Advanced Cell Biology. Lecture 6

Alexey Shipunov

Minot State University

January 26th, 2011

Outline

Lab cell images and organelles

Amino acids

Outline

Lab cell images and organelles

Amino acids

Previous final question: the answer

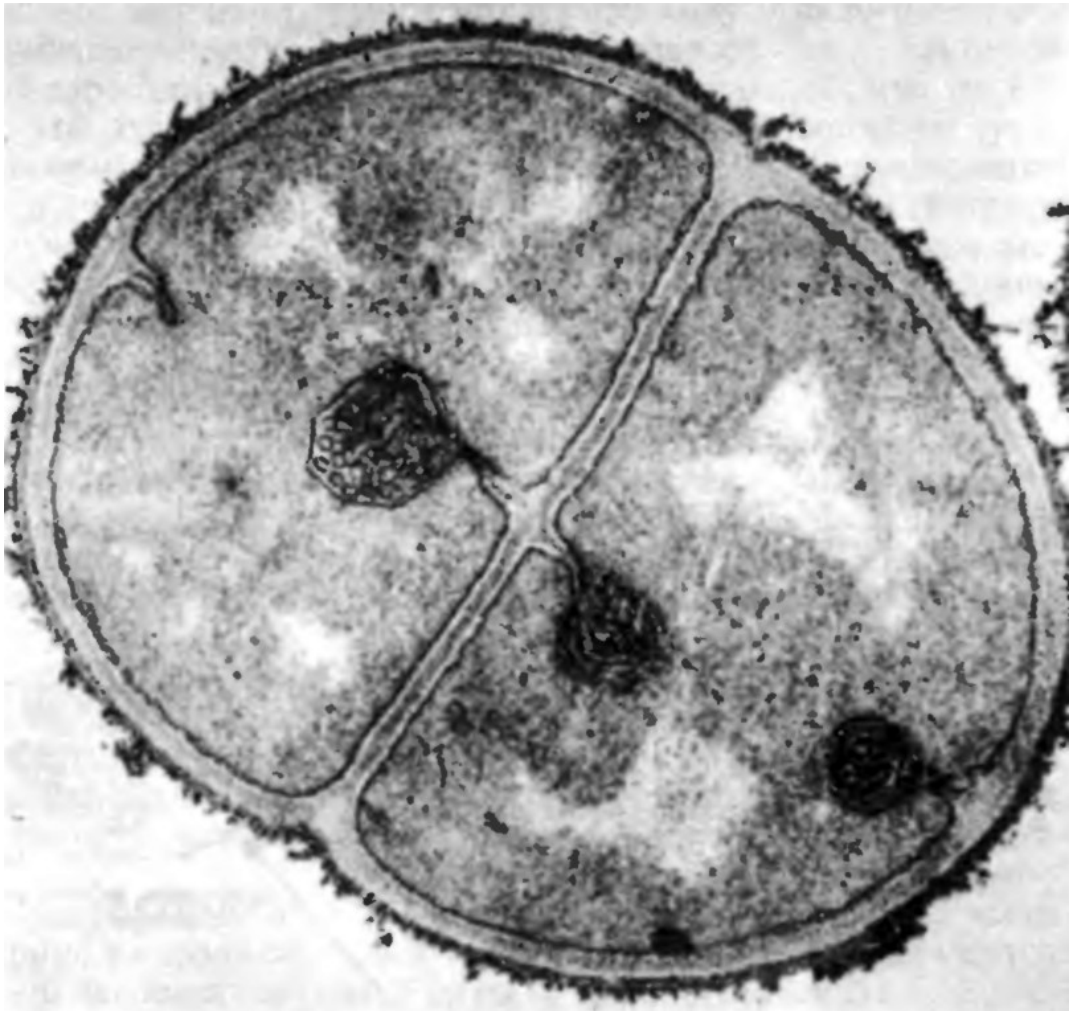
Which role in the cell lipids do NOT play?

Previous final question: the answer

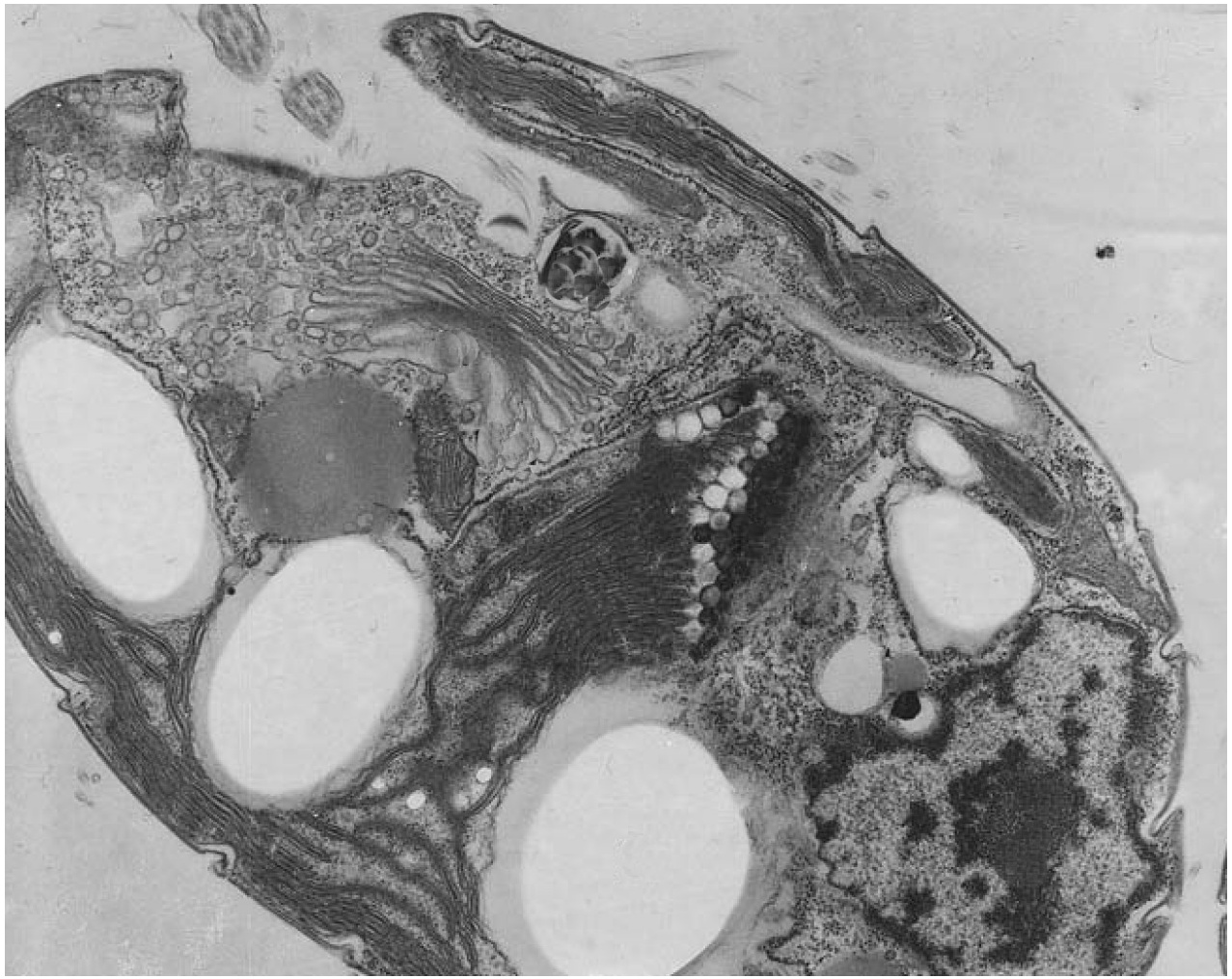
Which role in the cell lipids do NOT play?

1. Protein, DNA, RNA synthesis
2. Transport
3. Cellular respiration
4. ~~Making energy~~
5. ~~Exo- / endocytosis~~

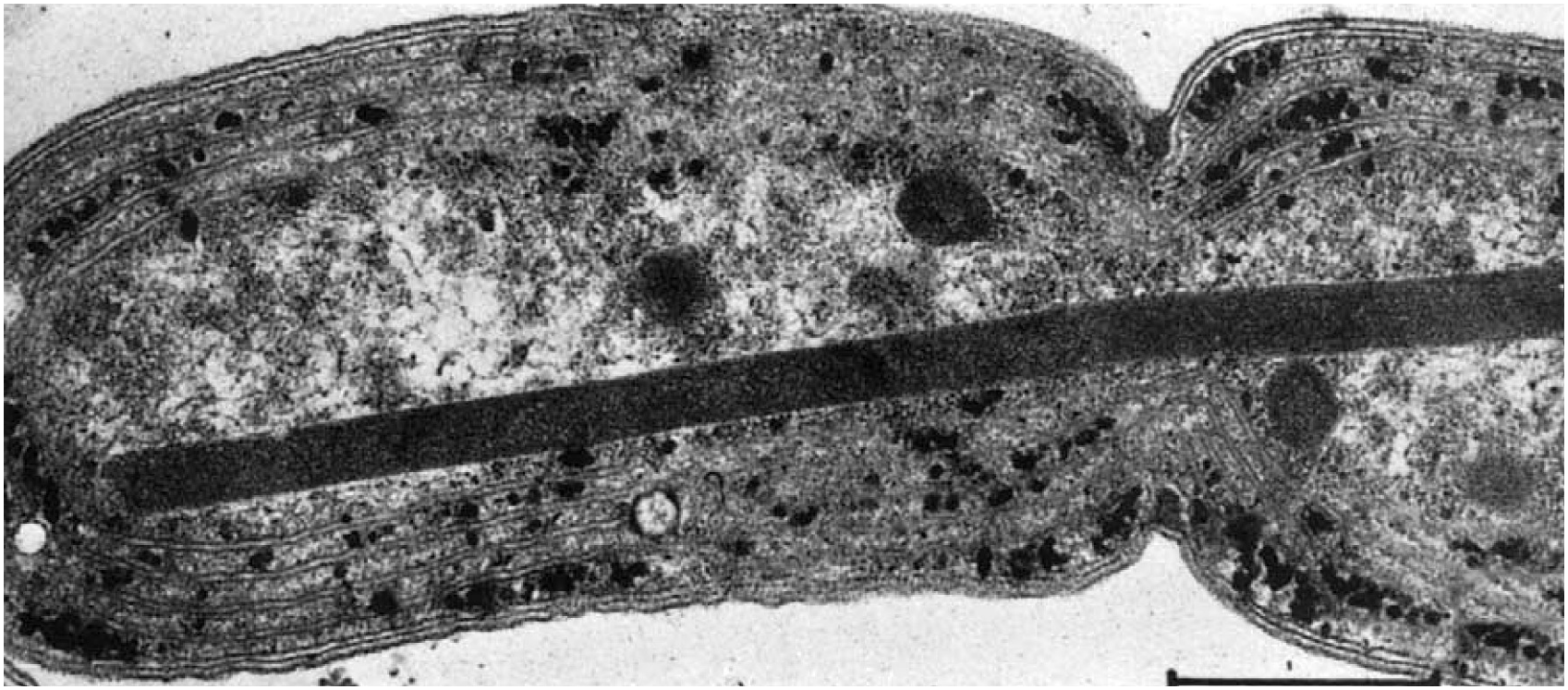
1. Dividing bacterial cell



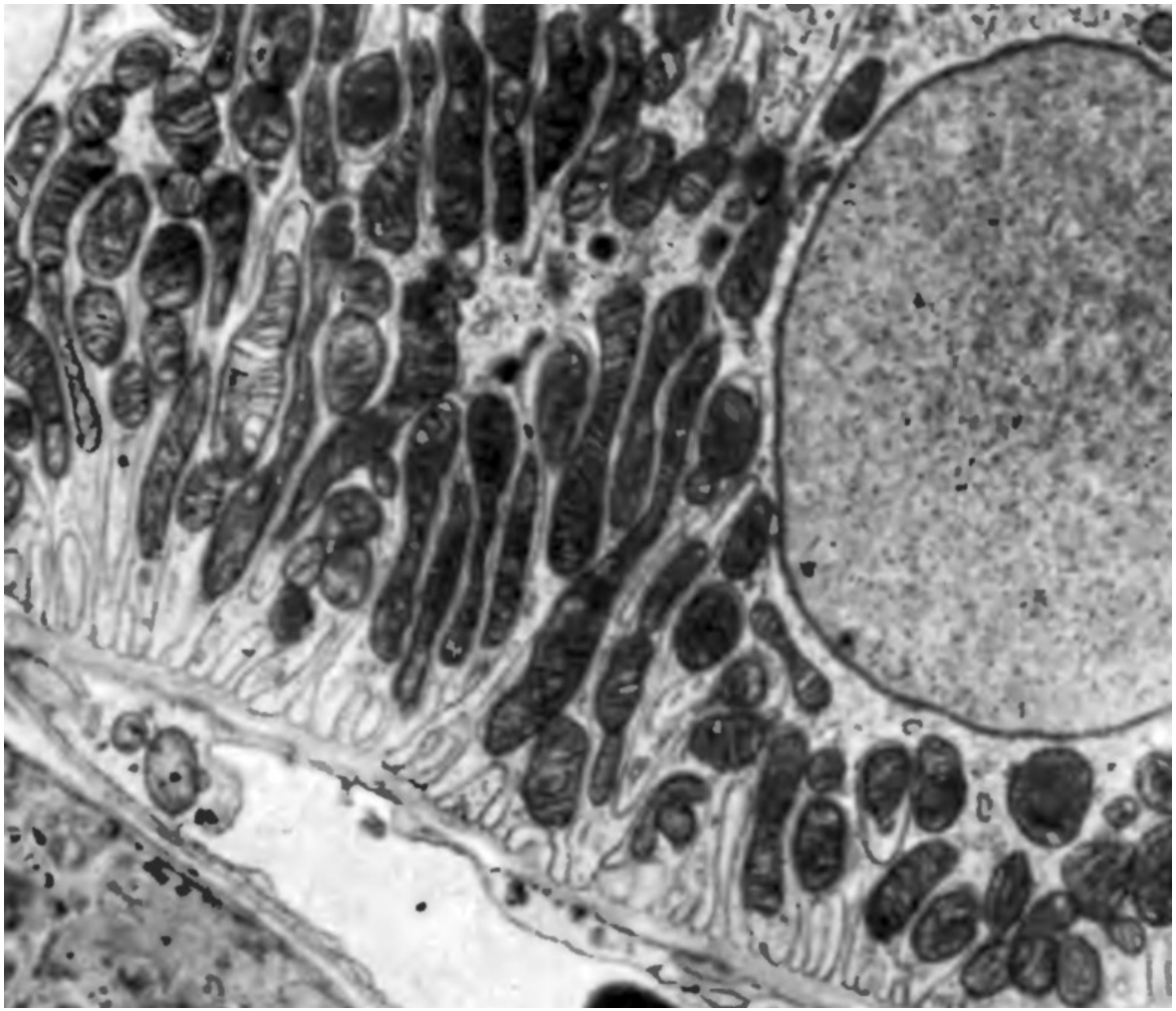
2. *Chroomonas*, unicellular alga



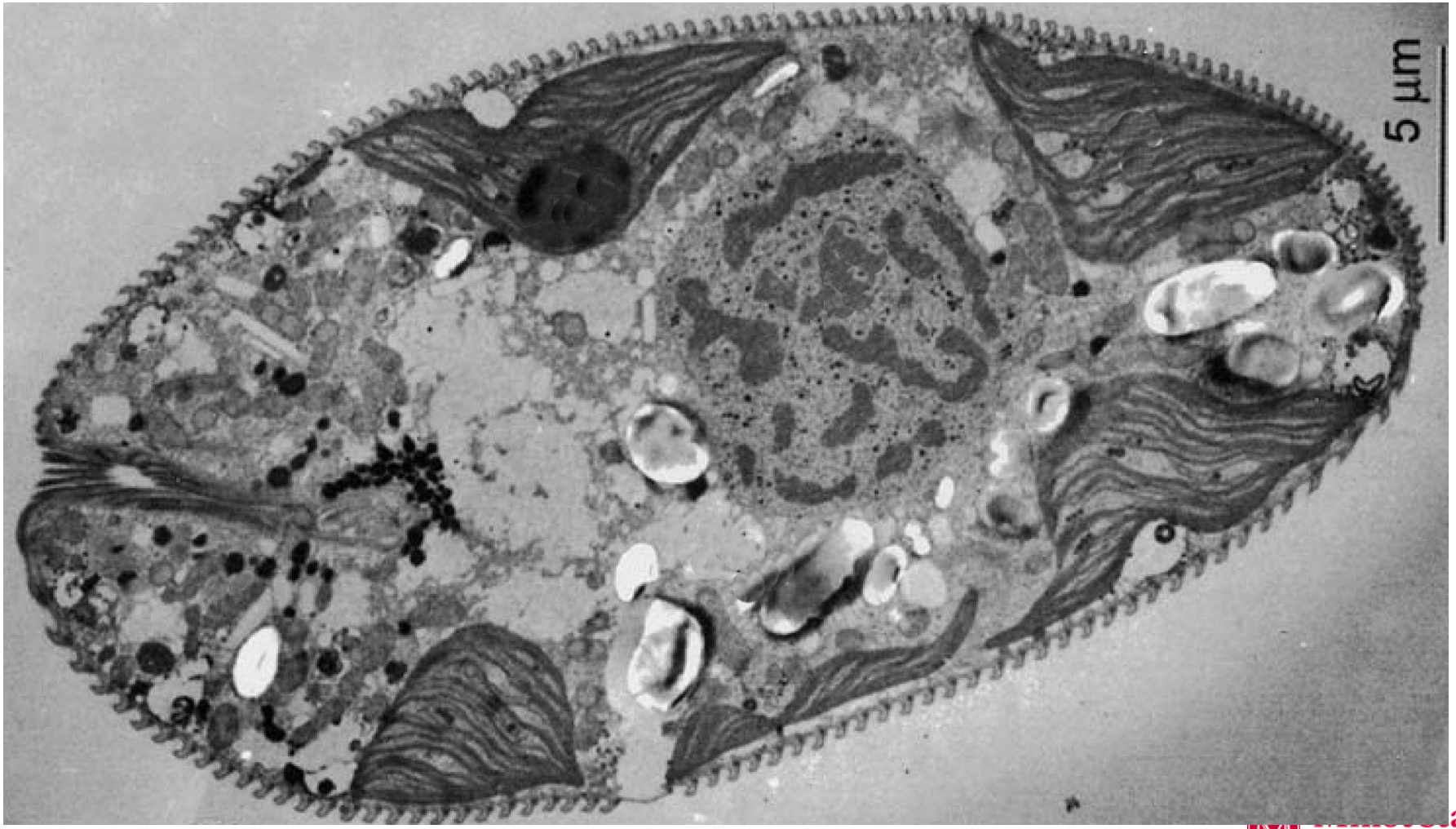
3. Part of cyanobacterium trichome



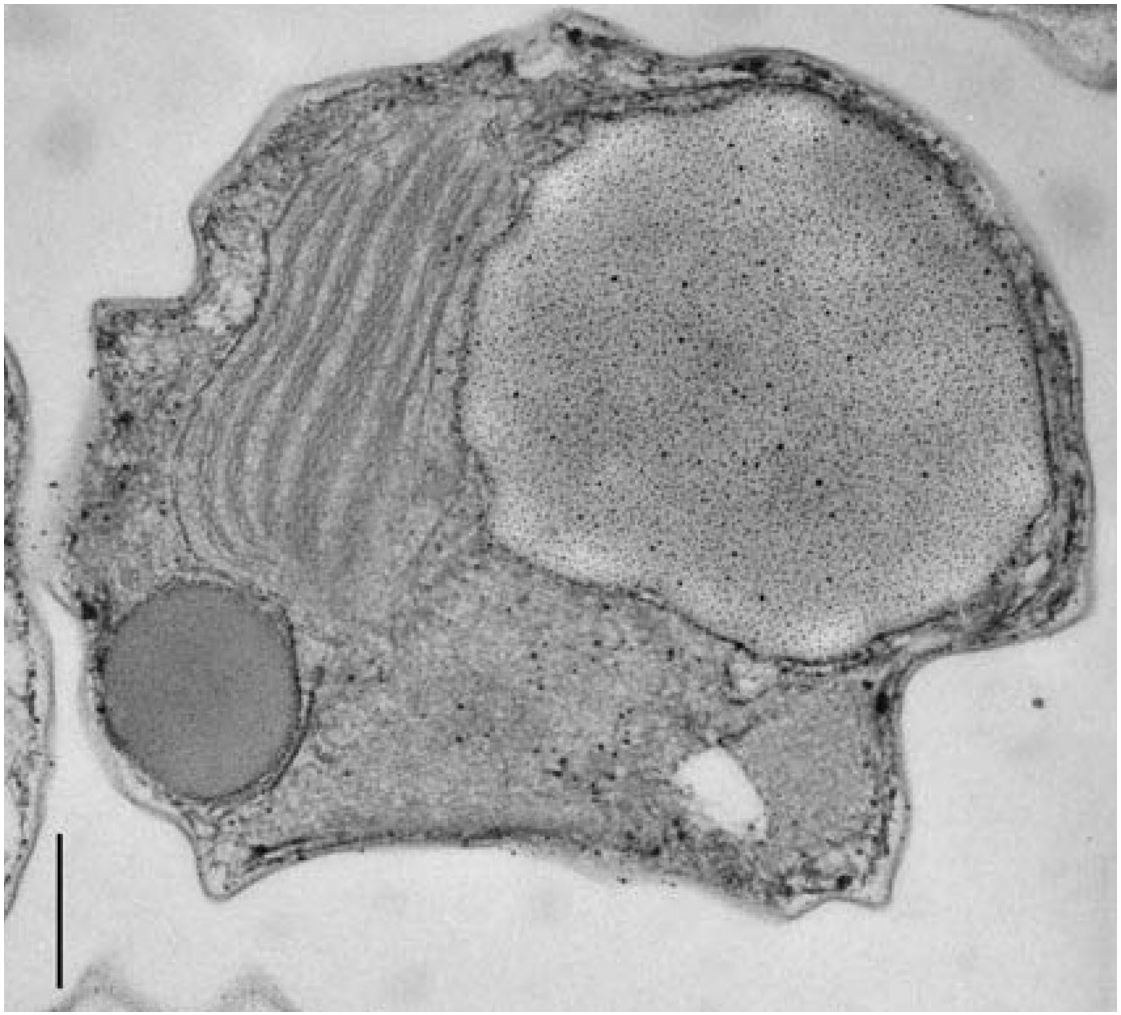
4. Mammal epithelial cell



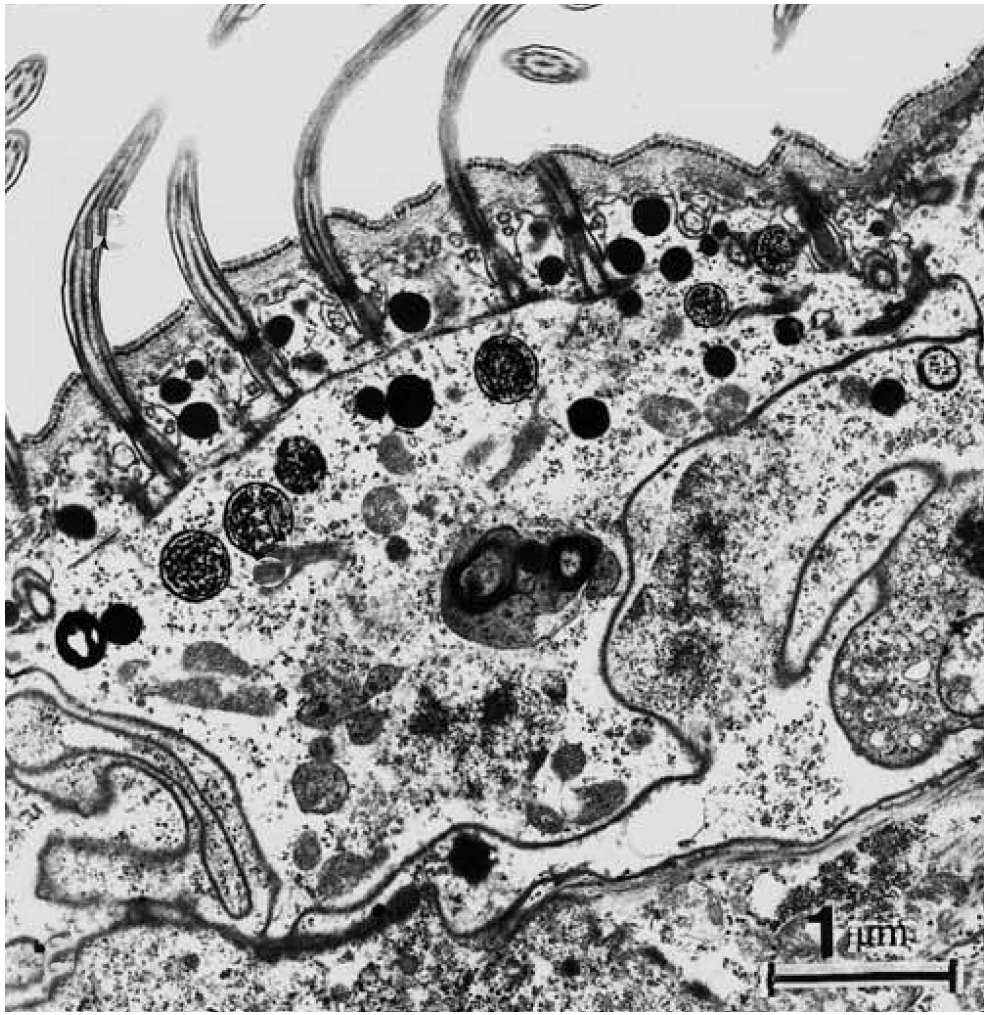
5. *Euglena*, unicellular protist



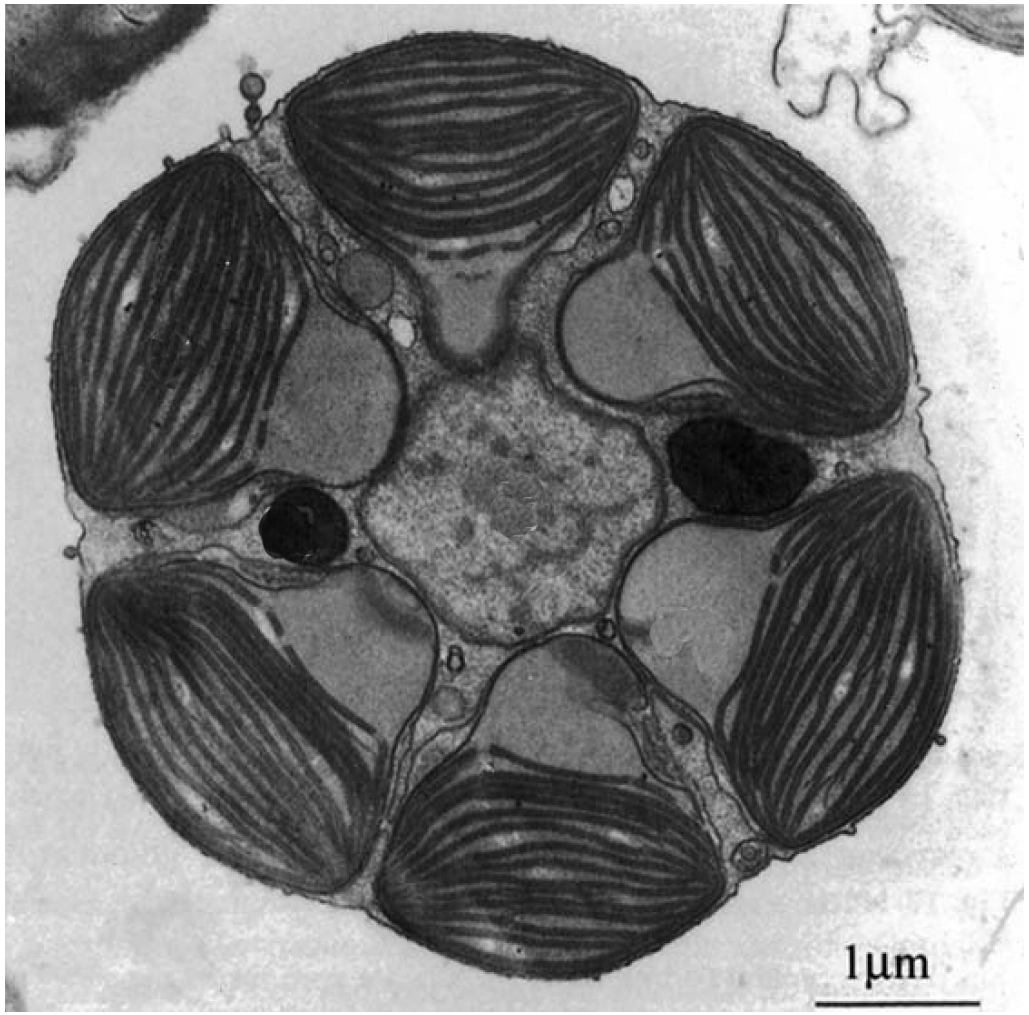
6. *Nannochloropsis*, unicellular alga



7. Surface cells or Orthonectida parasitic worm

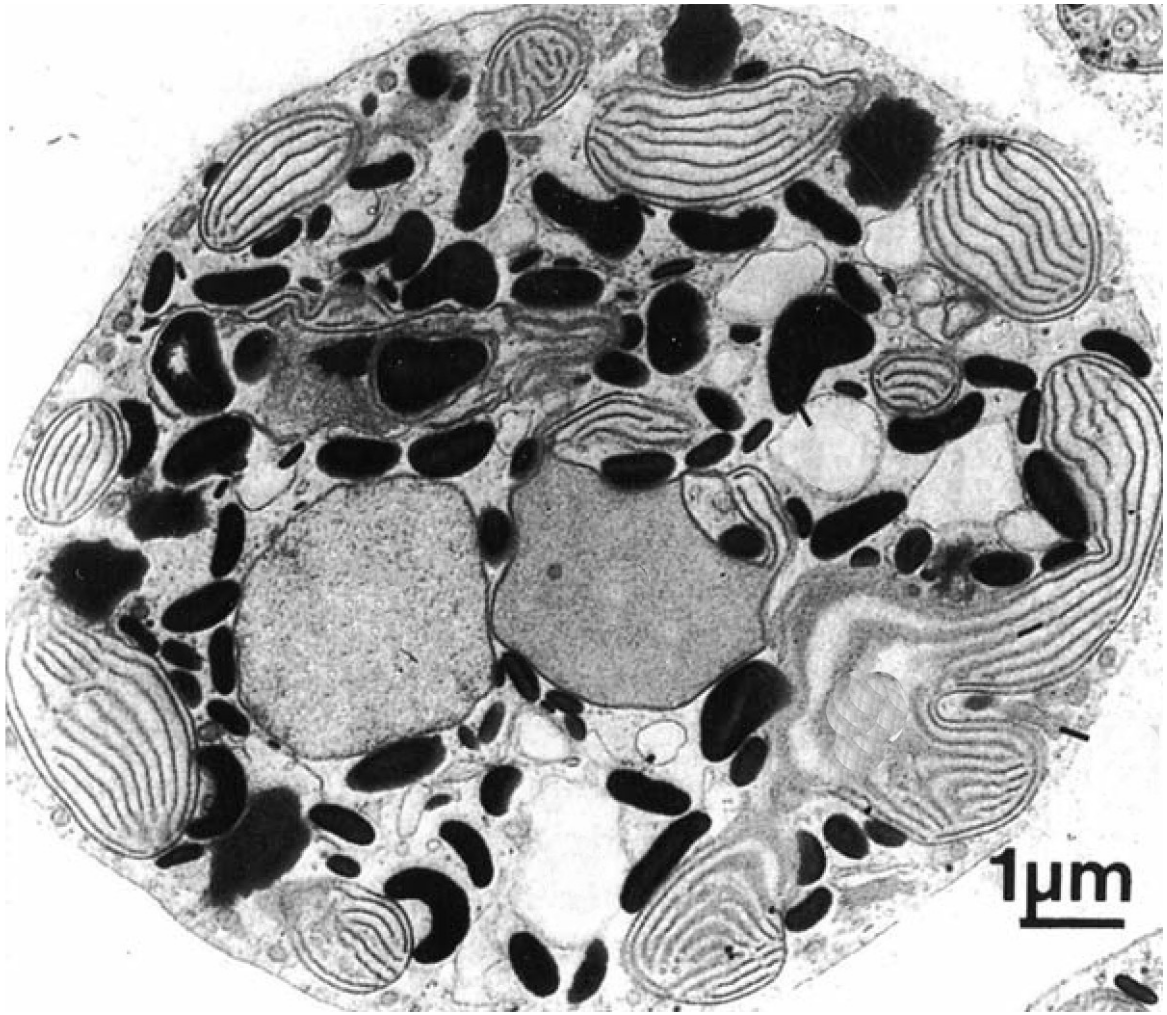


8. *Pedinella*, unicellular alga

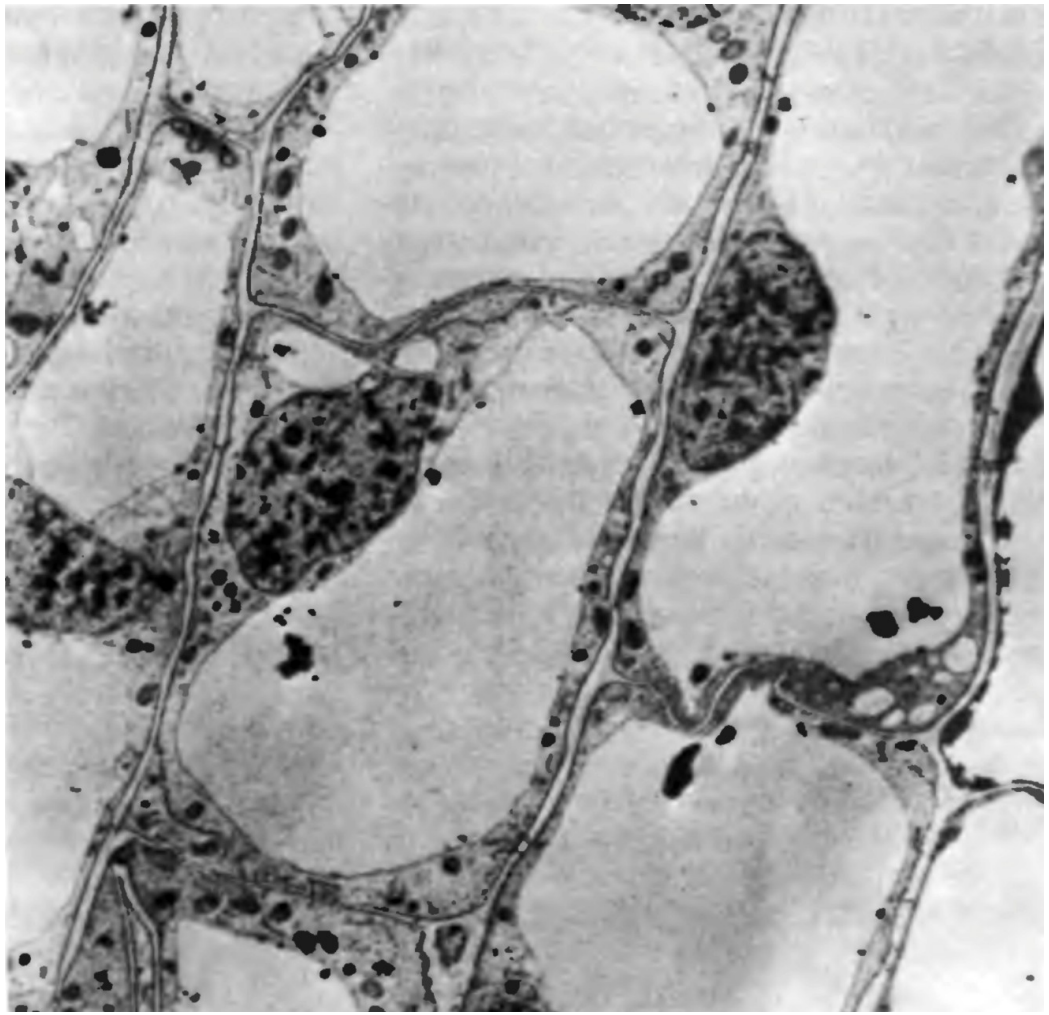


9. Plant meristem cell from onion root

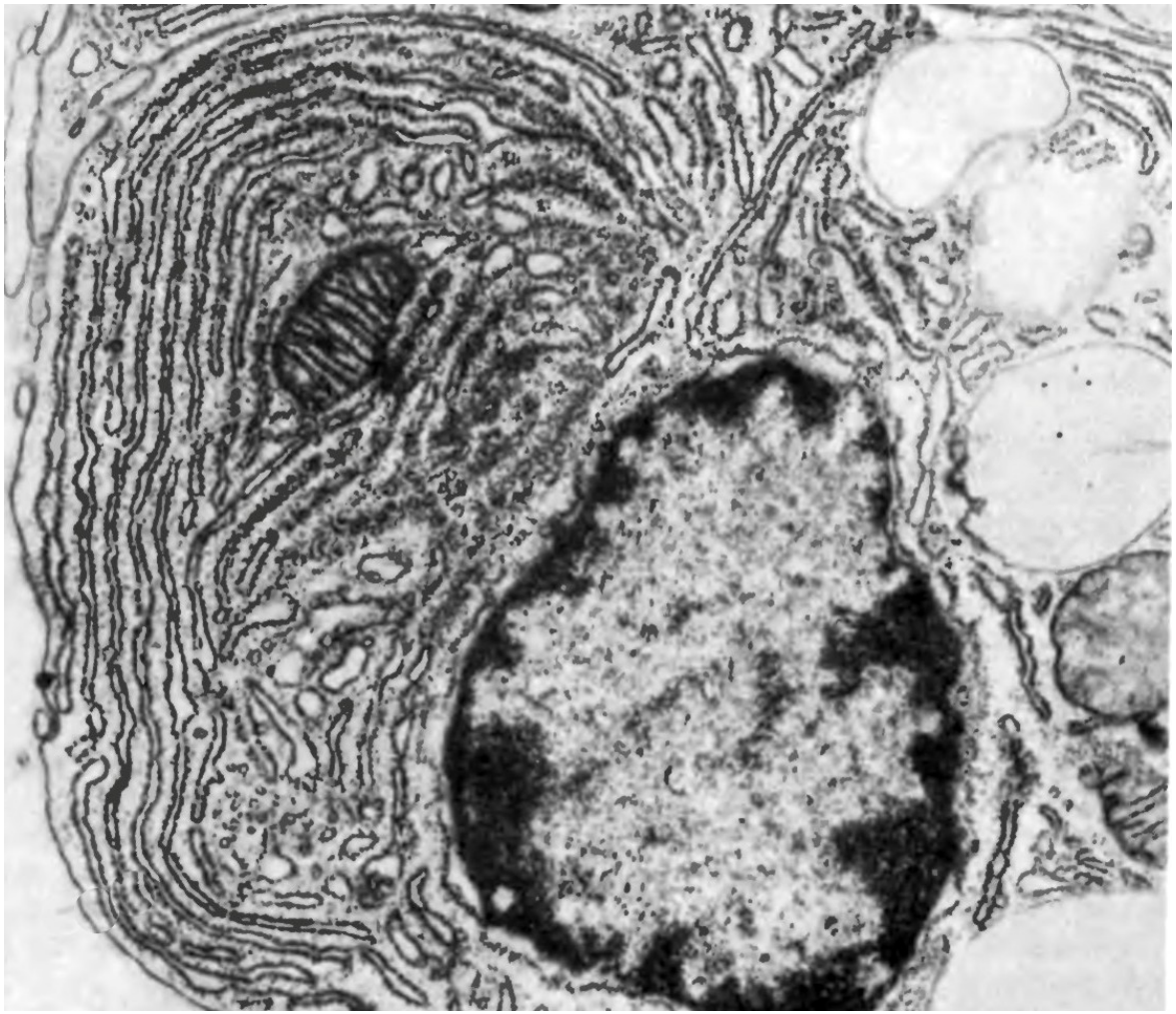
10. *Rhodella*, red alga



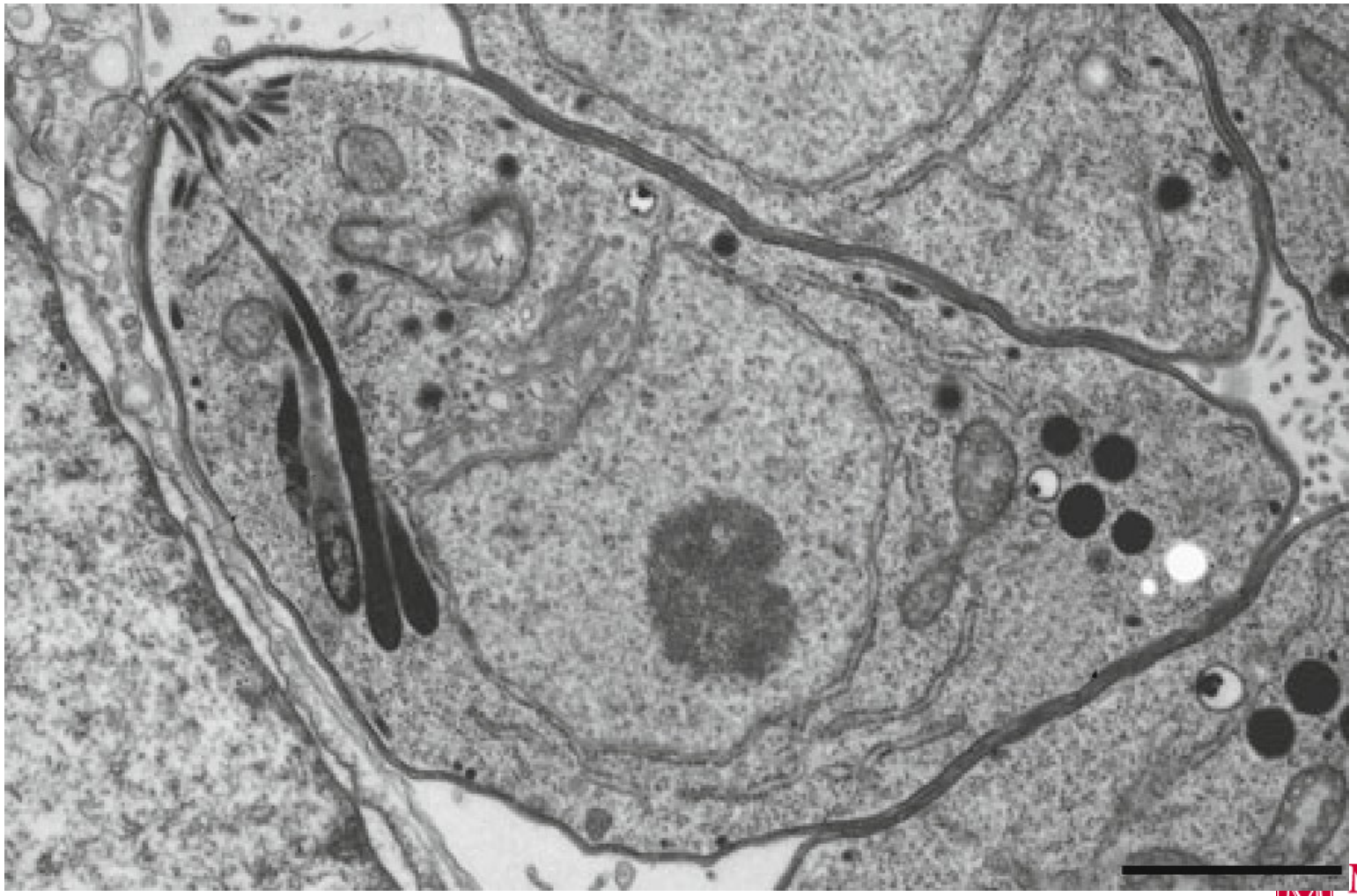
11. Plant root cell



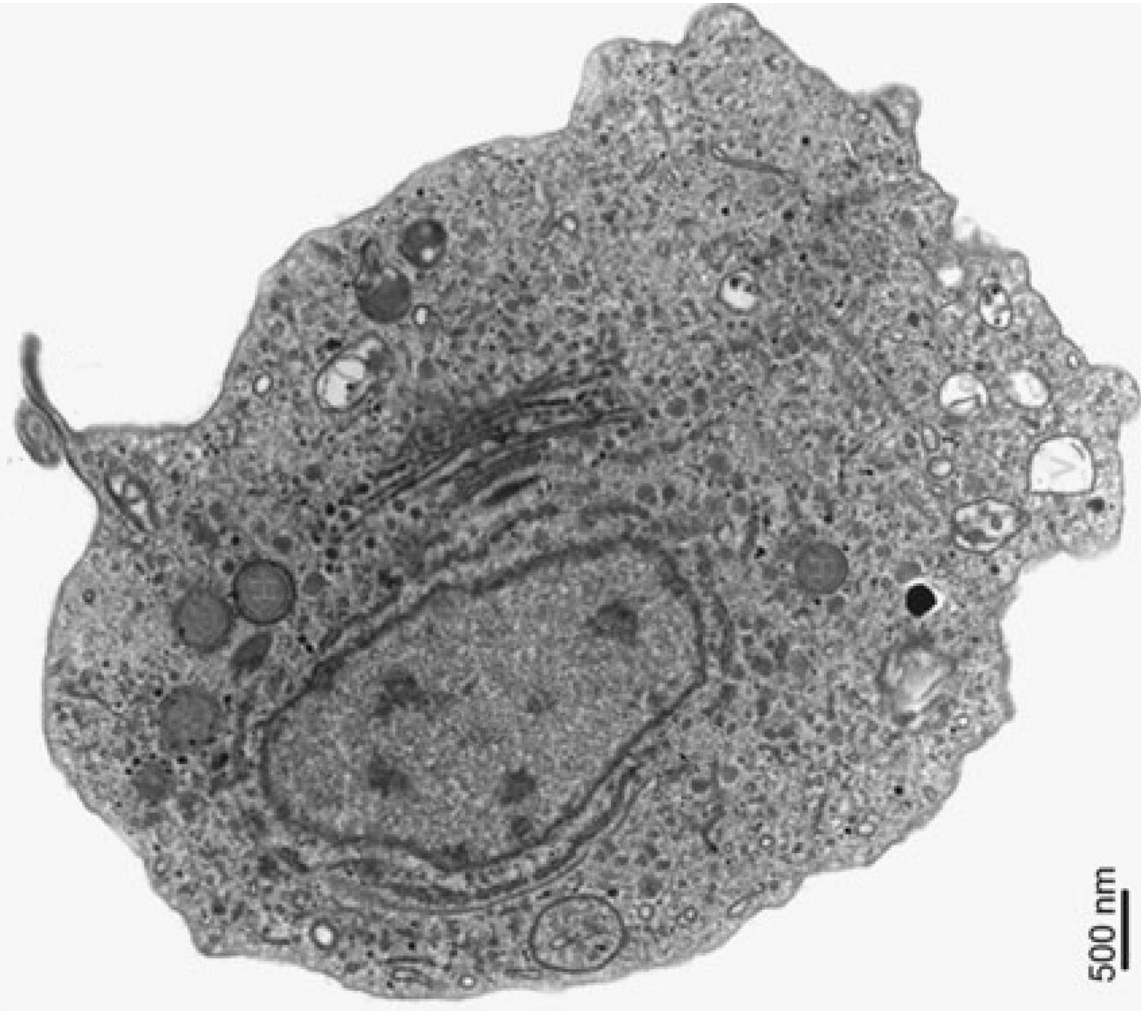
12. Stomach cell of rat (*Rattus*)



13. *Toxoplasma*, parasitic protist



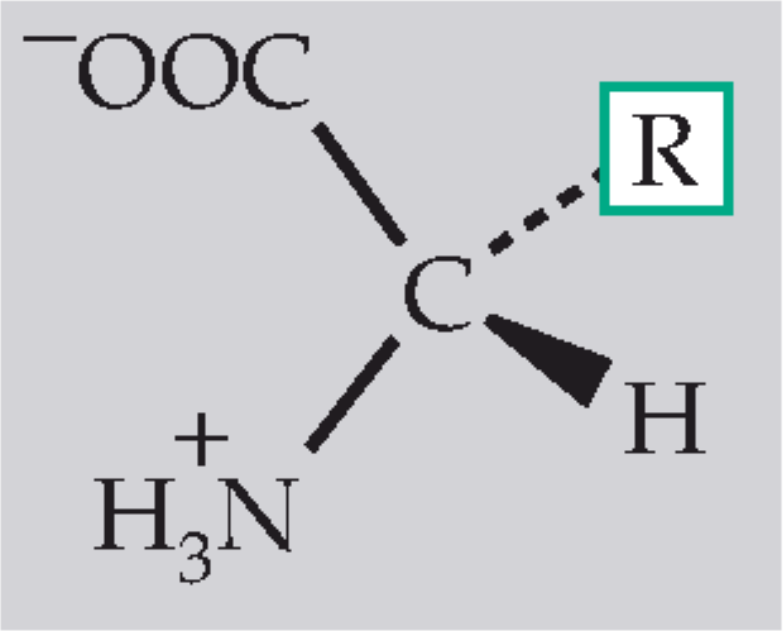
14. *Trichomonas*, parasitic amitochondrial protist



Structure

- Typical formula is $H_2NCHRCOOH$ where R is organic radical
- Amino group is normally attached to the first carbon in the chain: α-aminoacids

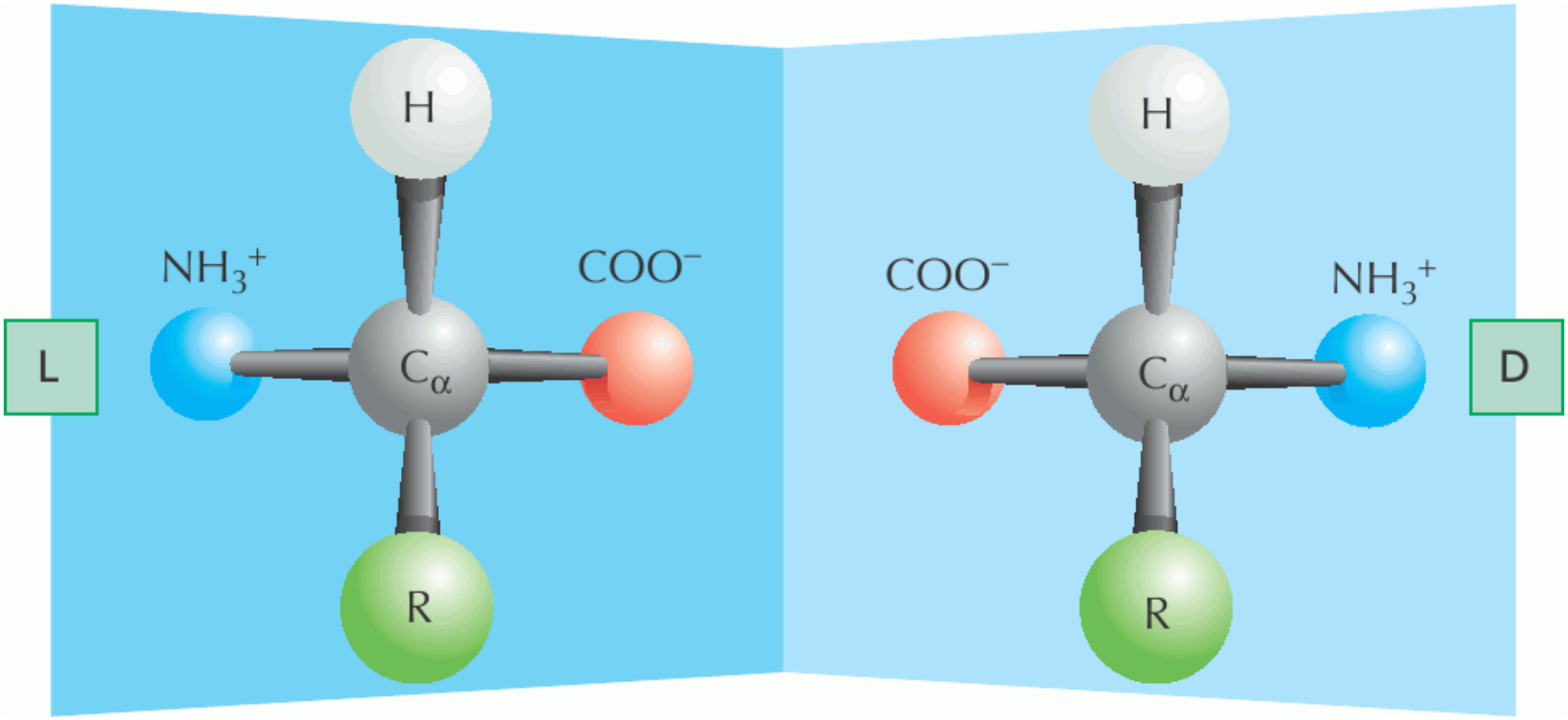
Amino acid



Isomerism

- α-carbon is an asymmetric atom
- Therefore, two optical isomers are possible
- However, in nature only L-isomers occur

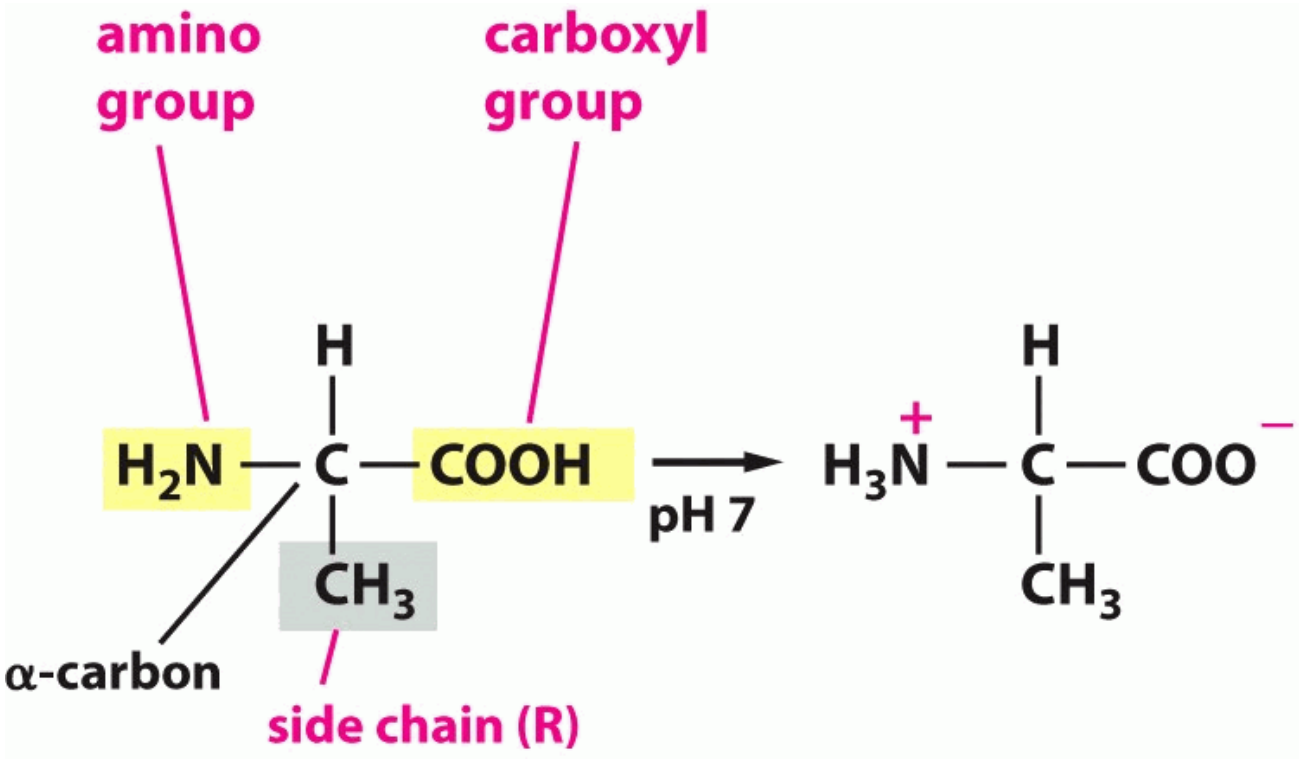
L- and D- isomers



Zwitterions

- If radical is neutral, amino acid could behave as both acid and base
- Many amino acids are present in water solution as **zwitterions**: polar structures similar to both acids and bases

Zwitterion


amino group
carboxyl group
H
H_2N — C — COOH
CH_3
α-carbon
side chain (R)
pH 7
H
H_3N^+ — C — COO^-
CH_3

Diversity: 20 standard and 2 additional

- Standard amino acids are structural units of proteins; they are encoded via DNA triplets
- There are exactly 20 standard amino acids
- In addition, there are two amino acids (selenocysteine and pyrrolysine) which may be coded in deviated genetic codes of some organisms

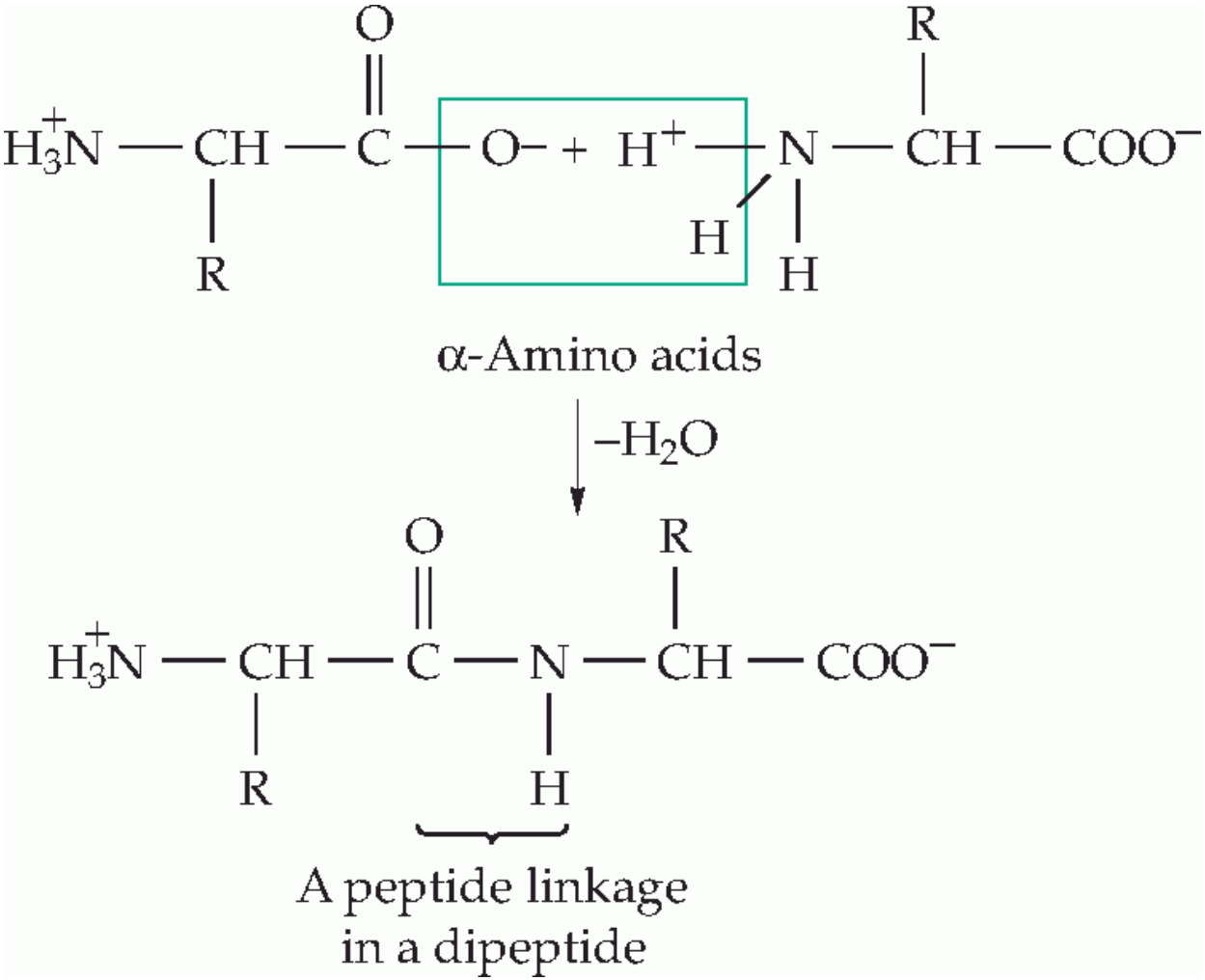
Essential and non-essential

- Essential amino acids could not be synthesized in human body
- Non-essential amino acids are derivatives of essential
- In all, there are eight essential amino acids:
  1. Isoleucine
  2. Leucine
  3. Lysine
  4. Methionine
  5. Phenylalanine
  6. Threonine
  7. Tryptophan
  8. Valine

Peptide bonds

- Amino acids may group together in peptides via peptide bonds
- This is **reaction of condensation**, it results also in one water molecule

Reaction of condensation



Roles

- Most important: components of peptides and proteins
- Many are intermediate stages of different biosynthetic processes, e.g.:
  - *Tryptophan* is a precursor of the neurotransmitter *serotonin*
  - *Aspartate*, *glycine* and *glutamine* are precursors of nucleotides

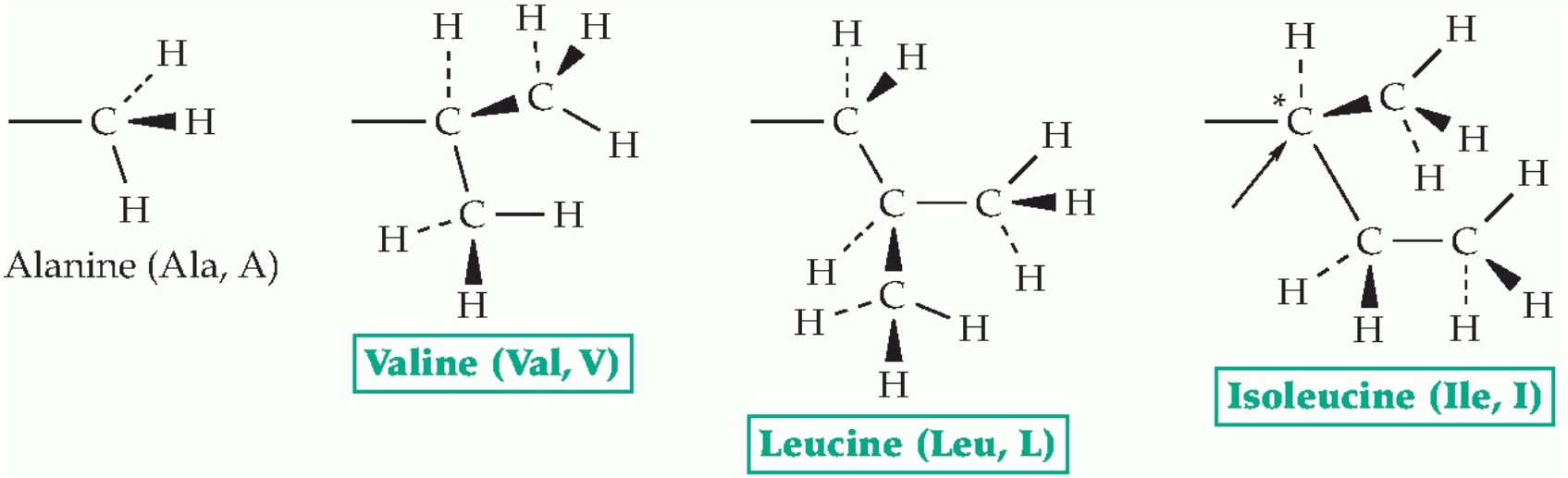
Amino acid diversity by groups: glycine

- Simplest amino acid
- “R” is simply H in case of glycine

Alkyls

- Have hydrocarbon groups as radicals
- Hydrophobic and therefore involving in protein shaping

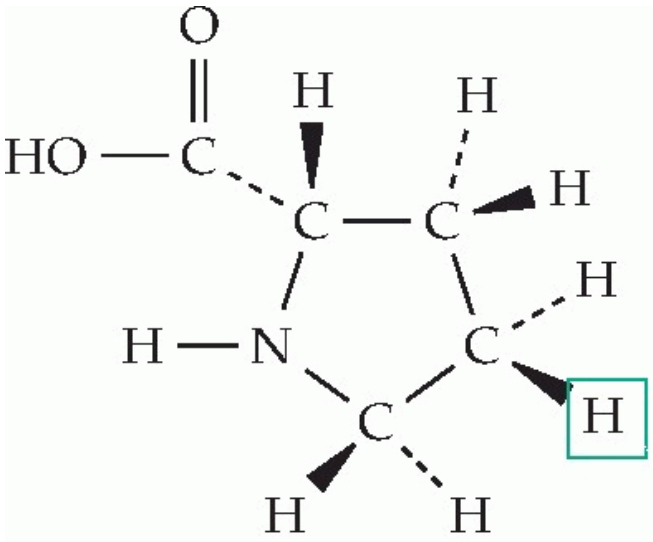
Alkyl amino acids



Imines

- Not an amino acids in a strict sense because there are no α-carbon
- Molecule is rigid and influence protein folding

Imines



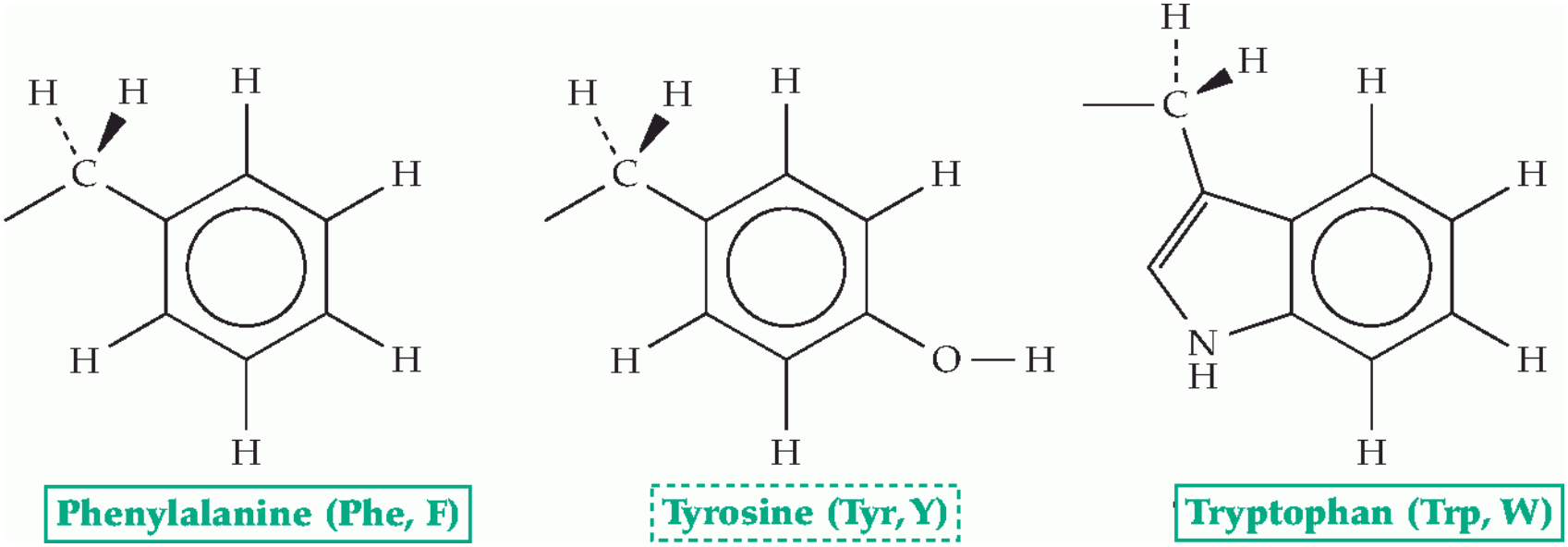
Proline (Pro, P)

H replaced by —OH in hydroxyproline (Hyp) which occurs in collagen

Aromatic

- Contain benzene groups
- May form hydrophobic bonds

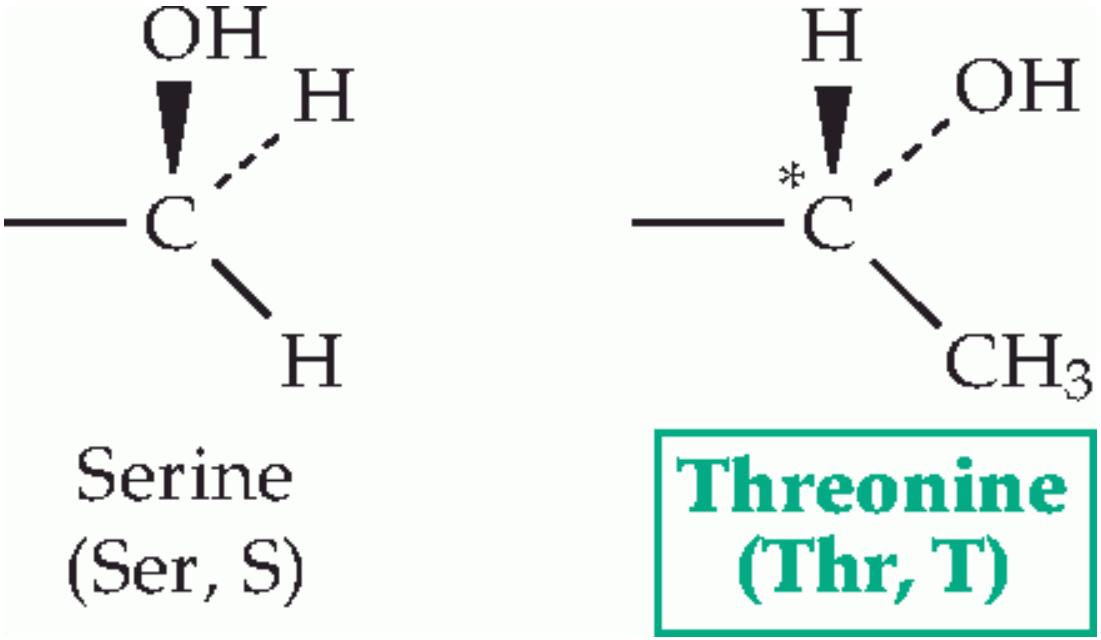
Aromatic amino acids



Alcohols

- –OH group is very weakly acidic
- May form active centers of some enzyme proteins

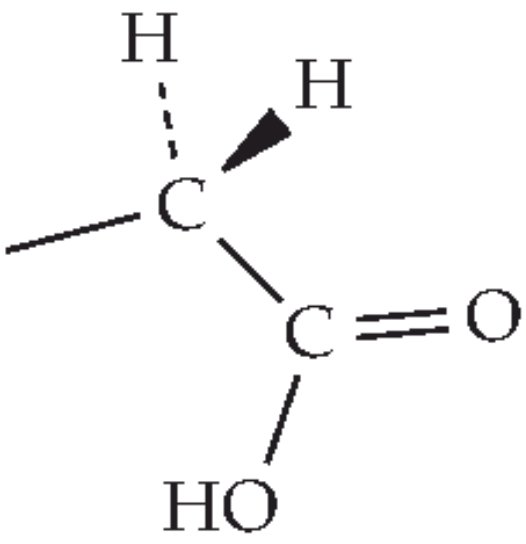
Alcohol amino acids



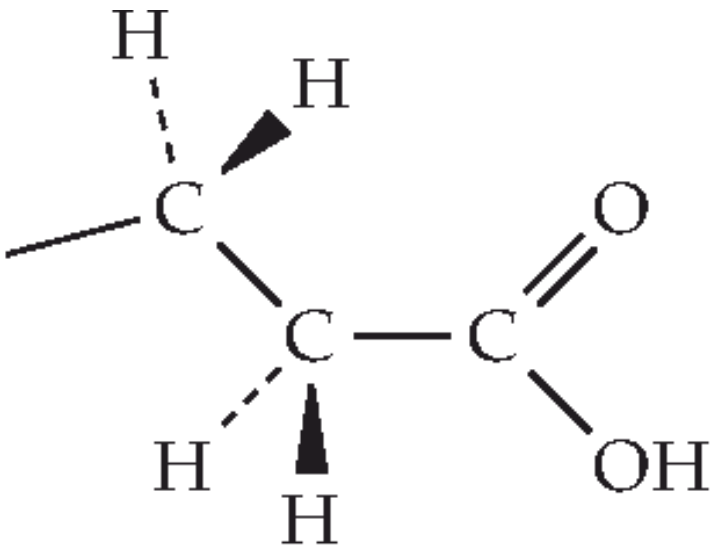
Acidic

- Weak acids
- Provide anionic (–) groups on the surface of proteins

Acidic amino acids



Aspartic acid (Asp, D)

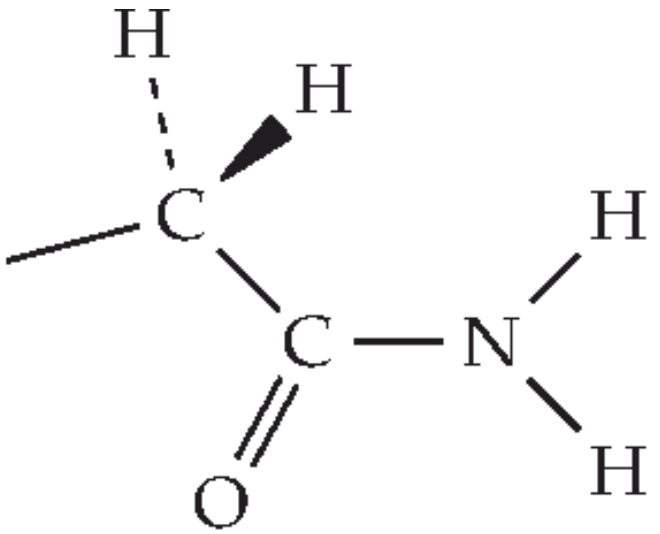


Glutamic acid (Glu, E)

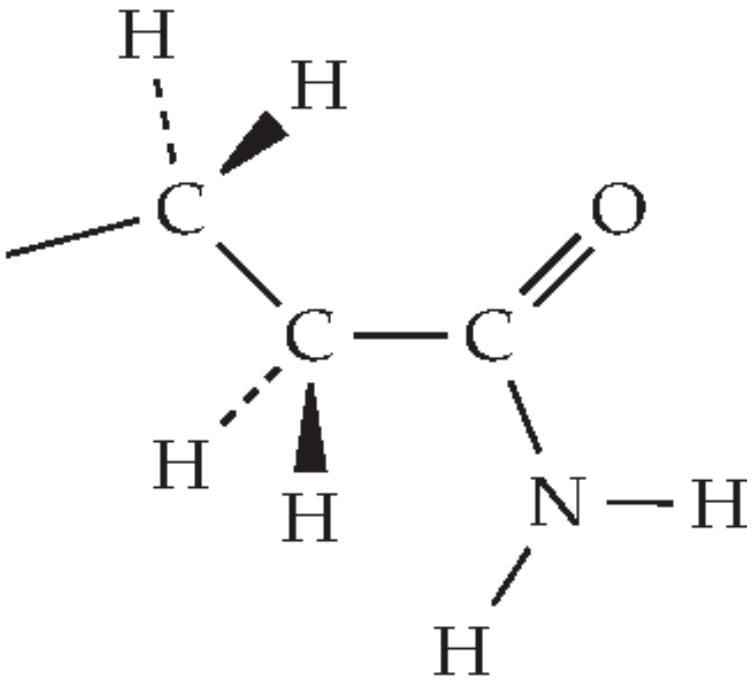
Amidic

- Contain amide group –CONH
- Not acidic, but polar and therefore participate in hydrogen bonding

Amidic amino acids



Asparagine (Asn, N)



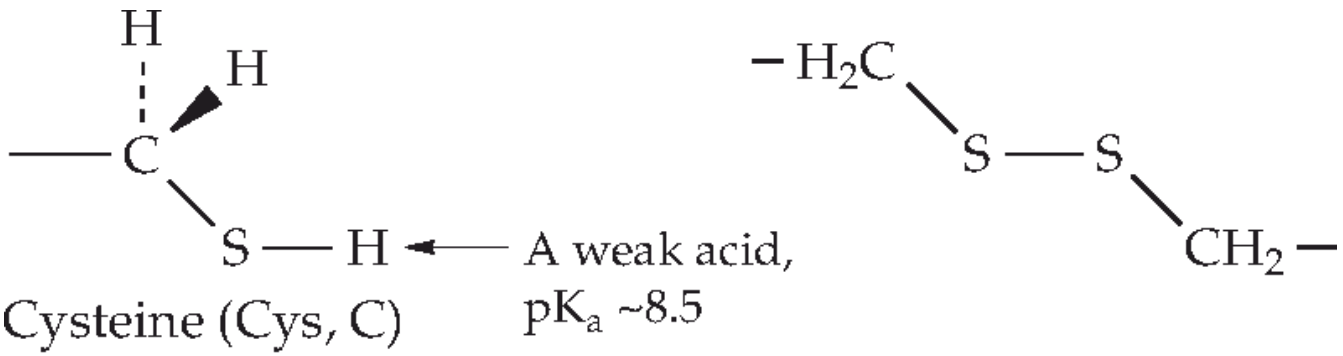
Glutamine (Gln, Q)

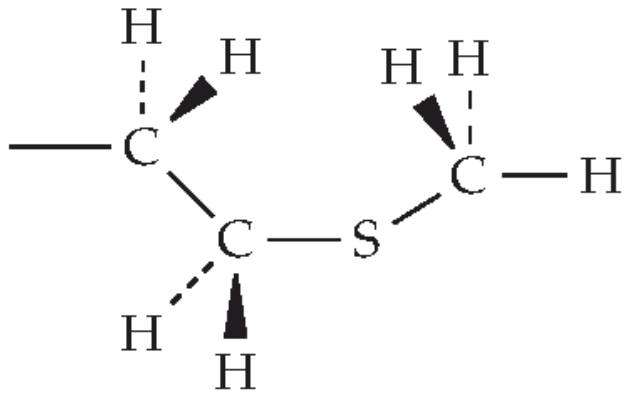
Sulfur-containing

- Two –SH groups of cysteine may form **disulfide bridge** between different parts of protein molecule

Disulfide bonds video

Sulfur-containing amino acids





Methionine (Met, M)

Final question (1 point)

Final question (1 point)

Name one of essential amino acids

Summary

- There are 20 standard amino acids classifying in 9 groups
- Since amino acids are extremely diverse, they produce infinite numbers of protein 2D and 3D structures

For Further Reading

A. Shipunov.
Advanced Cell Biology [Electronic resource].
2011—onwards.
Mode of access: http://ashipunov.info/shipunov/school/biol_250

B. Alberts et al.
Essential Cell Biology. 3rd edition.
Garland Science, 2009.
Chapter 2: Molecules in cells, Panel 2-5.