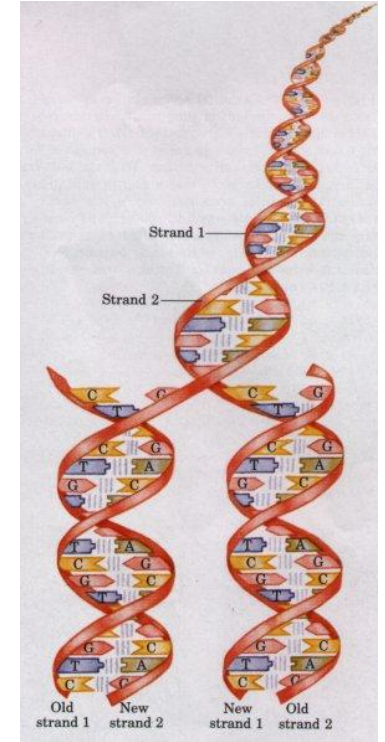
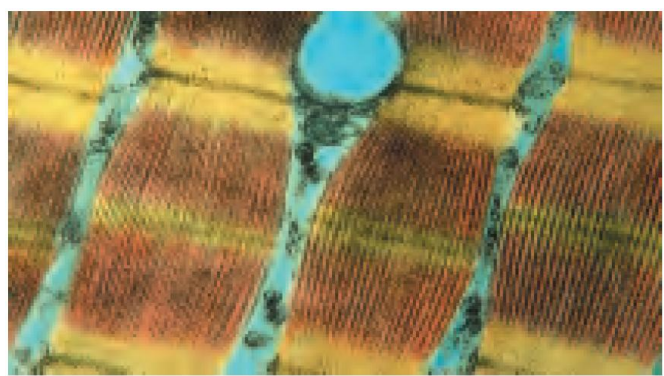


# The Chemistry of Life

BCHE 7200 Advanced Biochemistry I  
Lecture 1



# Biochemistry

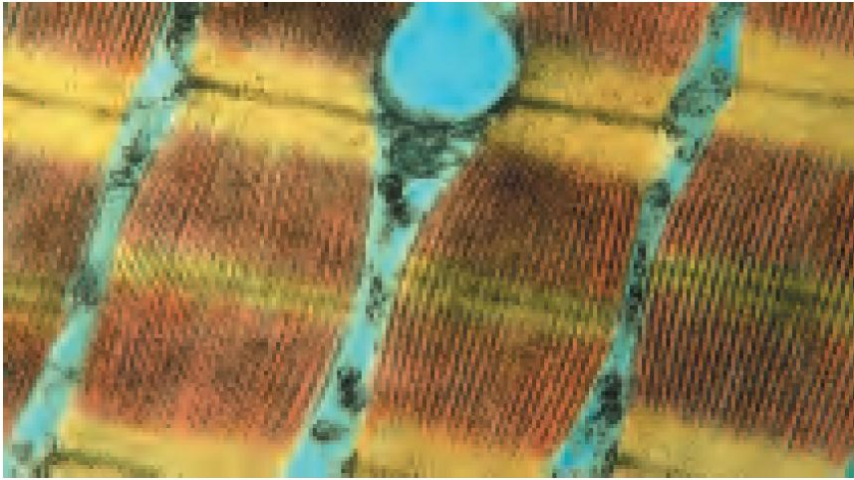
- The study of life on the molecular level.
- A molecule is a unit of matter composed of  $\geq 2$  atoms held together by covalent bonds.
- What is life?

# Biologically Relevant Elements

|          |          |          |   |          |          |          |          |          |          |          |          |          |          |          |          |          |          |
|----------|----------|----------|---|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|
| 1<br>H   |          |          |   |          |          |          |          |          |          |          |          |          |          |          |          |          | 2<br>He  |
| 3<br>Li  | 4<br>Be  |          |   |          |          |          |          |          |          |          |          | 5<br>B   | 6<br>C   | 7<br>N   | 8<br>O   | 9<br>F   | 10<br>Ne |
| 11<br>Na | 12<br>Mg |          |   |          |          |          |          |          |          |          |          | 13<br>Al | 14<br>Si | 15<br>P  | 16<br>S  | 17<br>Cl | 18<br>Ar |
| 19<br>K  | 20<br>Ca | 21<br>Sc | 22<br>Ti  | 23<br>V  | 24<br>Cr | 25<br>Mn | 26<br>Fe | 27<br>Co | 28<br>Ni | 29<br>Cu | 30<br>Zn | 31<br>Ga | 32<br>Ge | 33<br>As | 34<br>Se | 35<br>Br | 36<br>Kr |
| 37<br>Rb | 38<br>Sr | 39<br>Y  | 40<br>Zr  | 41<br>Nb | 42<br>Mo | 43<br>Tc | 44<br>Ru | 45<br>Rh | 46<br>Pd | 47<br>Ag | 48<br>Cd | 49<br>In | 50<br>Sn | 51<br>Sb | 52<br>Te | 53<br>I  | 54<br>Xe |
| 55<br>Cs | 56<br>Ba |          | 72<br>Hf  | 73<br>Ta | 74<br>W  | 75<br>Re | 76<br>Os | 77<br>Ir | 78<br>Pt | 79<br>Au | 80<br>Hg | 81<br>Tl | 82<br>Pb | 83<br>Bi | 84<br>Po | 85<br>At | 86<br>Rn |
| 87<br>Fr | 88<br>Ra |          | <div style="display: flex; justify-content: space-between; align-items: center;"> <div style="text-align: center;"> <p>↙ Lanthanides</p> <p>↘ Actinides</p> </div> </div> |          |          |          |          |          |          |          |          |          |          |          |          |          |          |

Bulk elements  
 Trace elements

# Properties of Living Organisms



complicated & highly organized



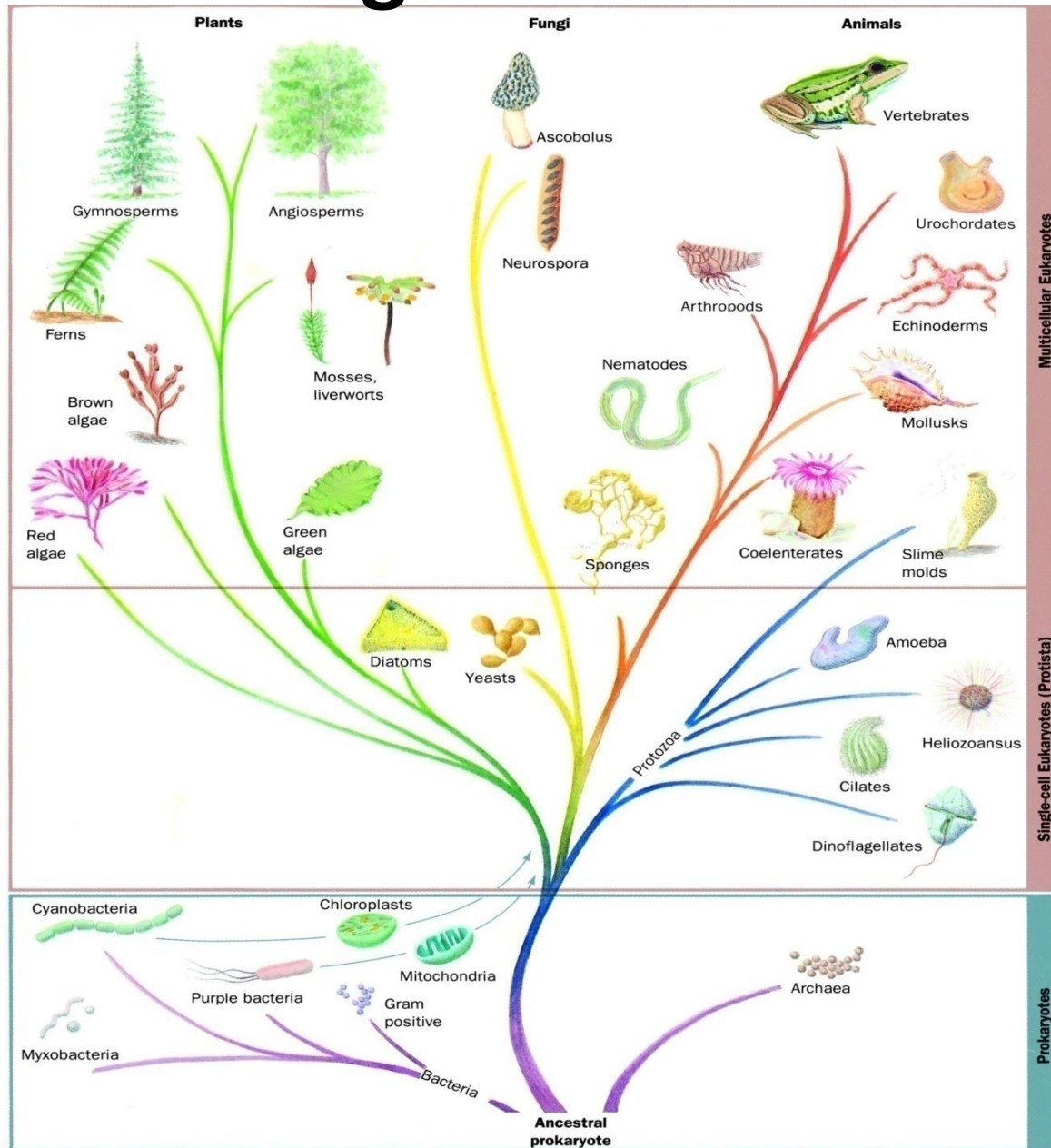
capacity for self-replication



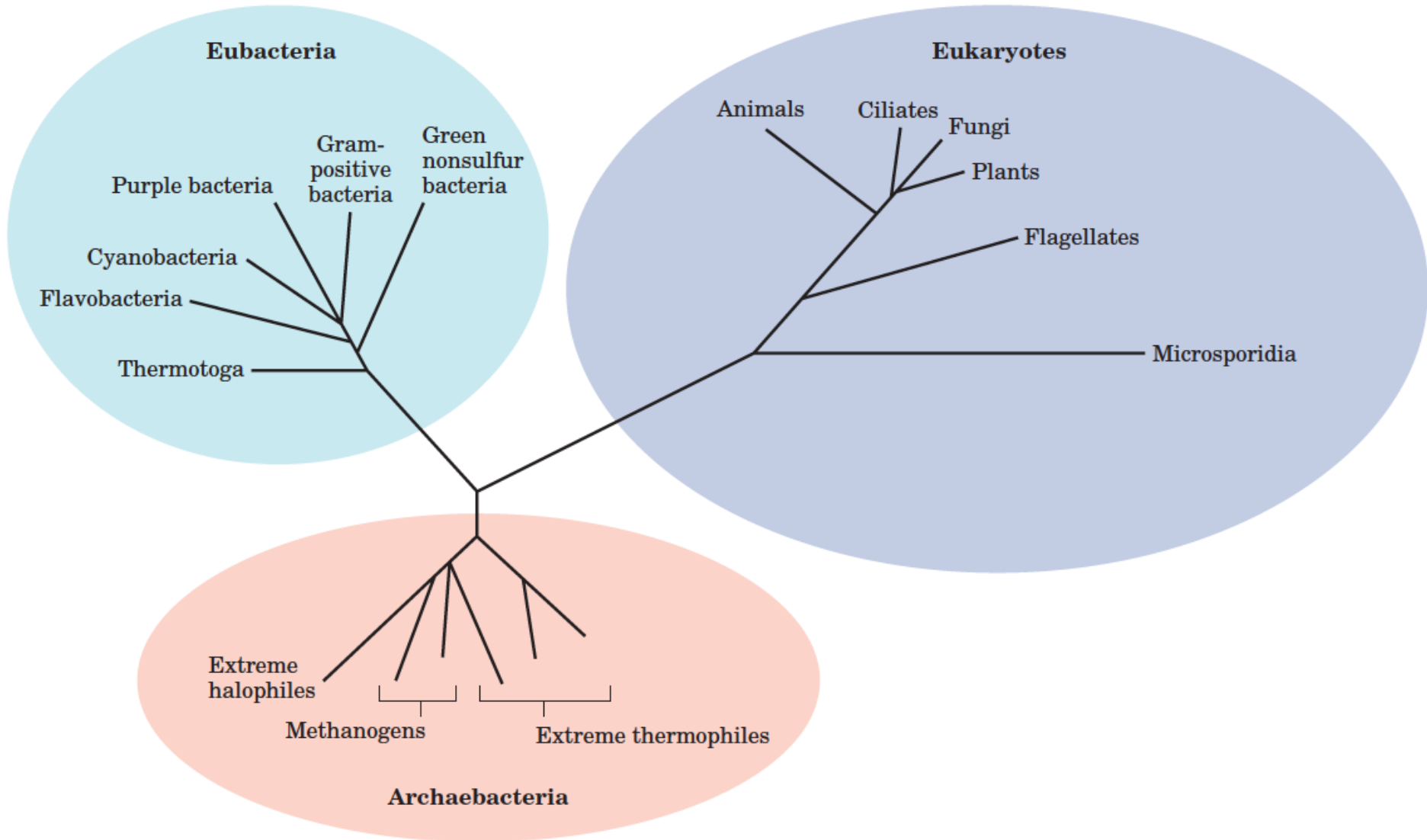
extract, transform & use energy



# 5 Kingdoms of Life



# 3 Domains of Life



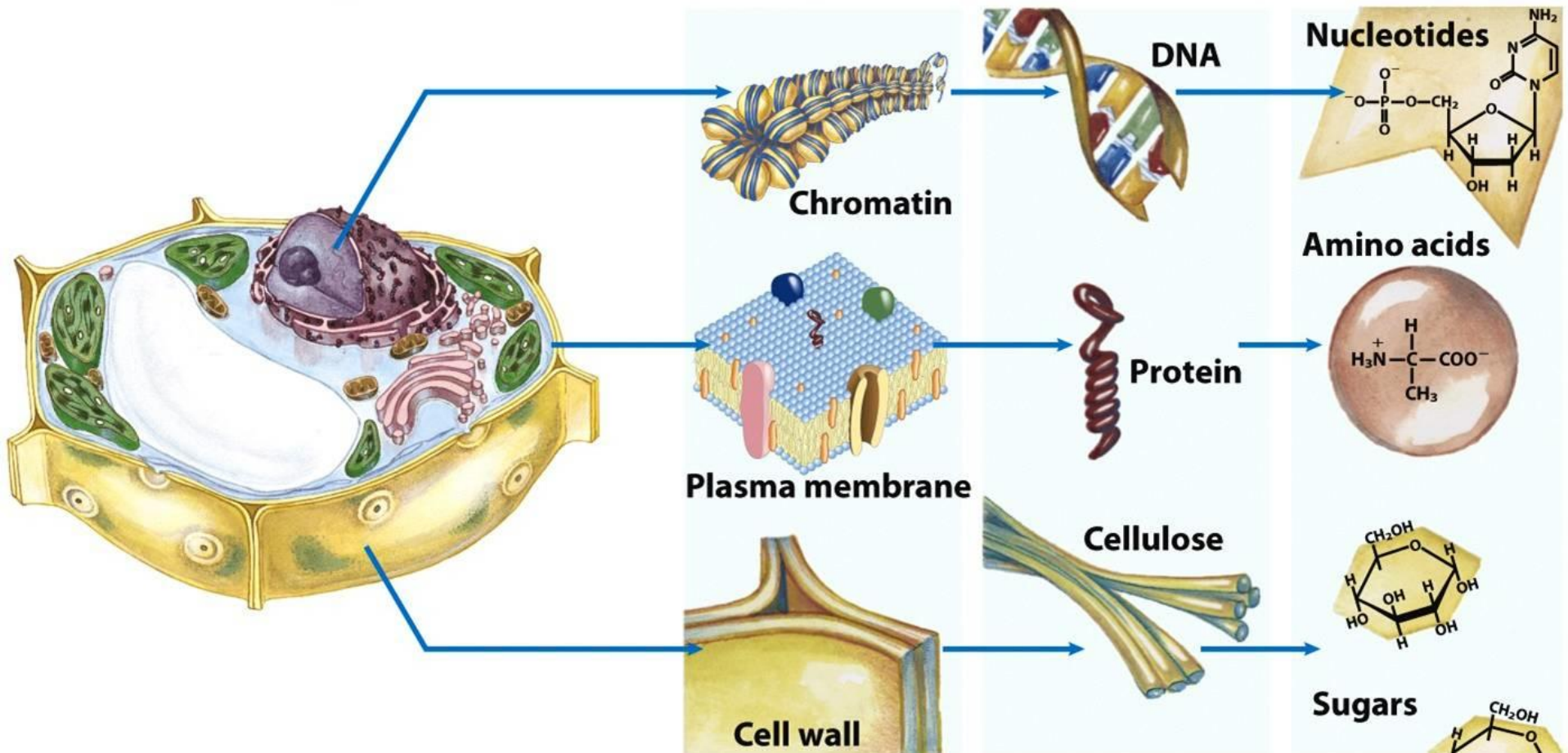
# Hierarchy of Molecular Organization

**Level 4:**  
The cell  
and its organelles

**Level 3:**  
Supramolecular  
complexes

**Level 2:**  
Macromolecules

**Level 1:**  
Monomeric units



# Covalent and Non-covalent Interactions

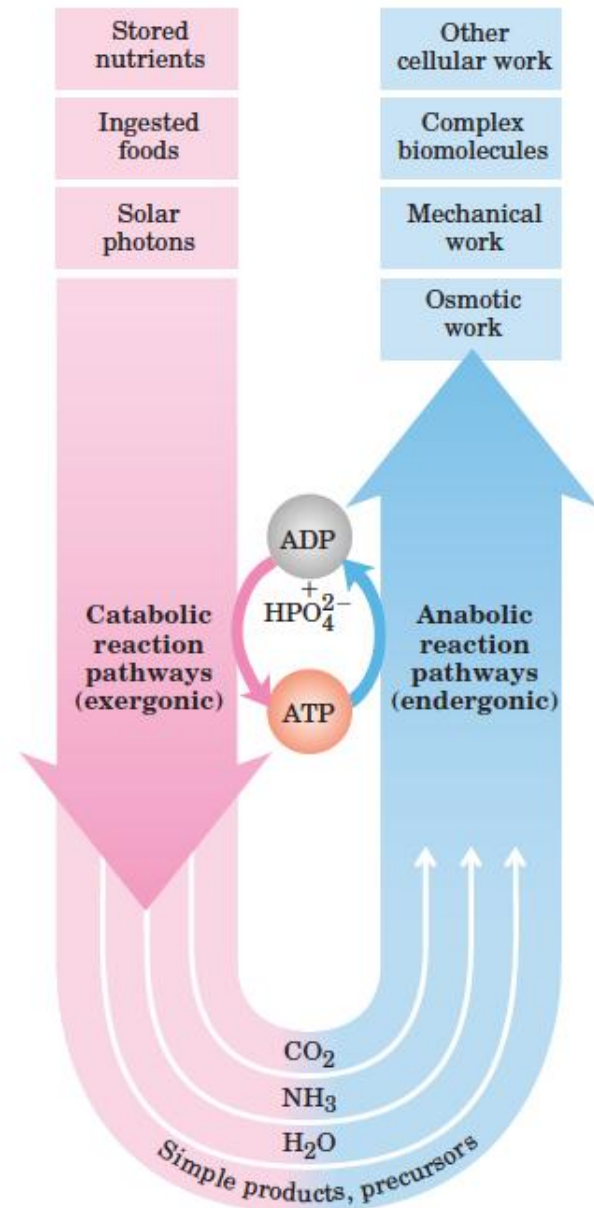
| Atoms     | e <sup>-</sup> pairing | Covalent bond  | Bond energy (kJ/mol) |
|-----------|------------------------|--|----------------------|
| H· + H·   | → H:H                  | H—H  | 436                  |
| ·C· + H·  | → ·C:H                 | $\begin{array}{c}   \\ -C-H \\   \end{array}$                  | 414                  |
| ·C· + ·C· | → ·C:C·                | $\begin{array}{c}   \quad   \\ -C-C- \\   \quad   \end{array}$ | 343                  |
| ·C· + ·N· | → ·C:N·                | $\begin{array}{c}   \\ -C-N \diagdown \\   \end{array}$        | 292                  |
| ·C· + ·O· | → ·C:O·                | $\begin{array}{c}   \\ -C-O- \\   \end{array}$                 | 351                  |
| ·C· + ·C· | → C::C                 | $\diagdown C=C \diagup$  | 615                  |
| ·C· + ·N· | → C::N·                | $\diagdown C=N-$   | 615                  |
| ·C· + ·O· | → C::O·                | $\diagdown C=O$  | 686                  |
| ·O· + ·O· | → ·O:O·                | -O—O-  | 142                  |
| ·O· + ·O· | → O::O·                | O=O  | 402                  |
| ·N· + ·N· | → N:::N·               | N≡N  | 946                  |
| ·N· + H·  | → ·N:H                 | $\diagdown N-H$  | 393                  |
| ·O· + H·  | → ·O:H                 | -O—H   | 460                  |

| Force                      | Strength (kJ/mol) |
|----------------------------|-------------------|
| Van der Waals interactions | 0.4–4.0           |
| Hydrogen bonds             | 12–30             |
| Ionic interactions         | 20                |
| Hydrophobic interactions   | <40               |

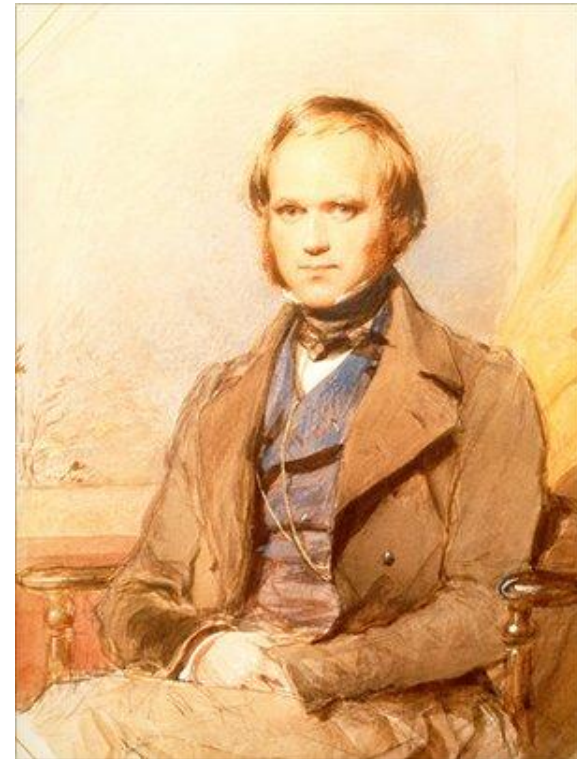
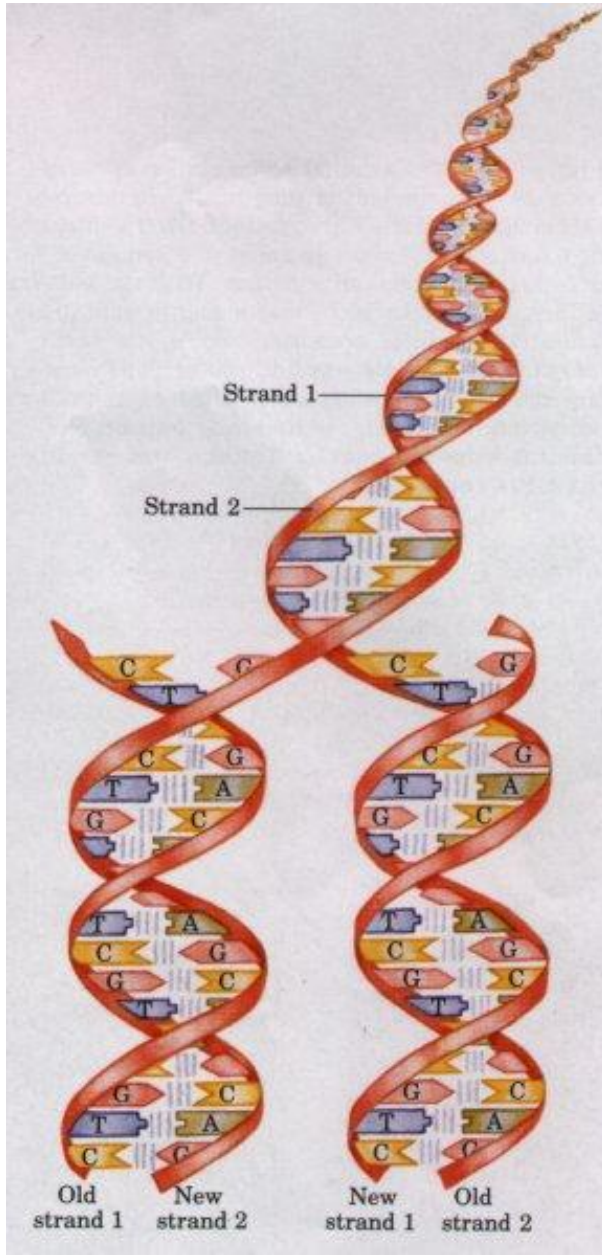


# Metabolism and Energy Conversion

- Organisms are in a state of 'disequilibrium'
- Organisms transform matter and energy from their surroundings
- Biochemical reactions are catalyzed by enzymes
- Metabolic processes are tightly regulated



# Replication and Evolution



**Charles Darwin**  
**1809 - 1882**

**Natural Selection**