

BIOLOGY

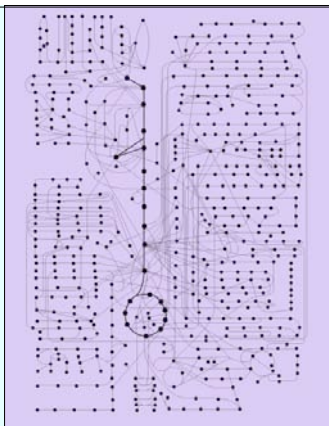
- *bios* - Gr.: “way of life”
- *logos* - Gr.: “words”
- *-logia*: “a collection of writings and speeches”
- “a body of knowledge”

What are the “Characteristics of Life”

- Complexity & Dynamic Order
- Regulation
- Respond to changes in environment
- Harness energy
- Growth and reproduction
- Cellular structure

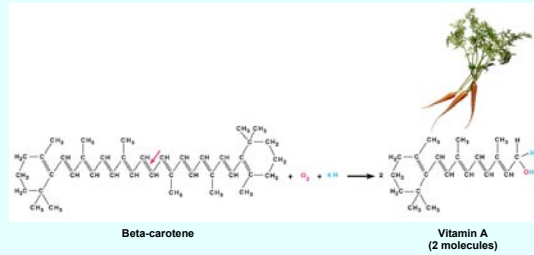
Biochemical Complexity & Order

- Basic metabolic pathways



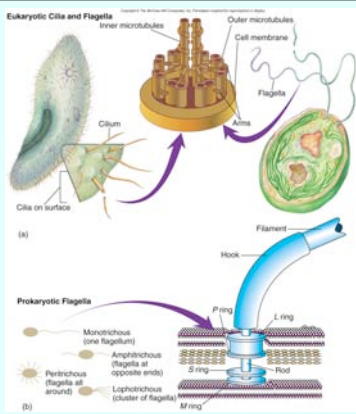
Living cells carry out millions of chemical reactions that rearrange matter in significant ways

- Biological molecules have many atoms bound precisely in complex forms.
- How does the right rearrangement of the right bond at the right time happen?



Biochemical Complexity & Order

- Molecular machines



Emergent Systems Analysis: attempting to map all interactions within the holistic living complex

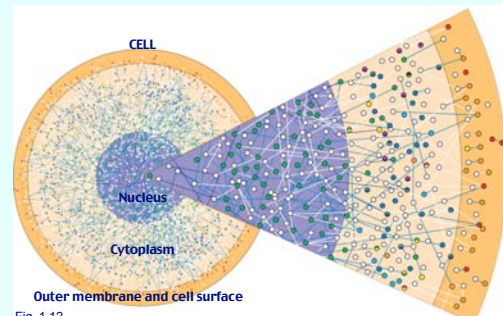
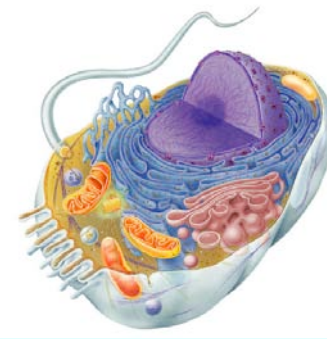


Fig. 1.12
A systems map of known interactions among 3500 proteins in a fly cell

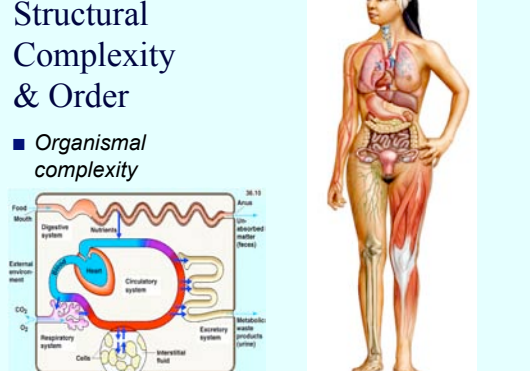
Structural Complexity & Order

- Cellular complexity



Structural Complexity & Order

- Organismal complexity



Structural Complexity & Order

- Structure correlates with function!

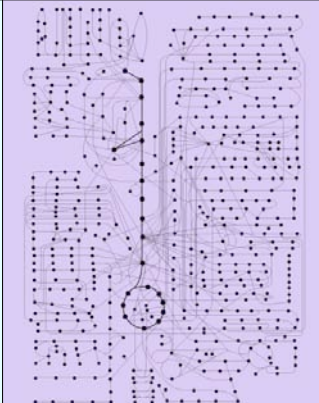


What are the "Characteristics of Life"

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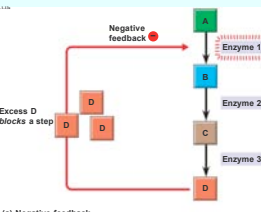
Biochemical Complexity & Order

- Basic metabolic pathways
- Each step tightly regulated in rate, time & location



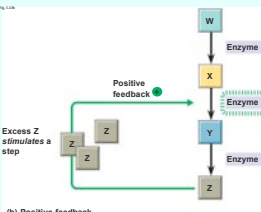
Regulation by feedback mechanisms

- Steady-state regulation: negative feedback loops



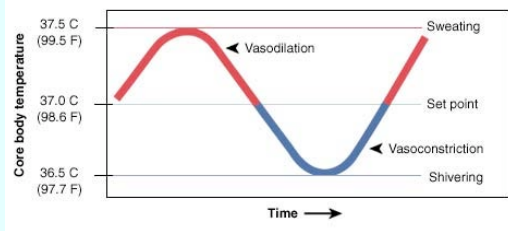
(a) Negative feedback

- Amplification: positive feedback loops



(b) Positive feedback

Homeostasis - maintaining an ideal constant internal environment

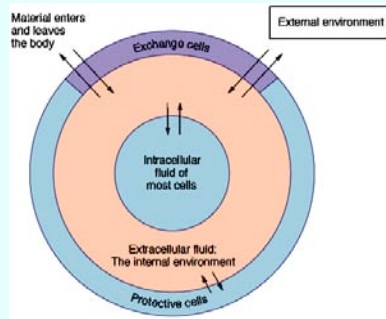


Homeostasis - maintaining an ideal constant internal environment

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Table 1.2 Approximate Normal Ranges for Measurements of Some Fasting Blood Values

Measurement	Normal Range
Arterial pH	7.35–7.45
Bicarbonate	24–28 mEq/L
Sodium	135–145 mEq/L
Calcium	4.5–5.5 mEq/L
Oxygen content	17.2–22.0 ml/100 ml
Urea	12–35 mg/100 ml
Amino acids	3.3–5.1 mg/100 ml
Protein	6.5–8.0 g/100 ml
Total lipids	400–800 mg/100 ml
Glucose	75–110 mg/100 ml

Life is dynamic



- Constant exchange between internal and external environments

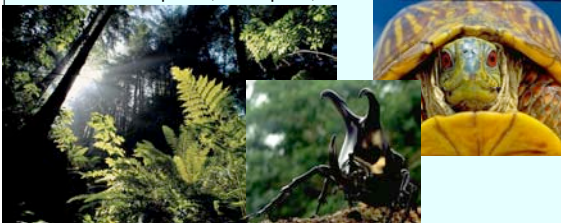
The Marine Environment

- Stable
 - Near constant temp; unlimited water availability; buoyant □ do not need to regulate internally
 - can “get away with” an extreme diversity of body forms



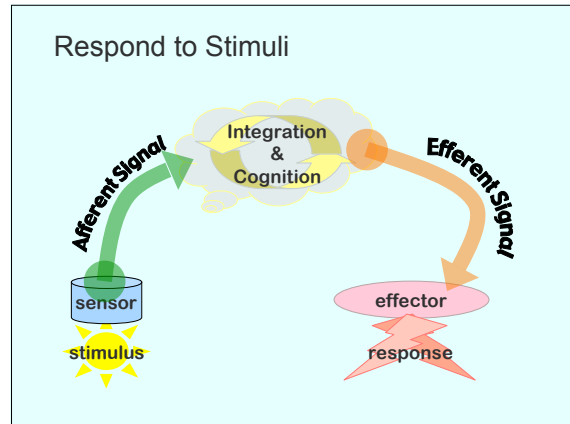
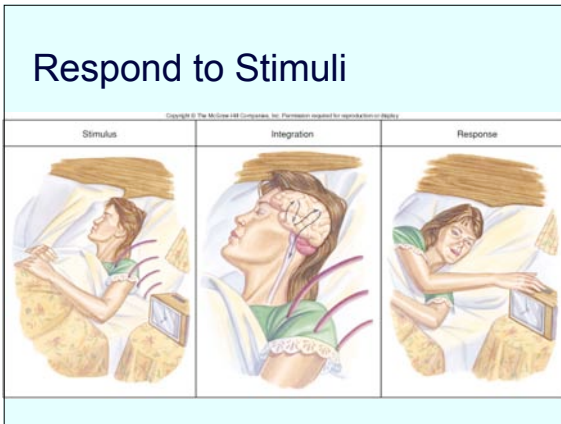
The Terrestrial Environment

- Harsh & Variable
 - Wide variations in temp & water availability; gravity □ need to strongly regulate internally
 - Only few body forms have necessary homeostatic mechanisms to succeed
 - ✓ Vascular plants, arthropods, & vertebrates



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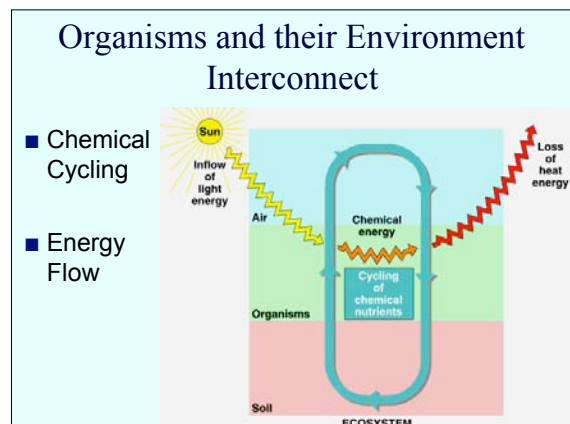
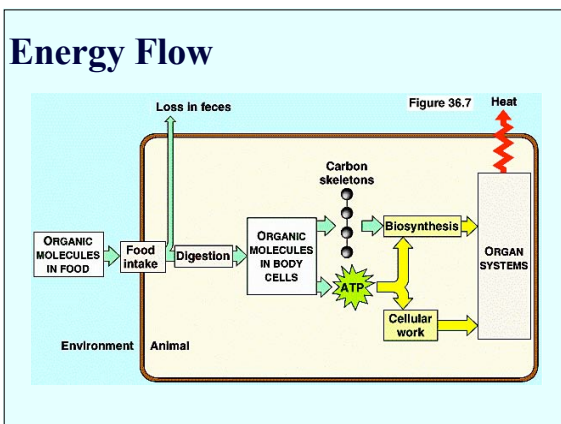


Environmental Selection

- These complex systems have been adjusted and refined by natural selection

NOTE: Biological evolution applies to populations, not to an individual organism. But the specific structures exhibited by an individual organism reflex the selection upon its ancestors for that structure's functions.

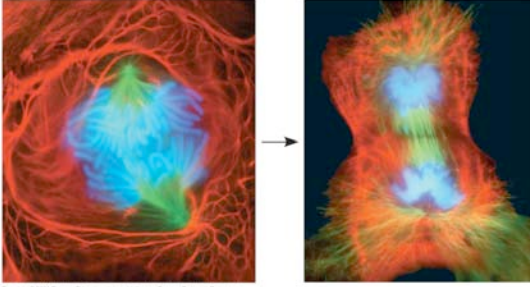
- ### What are the "Characteristics of Life"
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- **Harness energy - metabolism**
- **Growth and reproduction**
 - Inheritance - DNA - “Central Dogma”
- **Cellular structure**

Cellular Reproduction



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Organismal Reproduction

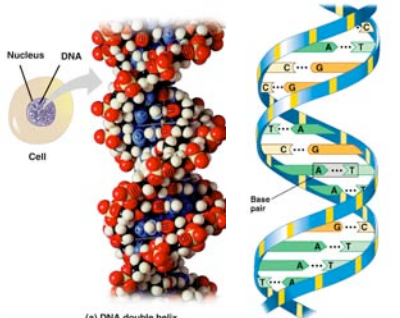
Sexual and/or asexual



“telescoping generations” in aphids — born already pregnant!

Molecular Inheritance:

double-stranded Deoxyribo-Nucleic Acid (dsDNA)

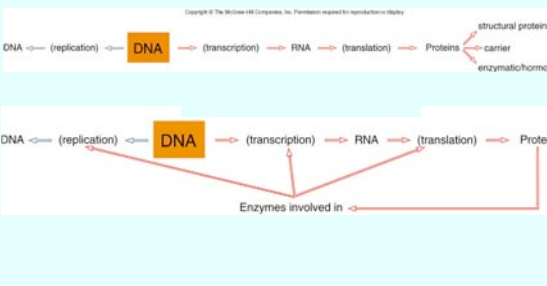


(a) DNA double helix

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- Sequence of bases (A, T, C, or G) along the DNA molecule are the “Genetic Information”

The Central Dogma of Biology



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What are the “Characteristics of Life”

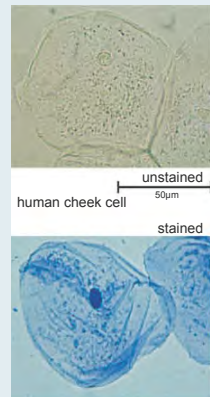
- **Complexity & Order**
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 - Inheritance - DNA - “Central Dogma”
- **Cellular structure - “Cell Theory”**

The Cell Theory

1. The cell is the basic unit of life.
2. All organisms are constructed of cells.
3. All cells derive from previous cells.

Early views of cells

- “Cytoplasm” (“cell fluid”)
- “Plasmalemma” (plasma membrane)
- “Nucleus” (“center”)
 - filled with “chromatin” (“colored stuff”)



Modern views of cells

- Better microscopes and stains
 - Electron microscope.
- “Cytoplasm” and “chromatin” much more complicated, structured, and dynamic than previously appreciated.



Two major types of cells

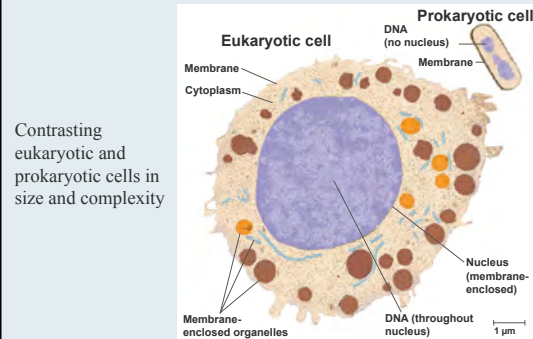


Figure 1.4

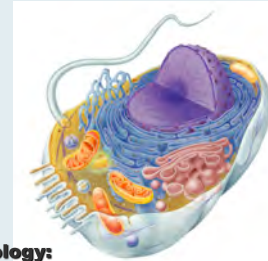
Contrasting eukaryotic and prokaryotic cells in size and complexity

What does a cell need?

- Selective isolation from environment (plasma membrane)
- Energy (ATP)
- Instructions (DNA)
- Machinery to carry out instructions and regulate processes (proteins)
- Compartmentalization of incompatible or specialized activities (organelles)

Biology: Levels of Organization

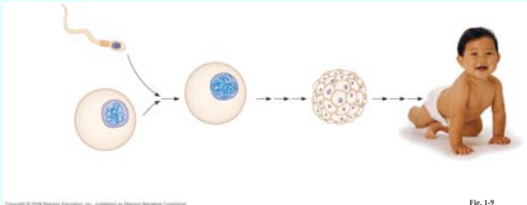
- Cells: the basic units of life



Top mystery of Biology:
Irreducible Complexity and the Origin of Life
— the first cell(s)?

Another great mystery of biology

- Differentiation of genetically identical cells into a coordinated, integrated, holistic multicellular organism

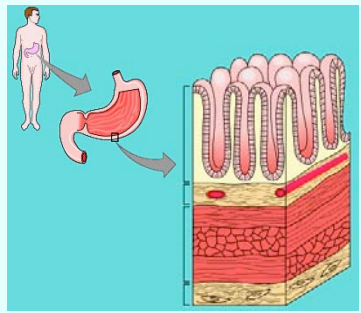


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Biology: Levels of Organization

Physiological levels:

- Tissues
- Organs
- Organ Systems



Biology: Levels of Organization


- Organism: the living individual



Biology: Levels of Organization

Ecological levels:

- Population
- Community
- Ecosystem



Biology: Levels of Organization

- Biosphere: the Earth as a living system



Biology: Levels of Organization

- Molecules and Atoms
- Cells
- Tissues
- Organs
- Organ Systems
- Organisms
- Populations
- Communities
- Ecosystems
- Biosphere

Biol-6B
Biol-6A
Biol-6C