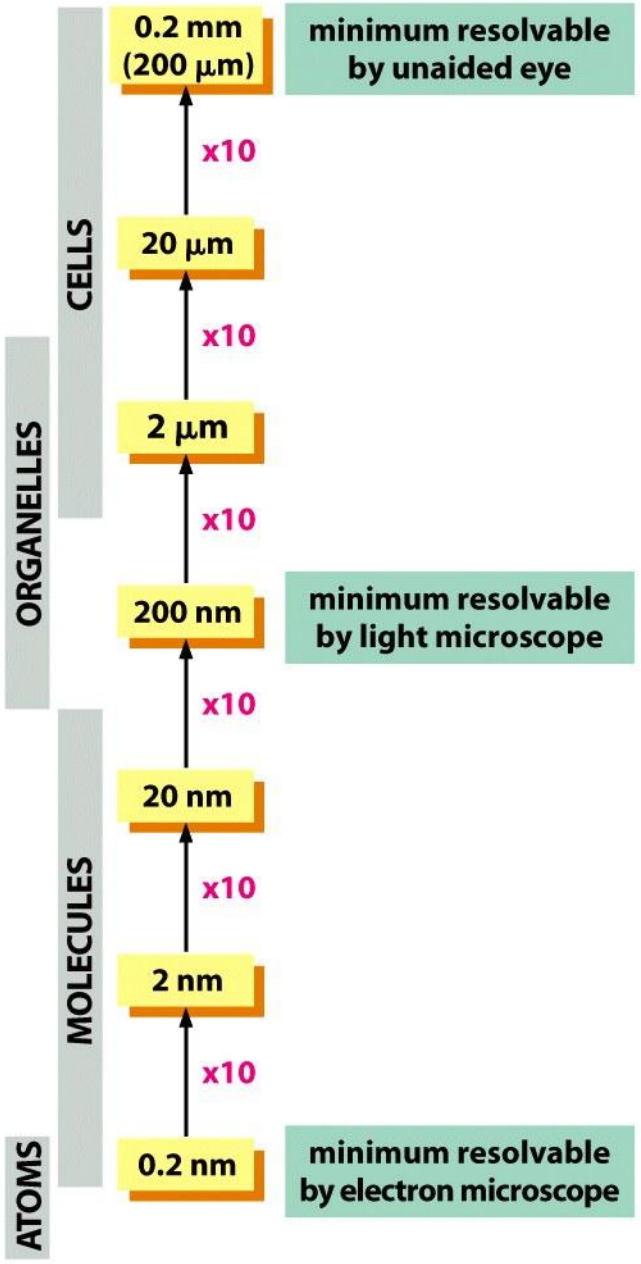
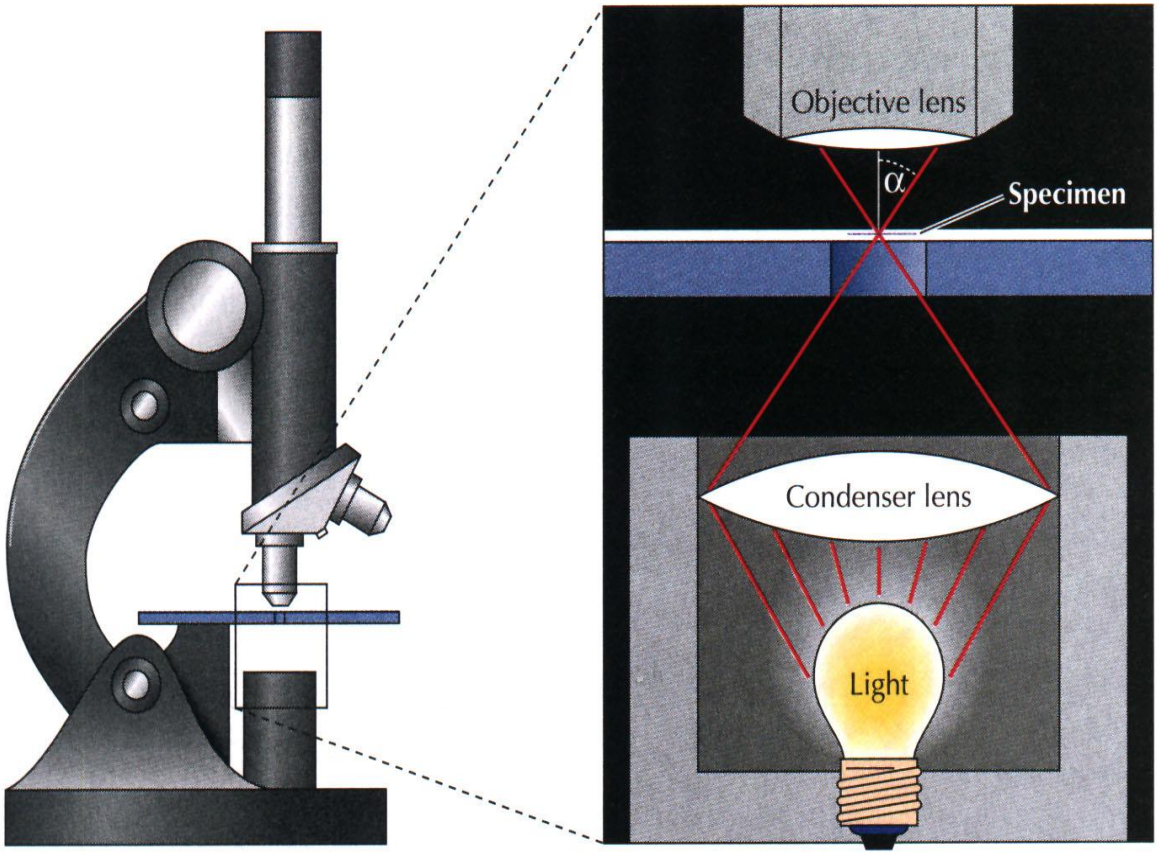


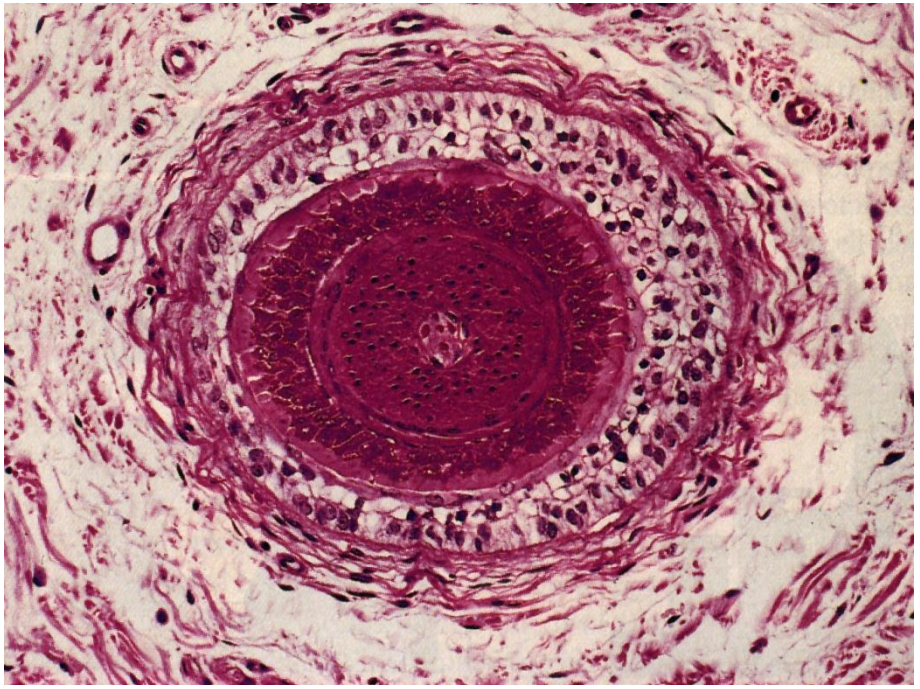
Figure 1-6 Essential Cell Biology 3/e (© Garland Science 2010)

Svetlobni mikroskop



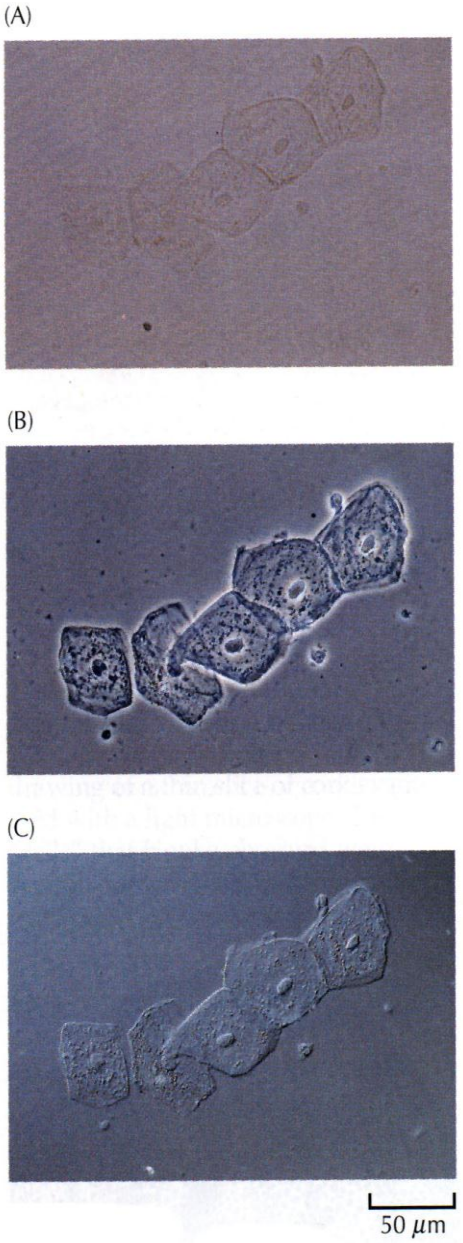
Mikroskopija s svetlim poljem

- Prerez lasnega folikla obarvanega s hematoksilinom in eozinom



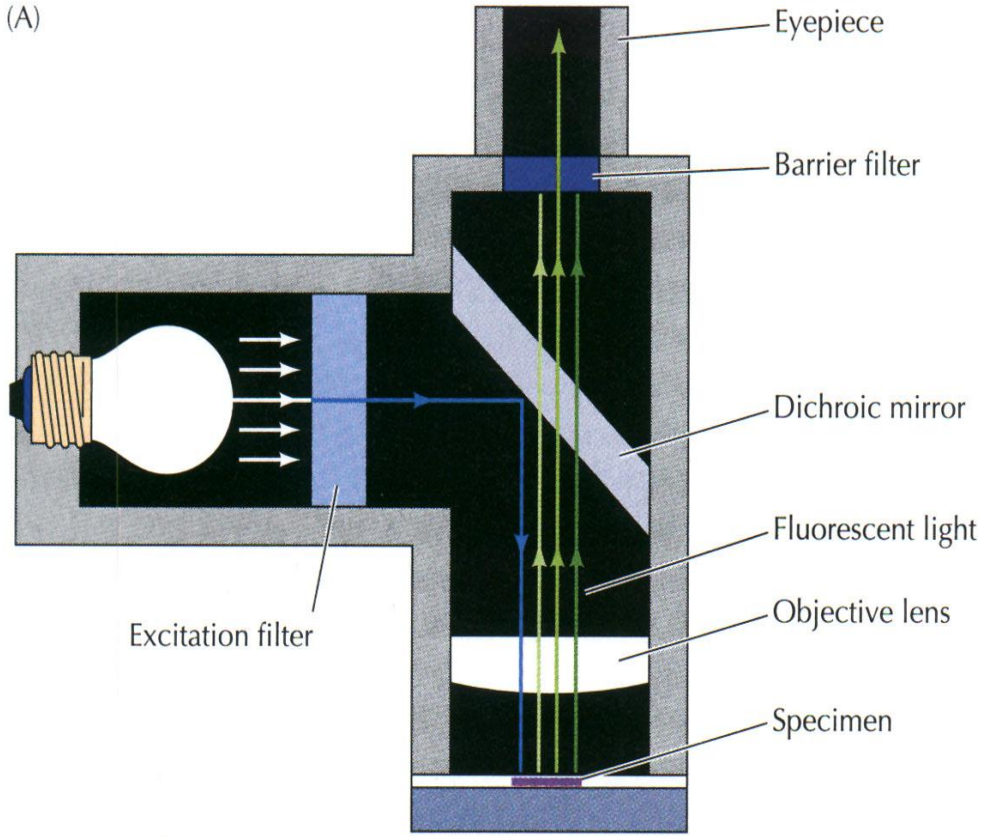
Svetlobna mikroskopija neobarvanih celic

- A - neobarvane celice
- B - fazni kontrast
- C - diferencialna interferenca kontrastne mikroskopije



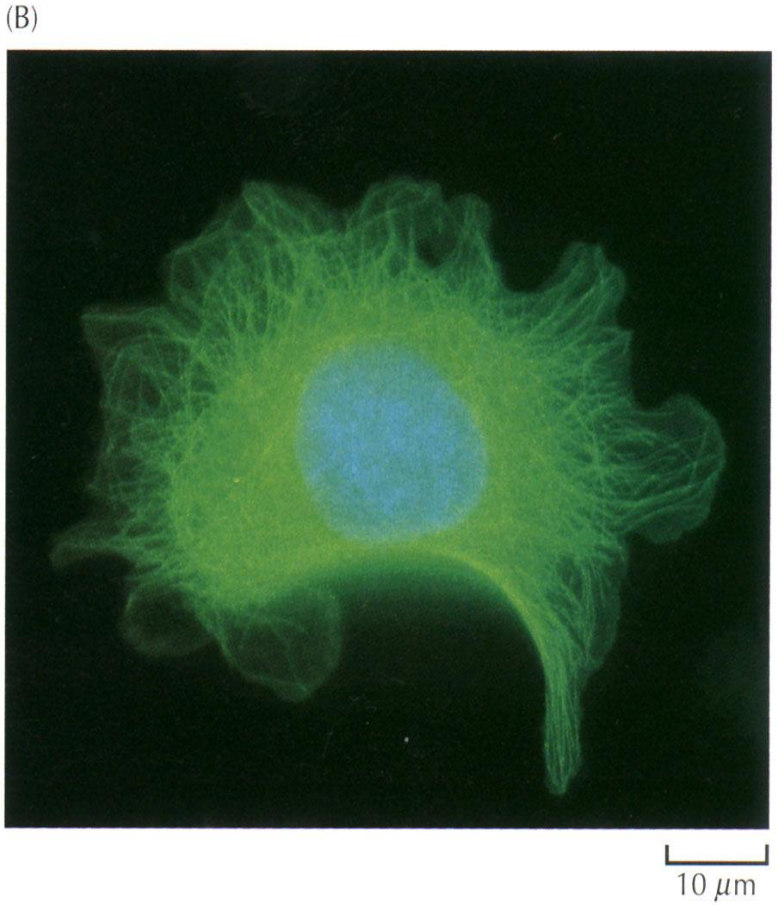
Fluorescenčna mikroskopija

- Barvanje celičnih struktur s fluorescenčnim barvilom
- Fluorescenčno barvilo absorbira svetlobo ene valovne dolžine in jo oddaja pri drugi volovni dolžini



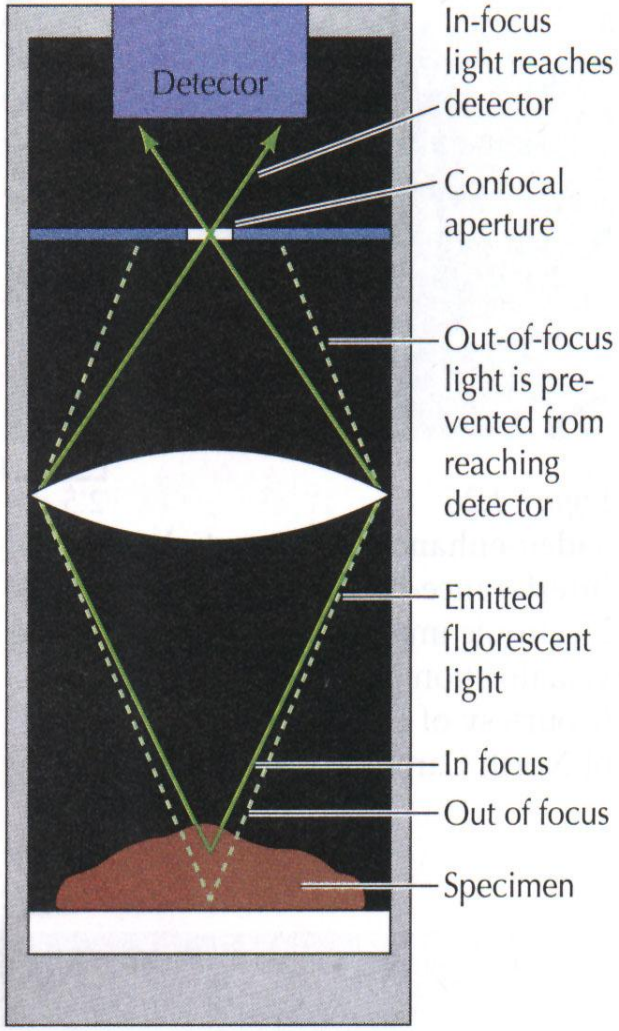
Fluorescenčna mikroskopija

- Pljučni fibroblast
- DNK - modro
- Mikrotubuli - zeleno

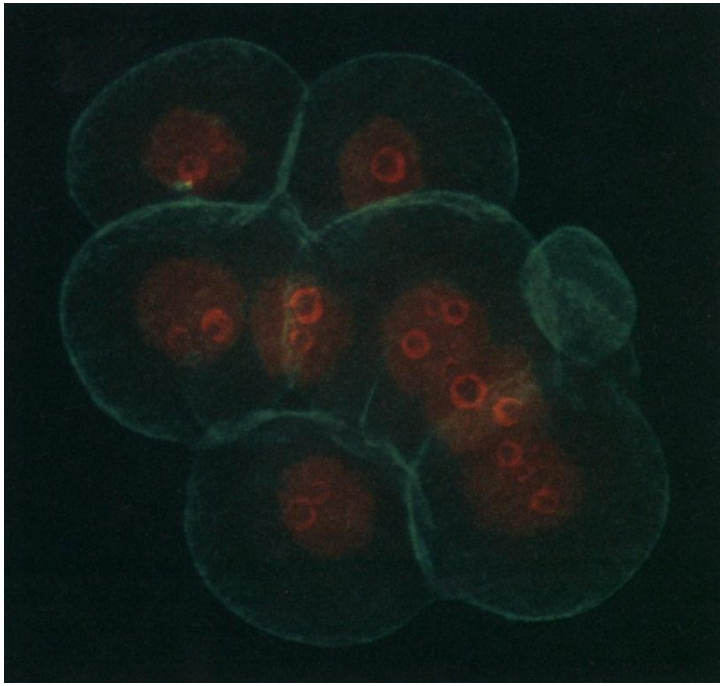


Konfokalna mikroskopija

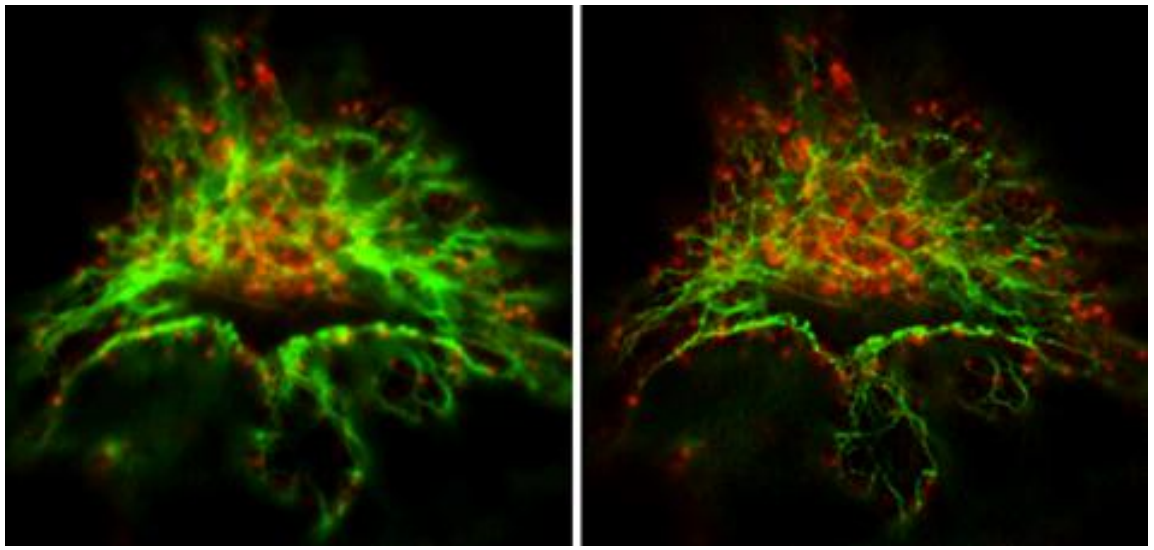
- Združuje fluorescenčno mikroskopijo z elektronsko analizo
- Rezultat je tri-dimenzionalna slika



Konfokalna slika mišjih embrionalnih celic



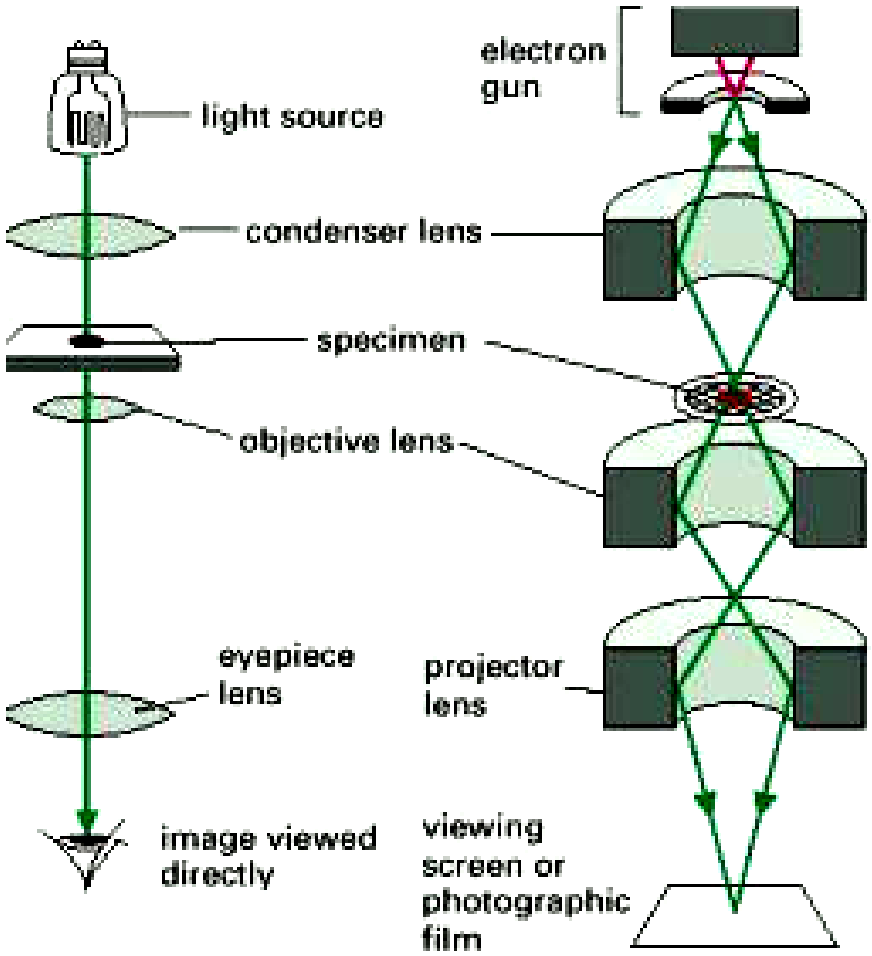
Primerjava med navadno fluorescentno in konfokalno mikroskopijo – vimentinski filamenti in klatrin



Elektronska mikroskopija

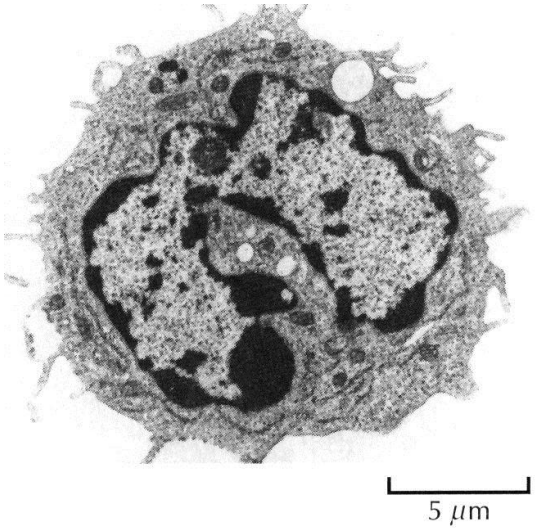
- Razvita v 1950-ih
- Vrste:
  - transmisijska
  - vrstična

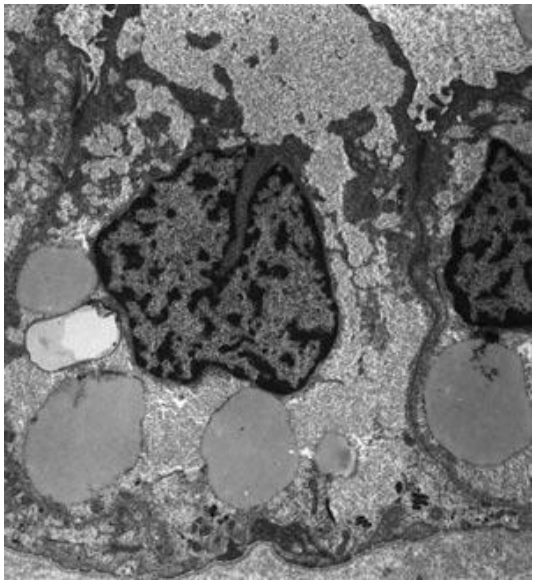
Svetlobni in transmisijski mikroskop



Transmisijska elektronska mikroskopija

- bela krvna celica





- celica karcinoma ledvic

Transmisijski elektronski mikroskop

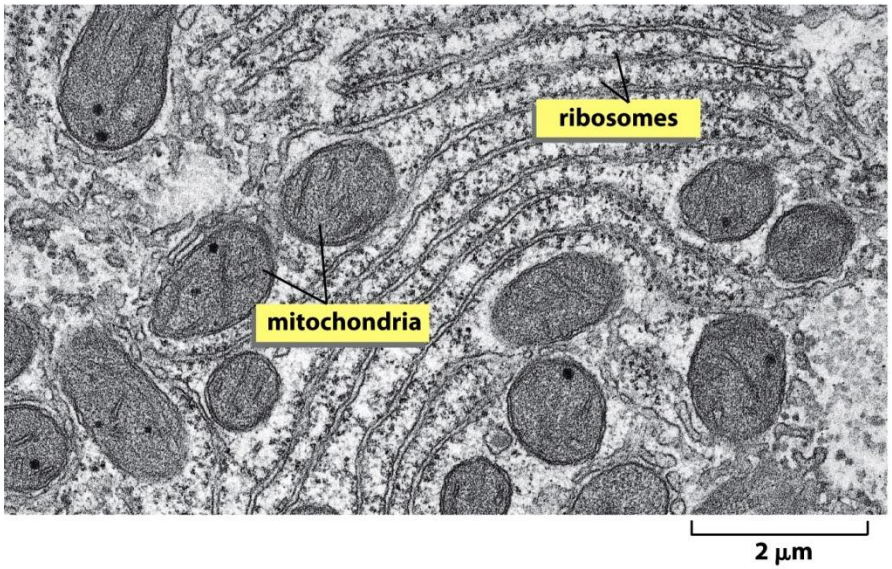


Figure 1-8b Essential Cell Biology 3/e (© Garland Science 2010)

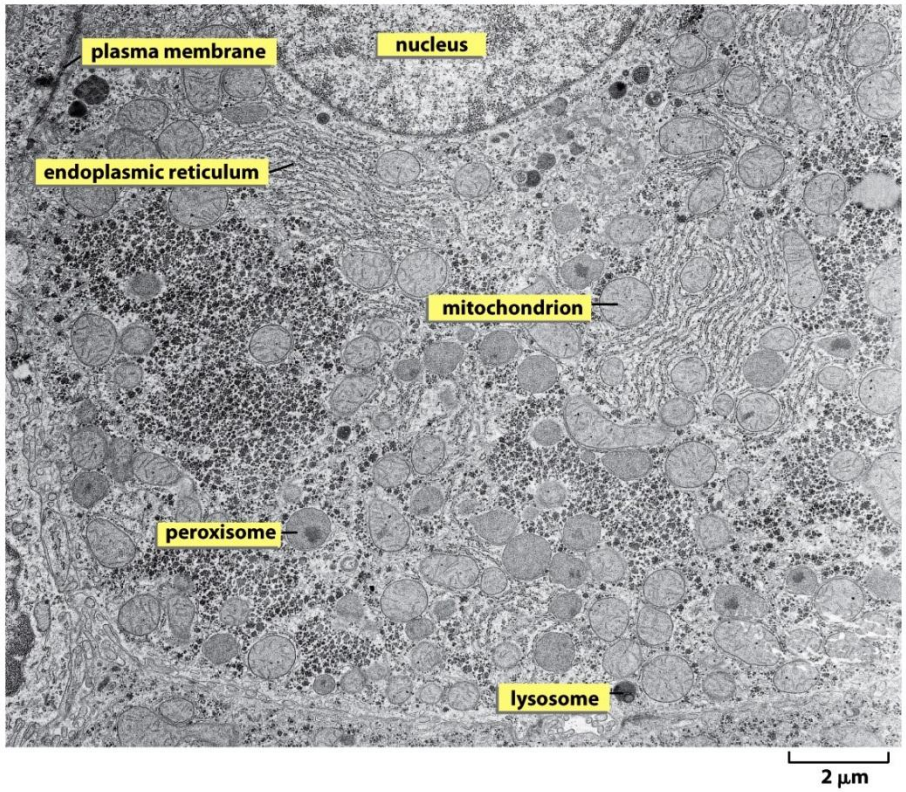
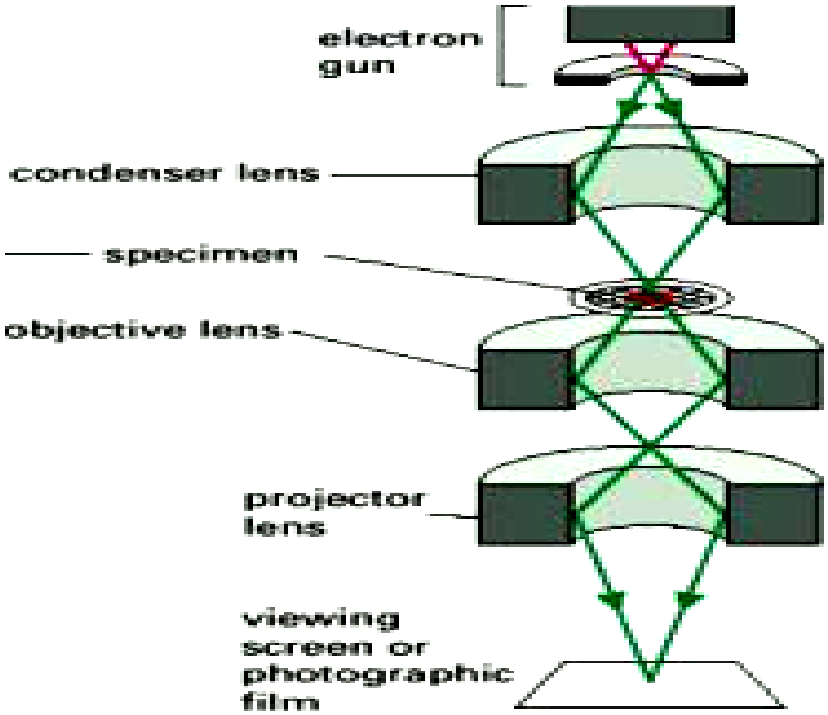
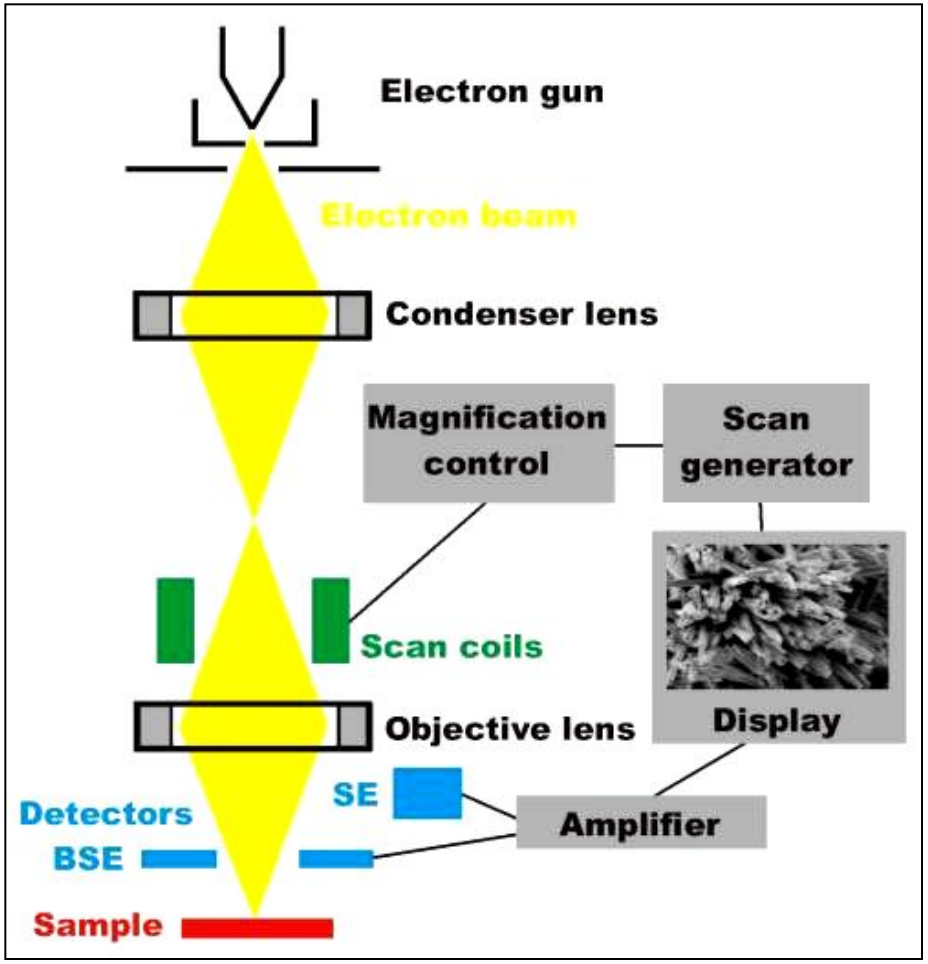


Figure 1-8a Essential Cell Biology 3/e (© Garland Science 2010)

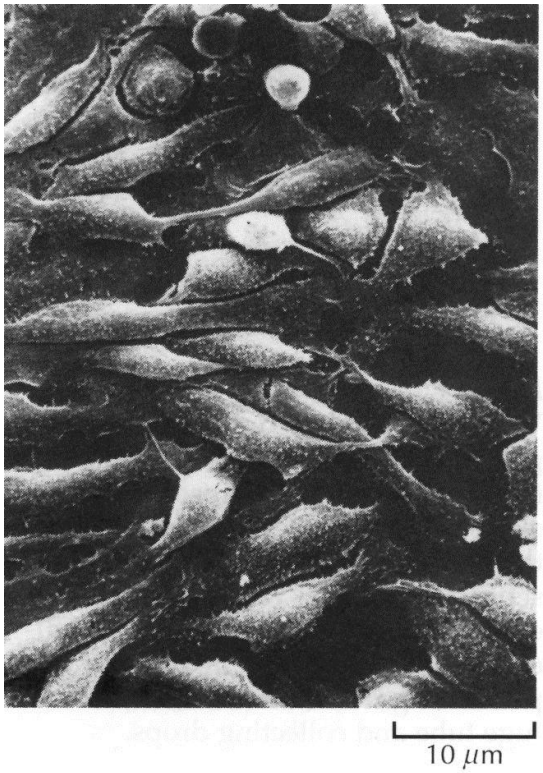
Vrstični elektronski mikroskop



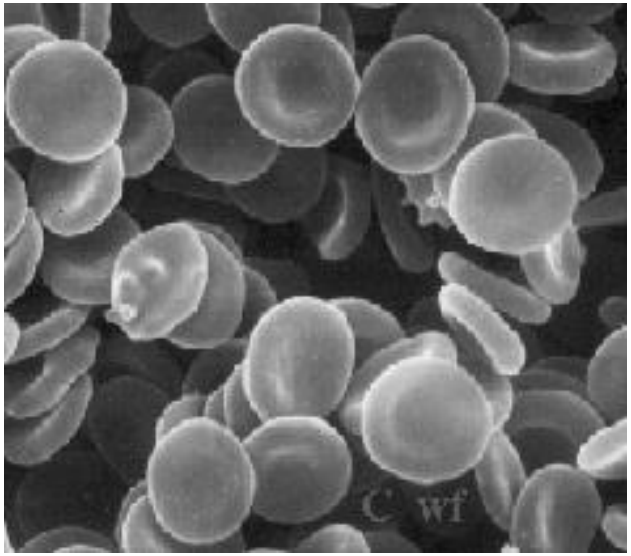


Vrstična elektronska mikroskopija

- humani fibroblasti v celični kulturi



Ebola virus



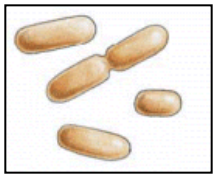
Eritrociti –
rdeča krvna telesca

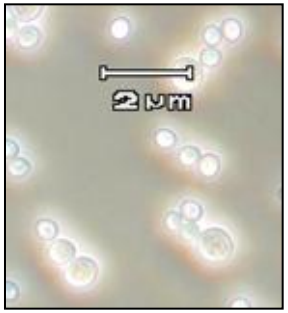
Modelni organizmi

- Ker vse celice izvirajo iz skupnega prednika in ker so njihove osnovne lastnosti ohranjene skozi evolucijo, lahko znanje pridobljeno na eni vrsti celic prispeva k razumevanju drugih.
- Modelne celice- nekateri organizmi so bolj primerni za študij v laboratoriju (hiro razmnoževanje, prosojni itd...)

Modelni organizmi

- Escherichia coli (E.coli) - bakterija

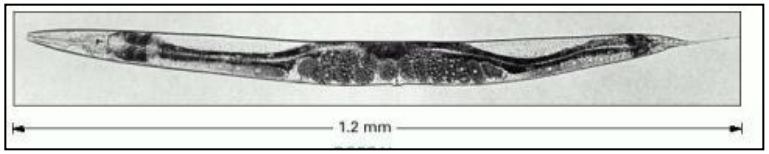




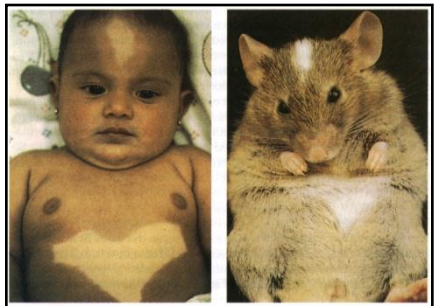
- Saccharomyces cerevisiae – kvasovka

- Arabidopsis thaliana – rastline

- Drosophila melanogaster – muha



- Caenorabditis elegans – nematoda (črv)



- Mus musculus – miši

Cebrice – Zebra fish

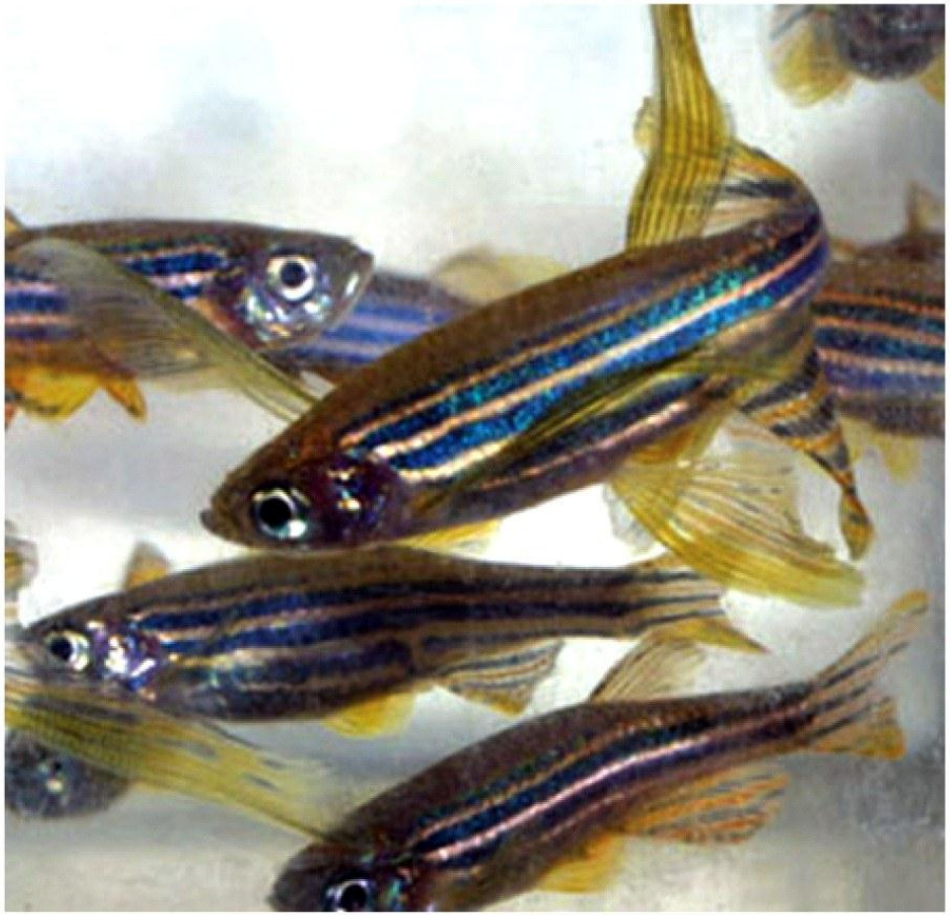
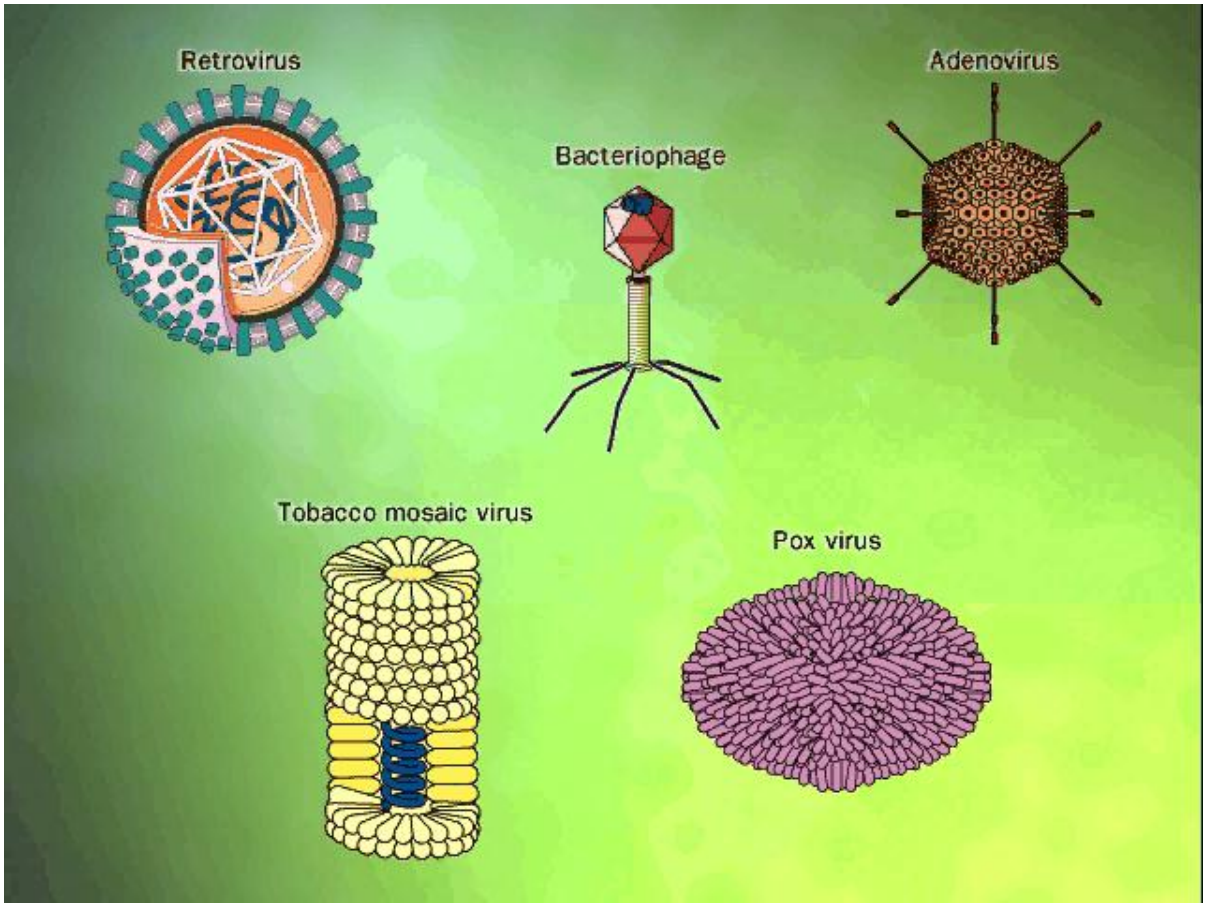


Figure 1-39 Essential Cell Biology 3/e (© Garland Science 2010)

Virusi

- Meja med neživim in živim



Osnovni pojmi

- Celice so osnovna enota življenja.
- Nastale naj bi iz skupnega prednika prb. 3 milijardami let
- Vse celice in s tem tudi vsa živa bitja rastejo, spreminjajo energijo iz eno oblike v drugo, zaznavajo in odgovarjajo na okolje in se razmnožujejo
- Vse celice so obdane s celično membrano, ki ločuje notranjost celice od okolice.

Osnovni pojmi

- Vse celice vsebujejo DNA kot skladišče genetske informacije, ki jo celice uporabljajo kot vodilo za sintezo RNA molekul in proteinov.
- Celice v večceličnem organizmu so lahko zelo različih oblik, kljub temu, da vsebujejo enako DNA.

Osnovni pojmi

- Živalske in rastlinske celice merijo v premeru od 5-20 μm. Opazujemo jih lahko s svetlobnim mikroskopom, ki nam prikaže tudi nekatere znitrajcelične komponente in organele.
- Elektronski mikroskop omogoča opazovanje manjših organelov in celo večjih molekul. Priprava vzorcev je dolgotrajna in celice ne moremo opazovati v živo.

Osnovni pojmi

- Najpreprostejše danes živeče celice so prokarionti. Vsebujejo DNA, nimajo pa jedra in organelov.
- Evkariontske vsebujejo jedro in druge organele. Razvile so se verjetno v več stopnjah. Izgleda, da je bil pomemben korak pridobitev mitohondrija, ki naj bi izviral iz bakterije, ki jo je zajela predhodnica evkariontske celice.

Osnovni pojmi

- Jedro je najbolj izrazit organel v večini rastlinskih in živalskih celic. Vsebuje genetsko informacijo organizma, ki je shranjena v DNA molekuli.
- Citoplazma zajema vso celično vsebino izven jedra. Vsebuje različne z membrano obdane organele, ki imajo specifične kemijske funkcije.