# Biologische Physik

## Kapitel 1

# Grundlagen der Biologischen Physik

Wahlpflichtfach: H. Stark

**Physikal. Konzepte "weiche Materie"** ⟷ **Biolog. Phänomene**

lebende Organismen: kT

=

4 × pN × nm

weiche Materie Nanowelt

**Inhalt:**

1. Einleitung:

   "Leben" ⟷ fernab vom thermodyn. GG

2. Bausteine des Lebens:

   Zellaufbau, DNA, ATP, Proteine, Ionenpumpen, Enzyme, Motoren

3. Thermische Bewegung und "Kinetik"

   ⟷ Geschichte der Vererbungslehre

4. Zufallswege, Reibung und Diffusion

   ⟷ DNA (Polymer), Membran−Durch−lässigkeit, −Potentiale (Nervenleitung)

5. Hydrodynamik (kleine Reynoldszahlen)

   ⟷ Fortbewegung von Zellen, Transport von Flüssigkeit / in Gefäßen

6. Thermodynamik und Statistische Mechanik

   ⟷ Faltung von RNA als 2−Niveau−System

7. Entropische Kräfte, Osmose, Wasserstoffbrücken

   ⟷ "molecular crowding", Membran−potentiale, Wasser und Leben

8. Chemische Reaktionen und "Kraefte"

   ⟷ Selbst−Aggregation, Membranen und Proteinfaltung

9. Makromoleküle als mechan. Objekte (Isingmodell)

   ⟷ Elastizität von Biopolymeren (DNA), "molekulares Schalten"

10. Smoluchowski−Gl., Kinetik von Reaktionen

    ⟷ molekulare Maschinen & Enzyme

11. Elektroosmose

    ⟷ Ionenpumpen in Membranen

12. Elektrische Netzwerke

    ⟷ Nervenzellen, Axone & Nervenimpulse

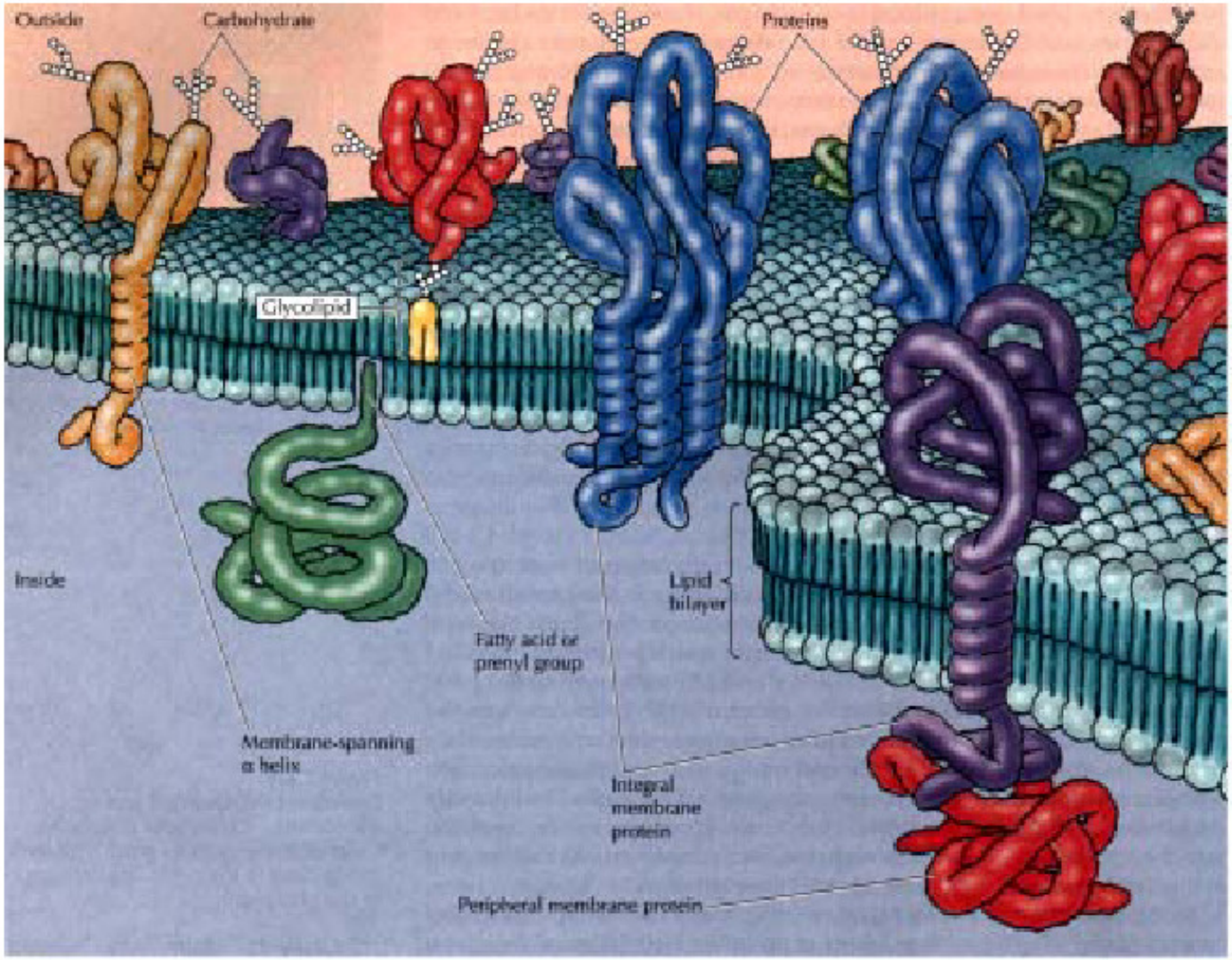
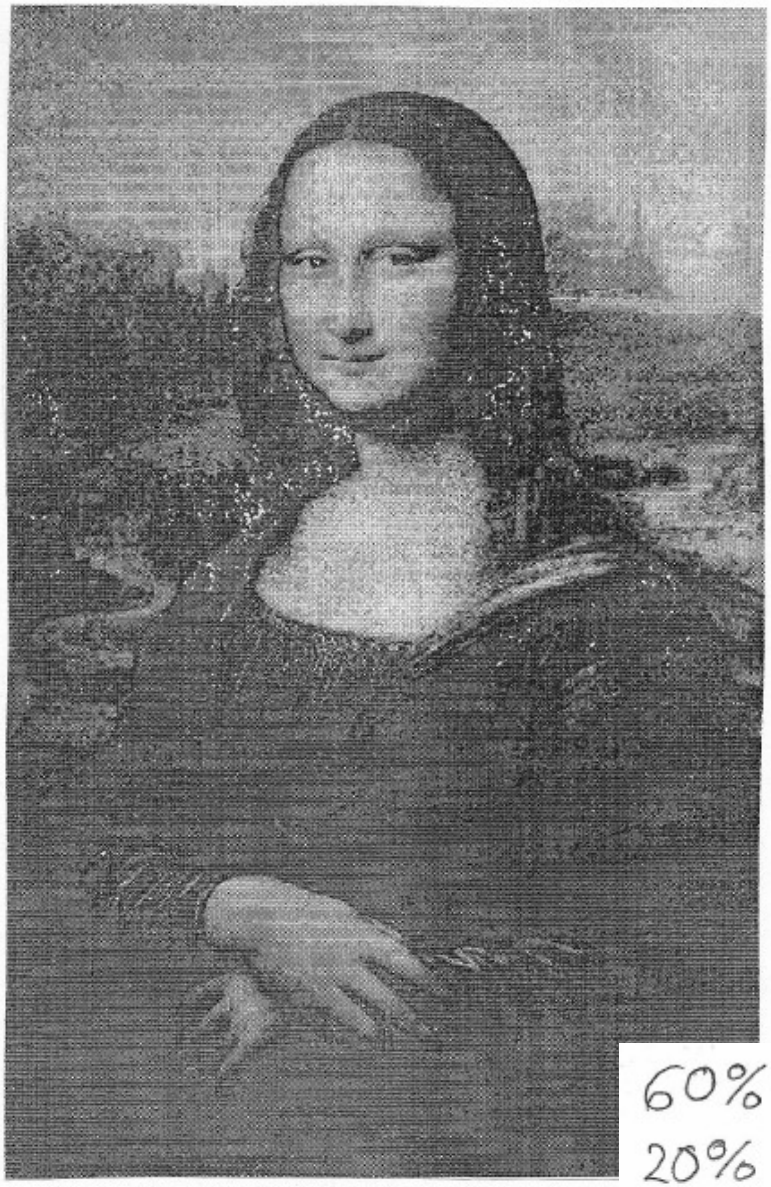
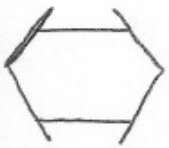



Figure 2.25: (Sketch.) Plasma membrane of a eukaryotic cell. The membrane consists mainly of proteins inserted into, or attached to, a bilayer of phospholipid molecules. Integral membrane proteins are embedded in the membrane, usually via short hydrophobic stretches. Some transmembrane proteins span the membrane only once; others have multiple membrane-spanning regions. Other proteins are anchored to the membrane by phospholipids that are chemically attached to the protein. Still other proteins can be anchored to the outer face of the plasma membrane by glycolipids (lipids chemically attached to sugar chains) and to the inner face by fatty acids. Peripheral membrane proteins are not inserted in the membrane, but rather are indirectly attached, for example by attaching to an integral membrane protein as shown.

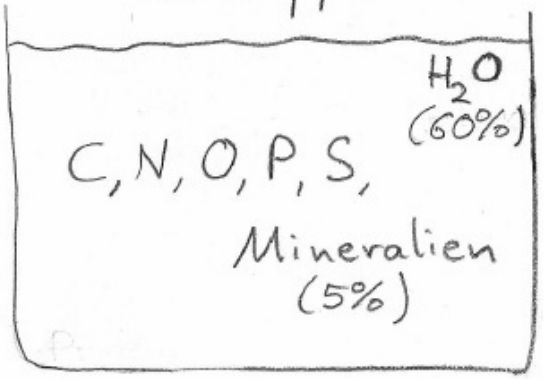
„Leben"



Ordnung



"Ursuppe" Mensch




Unordnung

60% $H_2O$
20% Proteine
15% Fette
5% Mineralien

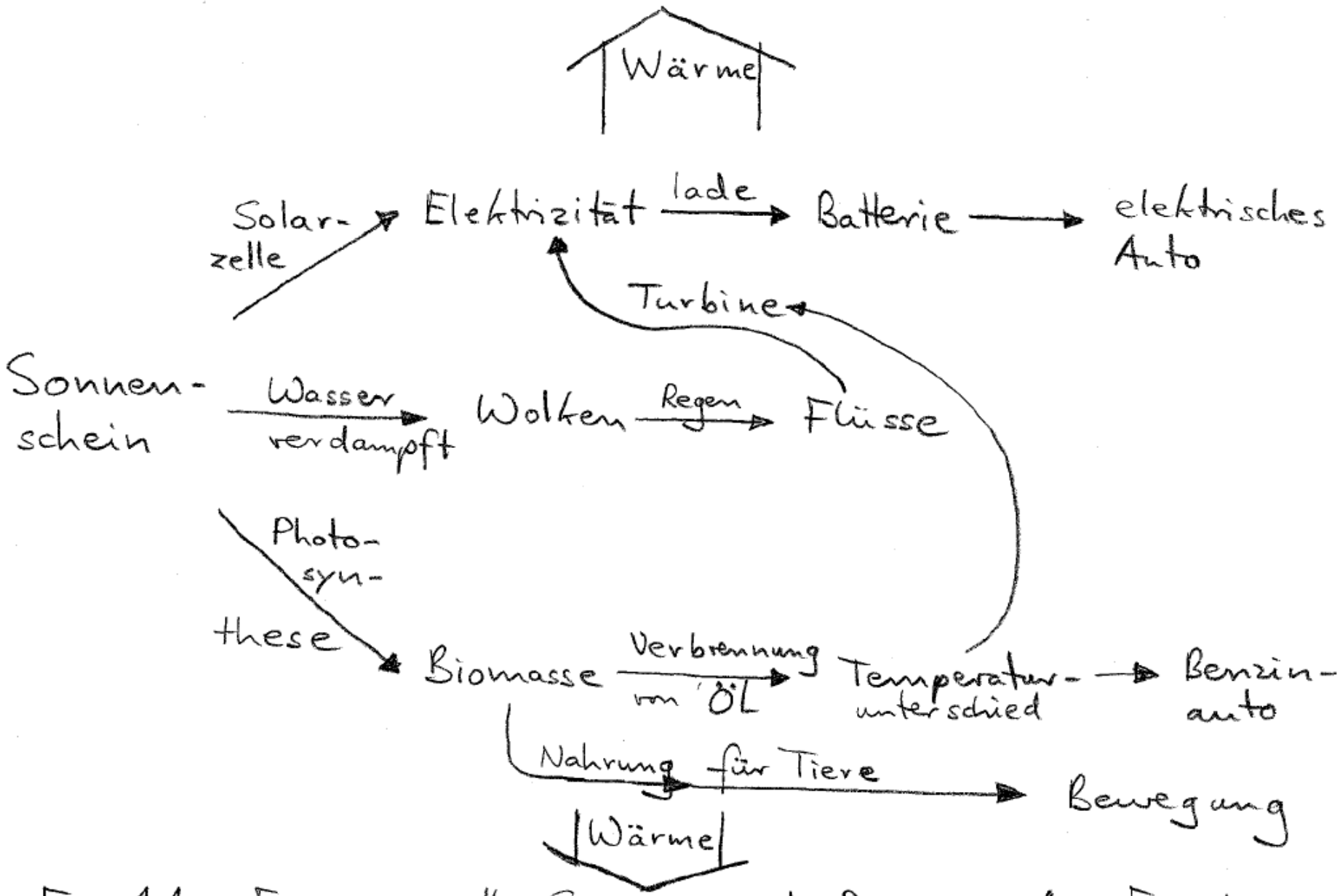
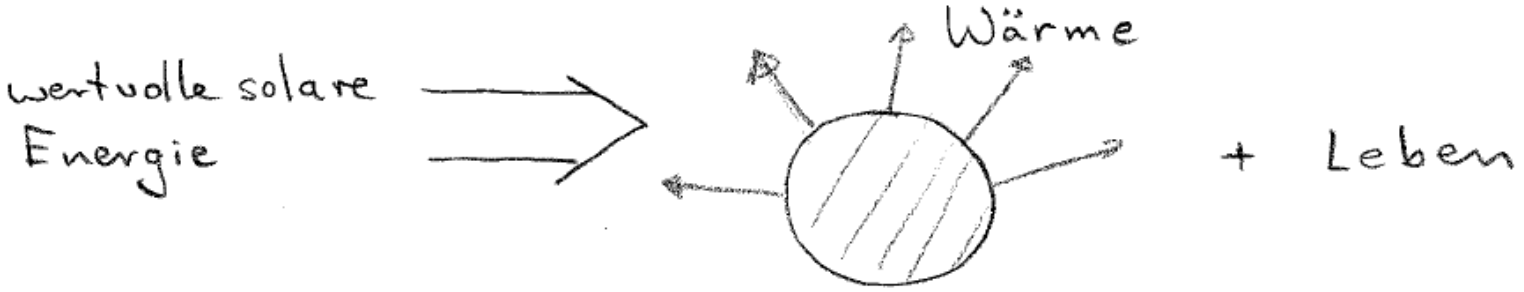
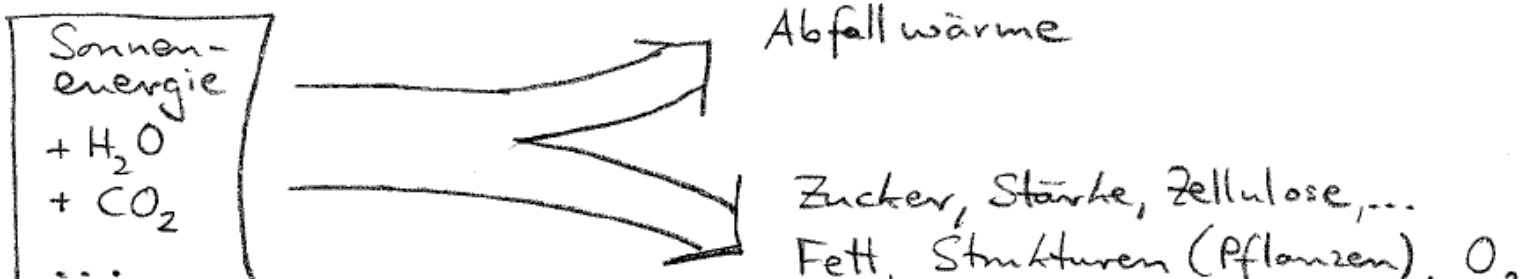



Fig. 1.1: Energiequelle Sonne und Prozesse der Energie-umwandlung (Pfeile)

a)




b) Pflanzen




Photosynthese: $6CO_2 + 12H_2O + \text{Sonne} \longrightarrow C_6H_{12}O_6 + 6O_2 + 6H_2O$

c) Tiere

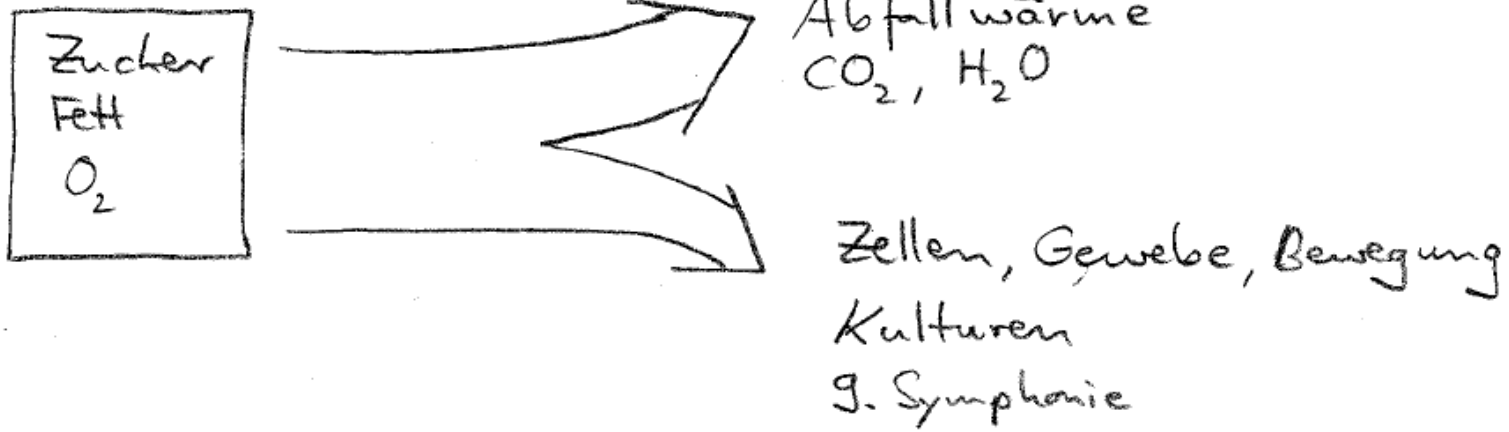
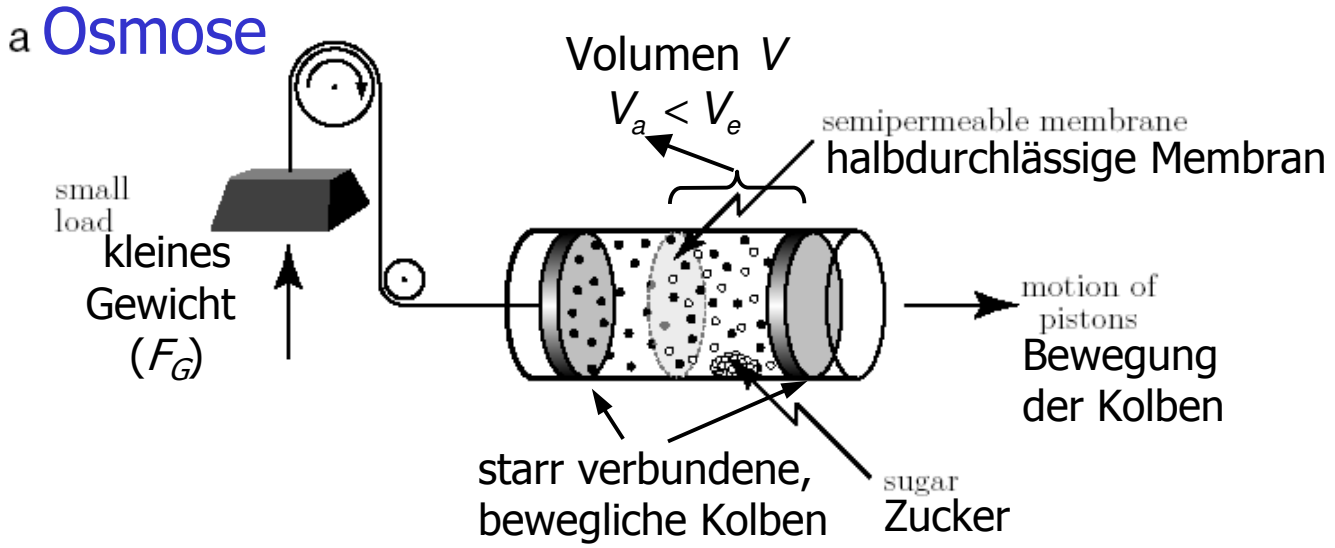
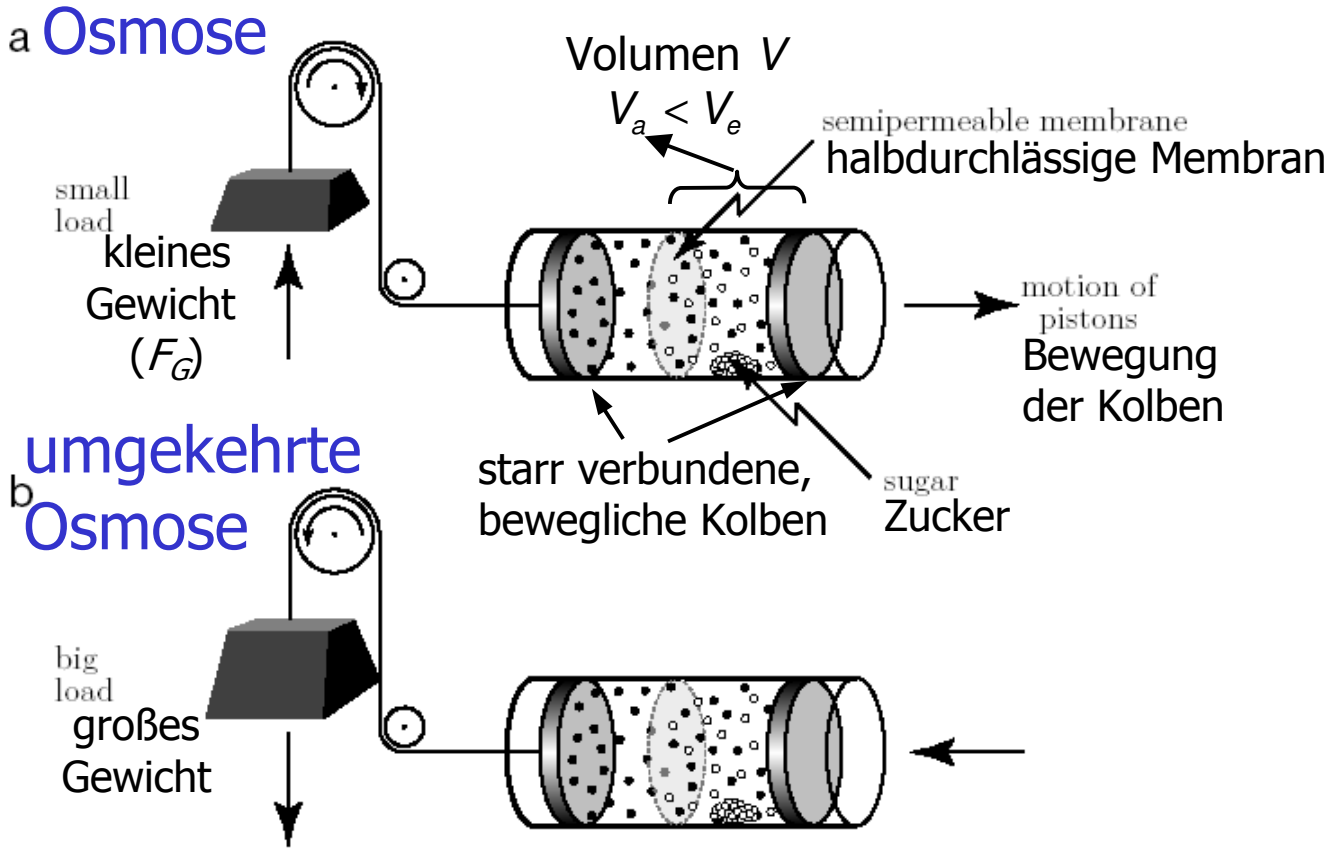



Fig. 1.2: Von Sonnenenergie zugeordneten Strukturen




1.3 (Schematic.) A machine transducing free energy. A cylinder filled with water is separated into two chambers by a semipermeable membrane. The membrane is anchored to the cylinder. Two pistons slide freely, thus allowing the volumes of the two chambers to change as water molecules (*solid dots*) cross the membrane. The distance between the pistons stays fixed, however, because the water between them is incompressible. Sugar molecules (*open circles*) remain confined to the right-hand chamber. (a) Osmotic flow: As long as the weight is not too heavy, when we release the pistons, water crosses the membrane, thereby forcing both pistons to the right and lifting the weight. The sugar molecules then spread out into the increased volume of water on the right. (b) Reverse osmosis: If we pull hard enough, however, the pistons will move to the *left*, thereby increasing the concentration of the sugar solution in the right-hand chamber and generating heat.

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