Introduction to Botany

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Lecture 6

Outline

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Questions and answers

Quiz

Quiz question (2 points)

What is a molecular weight of hydrochloric acid, HCl?

Quiz question (2 points)

What is a molecular weight of hydrochloric acid, HCl?

$1 + 35 = 36$ atomic units (not grams!)

Basics of life
Molecules of life

Concentration of protons, and pH and acidity

- If concentration of protons is 0.1 M (1×10^{-1}, 0.1 g of protons in 1 l of water), this is an extremely acidic solution
- In distilled water, concentration of protons is equal to 1×10^{-7} (0.0000001) M
- This is because water molecules can (rarely) dissociate: $H_20 \rightarrow H^+ + OH^-$
- pH of distilled water is equal to $-\log(10^{-7}) = -(-7) = 7$
- pH of the extremely acidic solution (first example) is 1

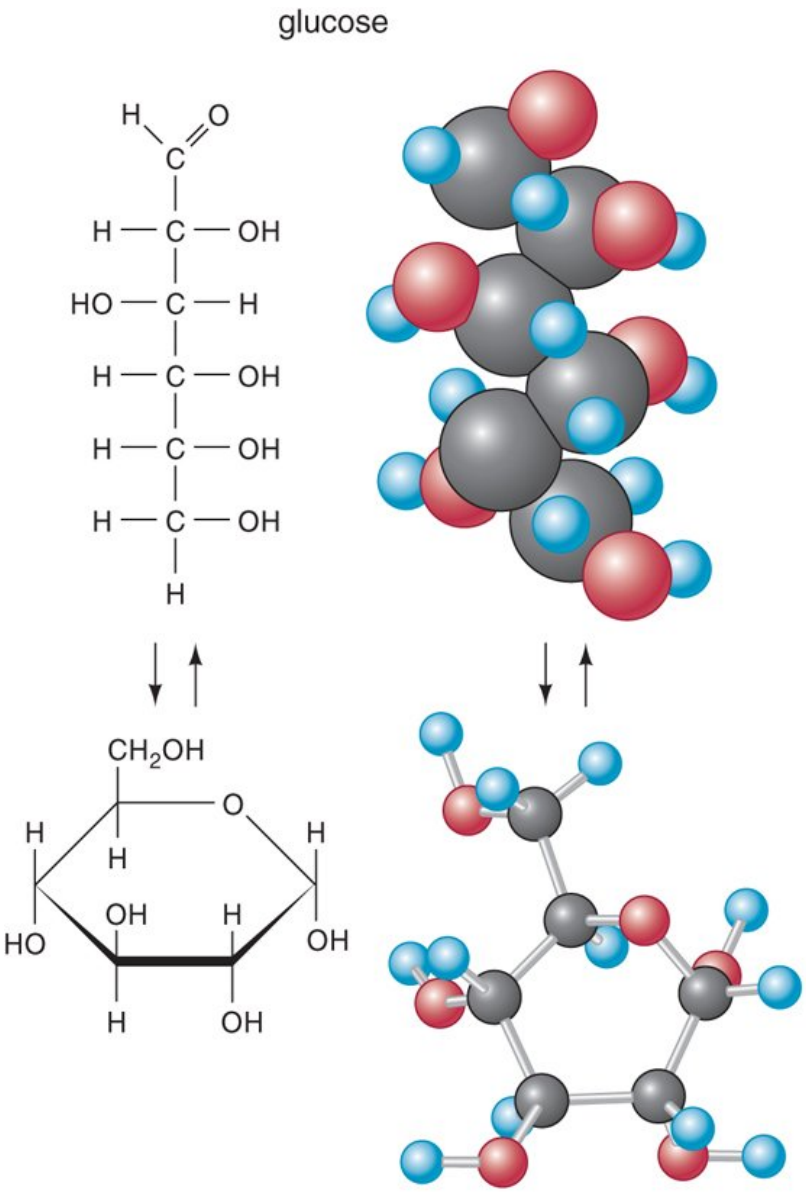
Organic chemistry: chemistry of carbon

- Carbon skeleton
- And H, O, N, P, S

Four types of biomolecules

- Lipids: hydrophobic
- Carbohydrates (sugars): multiple $-$OH groups
- Amino acids: N + C + O and hydrogen
- Nucleotides: cycle with nitrogen (heterocycle), sugar and phosphoric acid

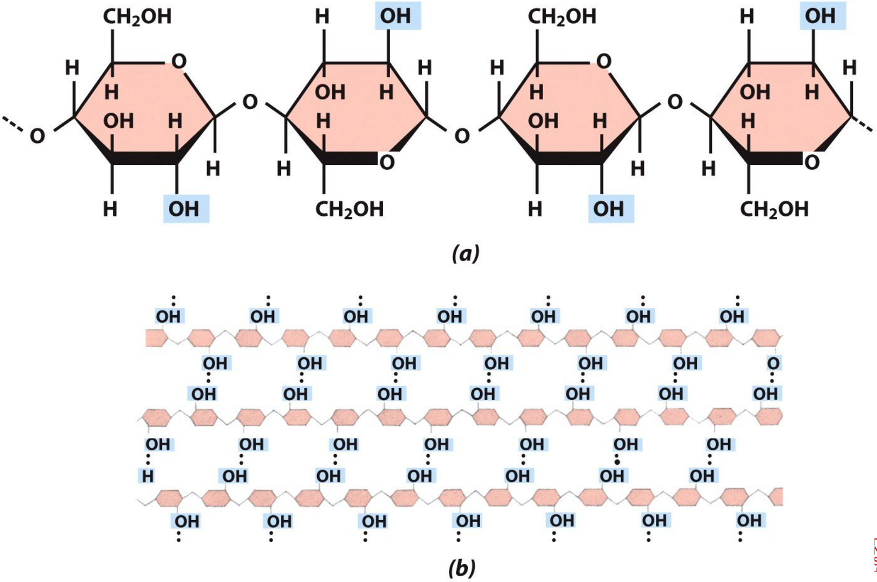
Carbohydrates



Organic polymers

- Polymeric carbohydrates: polysaccharides (like cellulose and starch)
- Polymeric amino acids: proteins
- Polymeric nucleotides: nucleic acids (DNA and RNA)

Cellulose



Summary

- Most important bonds: polar and non-polar covalent (intramolecular) and hydrogen (intermolecular)
- Obligatory biogenic elements: C, H, O, N, P
- Most important monomers: lipids, carbohydrates, amino acids, nucleotides
- Most important polymers: polysaccharides, proteins, nucleic acids

Photosynthesis

History of photosynthesis studies

van Helmont

- Johannes van Helmont (17th century) rejected the idea that plans take most of their biomass from soil
- Willow (*Salix* sp.) tree of 2.27 kg grew to 67.7 kg in five years, but weight of soil decreased only by 57 g
- van Helmont concluded that plants take most of their weight from water

Pristley

- Famous Joseph Pristley in 1772, made series of experiments with mouse, candle and sprig of mint (*Mentha* sp.)
- Mouse behave similar to candle, they both “spent” air
- Plant revives the air for both candle and mouse

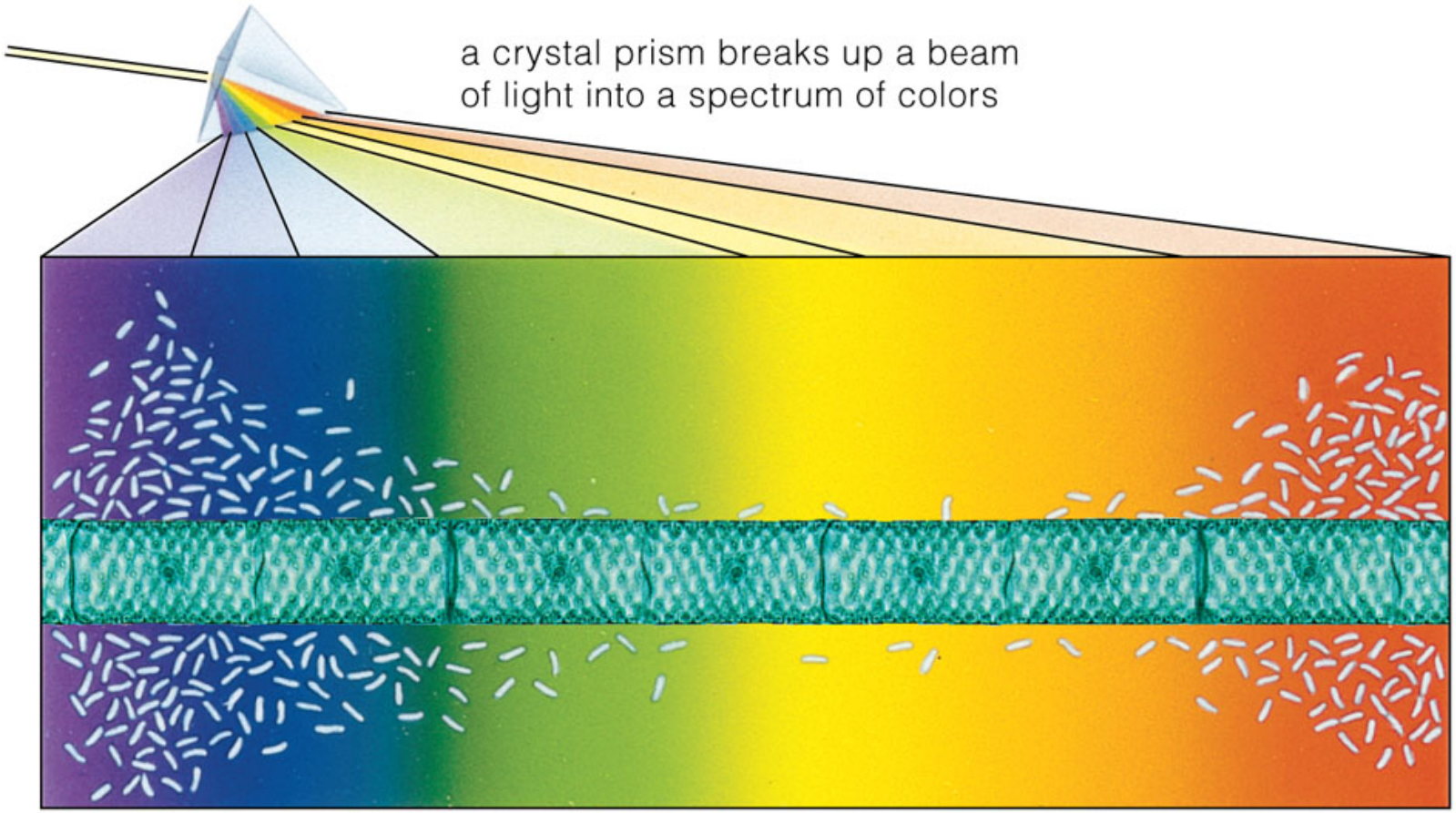
Further history

- Jan Ingenhousz (1779–1796) and Jean Senebier (1780) found that:
  - Only in day time the air is reviving
  - CO_2 is assembled
- Antoin-Laurent Lavoiser (1783) found that the “revived air” is a separate gas, **oxygen**

Engelmann

- Thomas Engelmann in 1884 found that *Spirogyra* alga produce oxygen mostly in blue and red parts of spectrum
- Therefore, the key photosynthetic pigment should accept blue and red rays and reflect green rays
- Chlorophyll fits best to this description

Experiment of Engelmann



Light and enzymatic (“dark”) reactions

- Light reactions depend on the light and water, they produce oxygen and energy (in form of ATP)
- Enzymatic reactions depend on carbon dioxide and water, they take energy from light reactions and result in production of carbohydrates

Final question (2 points)

Final question (2 points)

Why did Engelmann decide that photosynthetic pigment has a green color?

Summary

- Main biogenic elements: C, H, O, N, P
- Most important monomers: lipids, carbohydrates, amino acids, nucleotides
- Most important polymers: polysaccarides, proteins, nucleic acids
- From 17th century, in constantly become clear that plants make their biomass from light, water and carbon dioxide

For Further Reading

A. Shipunov.
Introduction to Botany [Electronic resource]. newblock Mode of access:
`http://ashipunov.info/shipunov/school/biol_154`

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