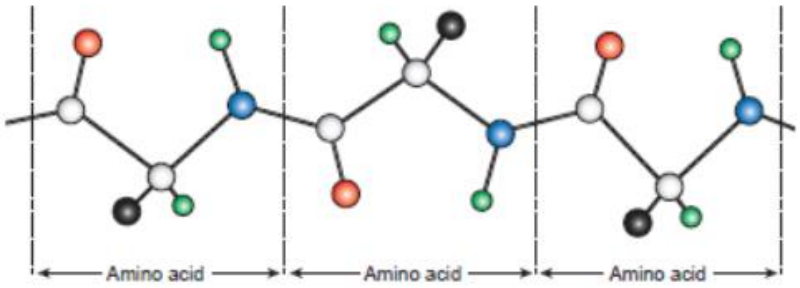
Lecture 5 Properties of living systems

Living organisms share same seven properties:

1. Chemical uniqueness

Living systems demonstrate a unique and complex molecular organisation.

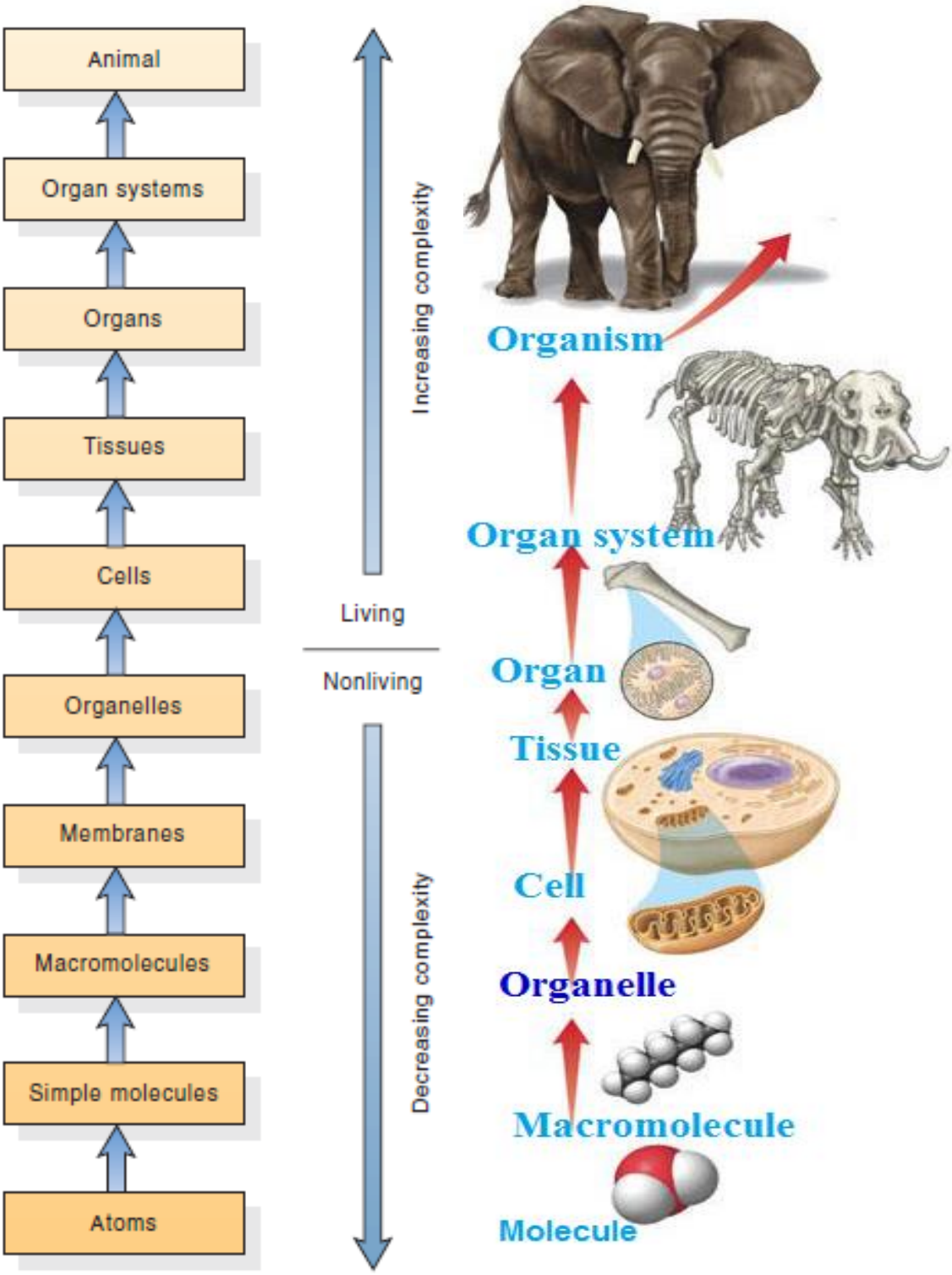
- **Living system made up of large molecules called Macromolecules - four types:**
  - **A. Proteins**
  - **B. Carbohydrates**
  - **C. Lipids**
  - **D. Nucleic acids**
- **Macromolecules in living things have same kinds of atoms (C, H, O & N) and chemical bonds that occur in non-living matter.**
- **Macromolecules in all living things have more complex structures compared to non-living things, which makes them unique.**



2. Complexity and hierarchical organization

- **Living systems demonstrate a unique and complex hierarchical organisation.**
- **Living organisms are organised in several levels of increasing complexity best described as: Hierarchy of life levels.**
- **Non-living matter is organized at least into atoms & molecules and has a high degree of organization as well, but atoms and molecules are combined into patterns in the living world that do not exist in the non-living world**
- **In living systems, a hierarchy of levels is organised in ascending order of complexity.**

- **Each level of biological organisation builds upon the level below, and it is more complex which has its own internal structure, and is also often hierarchical.**
- **Atoms (basic unit of matter) combined to form simple molecules (= micromolecules).**
- **Micromolecules combined to form macromolecules.**
- **Macromolecules combined to form a membrane.**
- **Membranes surround organelles (Mitochondria, Golgi apparatus, … etc.).**
- **Organelles are included within a cell.**
- **Cells are the smallest units of the biological hierarchy in living systems, and they are semiautonomous because of their ability to conduct basic functions (including reproduction).**
- **Cell is alive; it is made from non-living molecules**
- **Some cells are single (= Unicellular) and live independently (like *Paramecium*).**
- **Other cells are (multicellular), and contain more than one cell.**
- **In multicellular organisms, similar cells combine to form a tissue (like nerve and muscle tissues of animals).**
- **Tissues make up organs (such as the brain or a leaf).**
- **Organ work together to form organ systems (the brain works with the spinal cord and a network of nerves for the nervous system).**
- **Organ systems joined together to form an organism (animal or plant) such as an elephant.**
- **All these levels of biological organisation are interconnected and function as biological systems.**



Hierarchy of life levels

3. Reproduction

Living systems can reproduce themselves.

- **Life does NOT arise spontaneously but comes only from prior life through reproduction.**
- **At each level of the biological hierarchy, living forms reproduce to generate others like themselves.**
- **Genes (on the chromosome) are replicated (divided) to produce new genes.**
- **Cells divide to produce new cells.**
- **Organisms reproduce to produce new organisms.**
- **Types of reproduction: Asexual & Sexual.**
- **Populations may become fragmented to produce new populations.**
- **Reproduction at any hierarchical level usually features an increase in numbers.**
- **Reproduction at each of these levels shows the complementary phenomena of heredity and variation.**
- **Heredity is the transmission of traits from parents to offspring.**
- **Variation is the production of differences among the traits of different individuals.**
- **In a reproductive process, properties of offspring resemble those of their parents to varying degrees but usually are NOT identical to them.**
- **Cell division is exceptionally precise, especially with regard to the nuclear material, but chromosomal changes occur nonetheless at measurable rates.**
- **Organismal reproduction likewise demonstrates both heredity and variation.**
- **Variation is most obvious in sexually reproducing forms.**
- **Production of new populations demonstrates conservation of some properties and changes of others.**
- **If heredity were perfect, living systems would never change; if variation were uncontrolled by heredity, biological systems would lack the stability that allows them to persist through time.**

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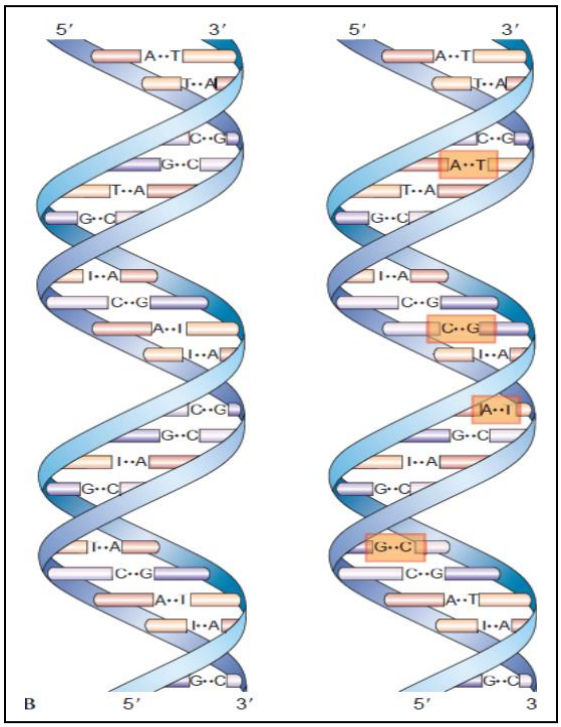
4. Possession of a genetic program

A genetic program provides fidelity of inheritance.

- **Structures of the protein molecules needed for organismal development and functioning are encoded in nucleic acids.**



5. Metabolism

Living organisms maintain themselves by acquiring nutrients from their environments.

- **Nutrients are used to obtain energy and build living systems.**
- **These essential chemical processes are called metabolism.**
- **Include digestion, acquisition of energy (respiration), and synthesis of molecules and structures.**
- **Metabolism is an interaction of:**
- **Anabolism (constructive): Building up reactions: synthesis carbohydrate, protein, lipid.**
- **Catabolism (destructive): Breaking down reactions: breaking down chemical bonds to produce energy.**
- **In animals, many fundamental metabolic reactions occur at the cellular level (Mitochondria).**
- **Cellular and nuclear membranes regulate metabolism by controlling the movement of molecules across the**

cellular and nuclear boundaries.

6. Development and growth

- All organisms pass through a characteristic life cycle.
- Development is changes that take place during life cycle of an organism (from zygote to adult form).
- Changes: might be in size and shape.
- Change might be simple (in one-celled organism).

- Change might be complicated (in multicellular organism).
- Some multicellular forms are so dissimilar that they are hardly recognisable as belonging to the same species.
- Embryos are distinctly different from juvenile and adult forms into which they develop.

7. Environmental interaction (response) & adaptation

All animals interact with their environments.

- **Ecology: Study of interactions between organisms and their environment.**
- **Adaptation: modifications that make organisms better able to function in particular environment.**
- **Interaction Effects on geographical distribution & abundance of organism.**
- **Organisms responding to environmental stimuli (heat, light,..).**
- **Type of stimulus & response:**
- **Simple (unicellular organism moving from or toward a light source or away from a noxious substance)**
- **Complex (bird responding to a complicated series of signals in a mating ritual).**
- **Responses help ensure the survival of the organism and allow it to carry on its daily activities.**
- **All together, these activities are termed the *behaviour* of the organism.**