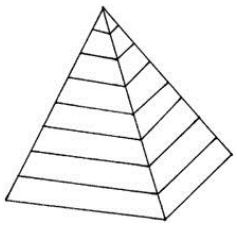
The Pyramid of Life (Levels of Biological Organization)

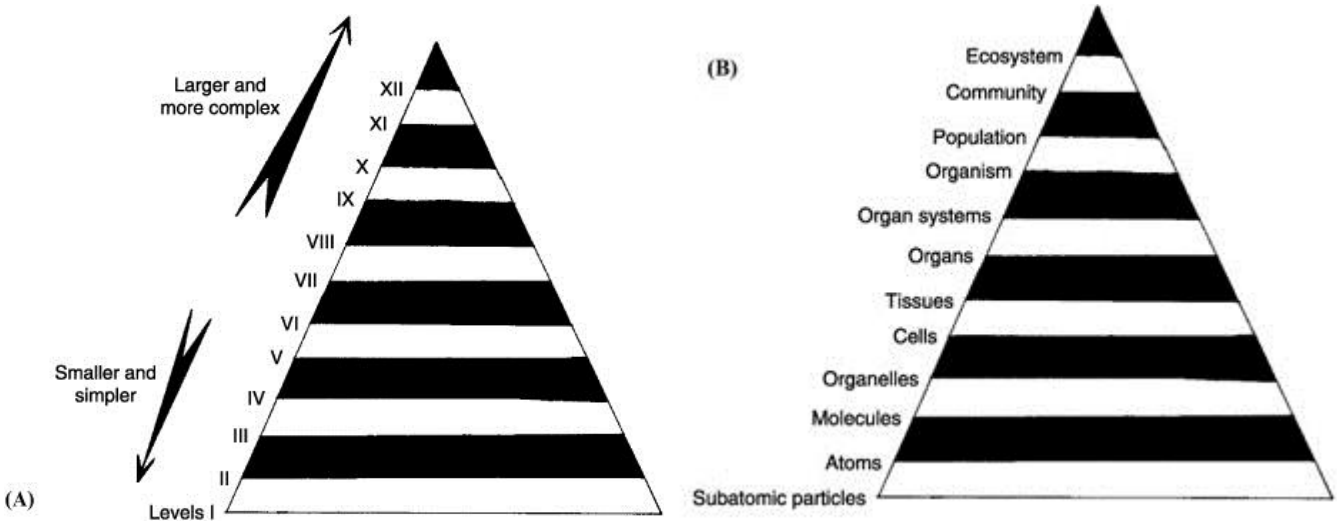
Introduction to The Pyramid of Life (Levels of Biological Organization)

Prominent among Biological concepts was the notion of Biological Order – a particular pattern associated with living things. Recall that the spotted body pattern of a giraffe was used to symbolize Biological Order within the individual organism. And a spider in its web represented Biological Order extending outward beyond the organism. This elegantly simple visual pattern suggested a criss-crossing network of linkages existing among various living things in the external environment.



Now it is time to consider still another pattern, one well-known to the Ancient Egyptians. Of course, you have already guessed it! It is the distinctly pointed-and-sloped pattern of the pyramid:

The pyramid shape consists of a number of horizontal levels, stacked one upon the other. This stacked pyramid is sometimes used in biology to help model the various *levels of biological organization.* A level of biological organization represents a certain degree of size and complexity of body structures, as well as the inter-relationships between them and other non-body structures. In biology, a *Pyramid of Life* can be identified. This Pyramid consists of 12 stacked horizontal levels of biological organization (Figure 2.1, A). Observe that these levels are numbered from bottom-to-top (Levels I-XII). Level XII, the peak of the Pyramid of Life, is the largest and most complex. This position at the top or peak symbolizes the fact that Level XII contains all the other levels of biological organization below and within it. Further, each of the other levels likewise contains the lower levels closer to the broad base of the Pyramid. The farther one goes up in the Pyramid, the greater is the size and complexity of the biological patterns encountered.



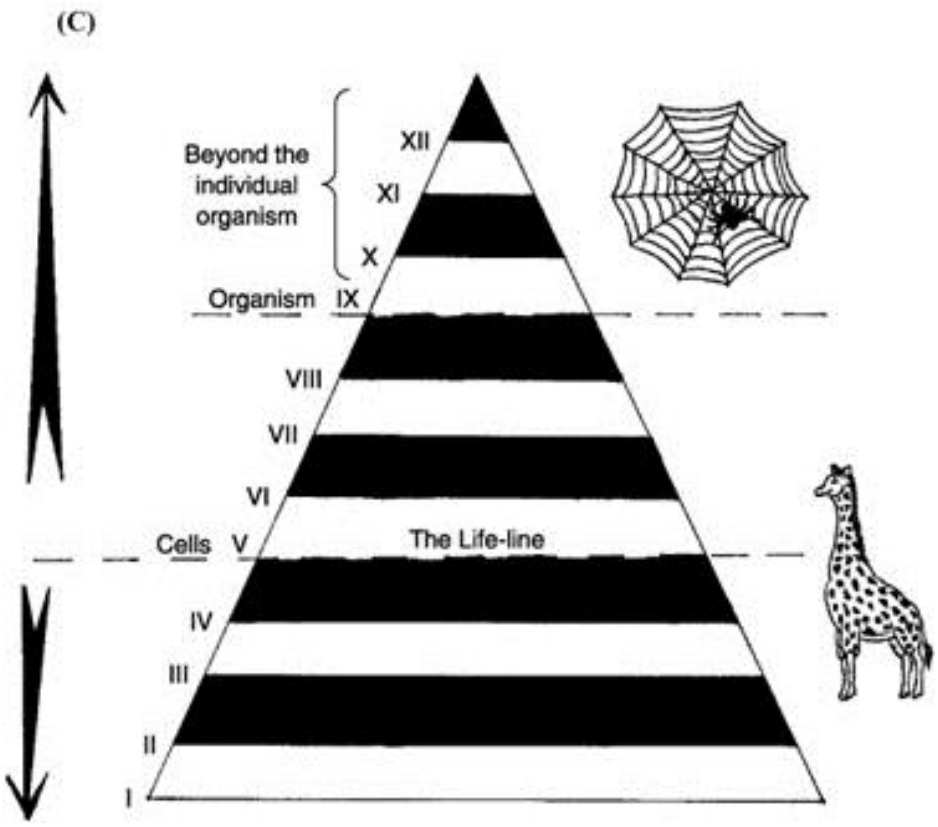


Fig. 2.1 The pyramid of life: The 12 levels of biological organization.

"Why is this diagram called the Pyramid of Life?" you may well ask. The reason is that life begins at a certain level of the Pyramid (Level V), and then continues upward through each of the higher levels of biological organization (Levels VI–XII). As Figure 2.1 (B) shows, the 12 Pyramid levels are as follows: *subatomic* (sub-ah- **TAH** -mik) *particles, atoms, molecules, organelles* (**OR** -gah- **nels**), *cells, tissues, organs, organ systems, organism, population, community* , and *ecosystem* (**E** -koh- **sis** -tem). Figure 2.1 (C) labels and tags certain levels in special ways. For example, Level V (cells) is labeled as "The Life-line." This indicates that the cell is the lowest *living* level of biological organization. All levels above this "Life-line," therefore, also include living things. Note, too, that the spotted giraffe (Biological Order) icon appears alongside Levels I–IX. This is because the giraffe, as an organism (Level IX), includes all the lower levels (organ systems down to subatomic particles) within it. Finally, observe that the spider in its web icon occurs beside Levels X–XII. The explanation is that a population, community, and ecosystem are all above the organism level of the Pyramid.

The Chemical Level Of Organization

Not specifically mentioned, yet, is the *chemical level* of biological organization. The chemical level includes the lowest three levels of the Pyramid (Figure 2.2). Specifically, this includes subatomic particles, atoms, and molecules.

The most important of these is the atom. An atom is the simplest form of a chemical *element* , or primary type of matter. A carbon (C) atom, for instance, is the simplest form of the element carbon. The four most common elements (atoms) found in the human body are carbon (C), oxygen (O), hydrogen

(H), and nitrogen (N). [**Study suggestion:** Remember the four letters, COHN, as in the slang expression, "Don't COHN me, Man! Tell me the truth!"]

The subatomic level is the one immediately "below" (*sub* -) the entire atom. This level consists of three main types of subatomic particles: *protons* (**PROH** -tahns), *neutrons* (**NEW** -trahns), and *electrons* (**e-LEK** -trahns). Each proton has an electrical charge of +1, while each neutron (as its name suggests) is electrically "neutral" (neither positively nor negatively charged).

Together, a certain number of protons and neutrons make up the *nucleus* (**NEW** -klee- **us**) or central "kernel" (*nucle*) of the atom. And orbiting very rapidly around this nucleus are one or more negatively-charged electrons. The carbon atom, for example, contains 6 protons and 6 neutrons within its nucleus. Orbiting around it is a total of 6 electrons. Since the number of positively charged protons in the nucleus always equals the number of negatively charged electrons rapidly orbiting around the nucleus, the net charge of any atom is 0. Thus, the carbon atom, which has a nucleus of charge +6 (from the six protons), and a cloud of electrons with a charge of —6, has a net (overall) charge of 6—6 — 0. [**Study suggestion:** As shown in Figure 2.2, visualize the atom as being a hard gumball – the nucleus – surrounded by a sticky cloud of cotton candy, representing the movements of all the electrons orbiting around the nucleus.]

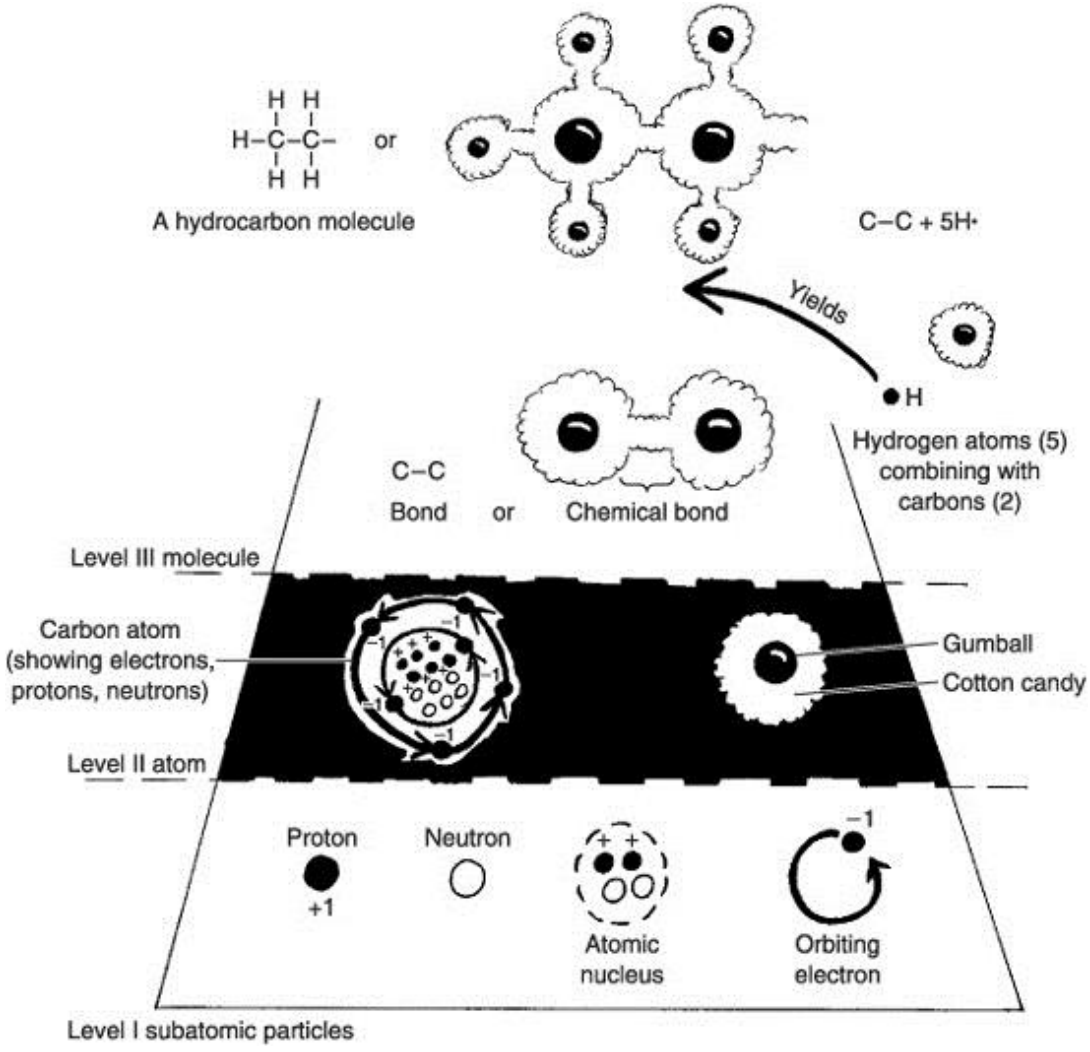


Fig. 2.2 The chemical level of biological organization.

Lying just above the atom level is the molecule. A molecule is a combination of two or more atoms held together by *chemical bonds.* A chemical bond is a linkage created by the sharing or transfer of electrons between the outer surface clouds of atoms. For example, a C–C (carbon–carbon) bond (Figure 2.2) can be visualized as resulting from the linkage of two gumballs. Each gumball (nucleus of a C atom) is surrounded by a sticky (electron) cloud of cotton candy. When the two clouds are smashed together, and then pulled apart slightly, a chemical bond or sticky connection is made between them.

If one or more carbons and other types of atoms are bonded together in a string or ring shape, an *organic molecule* results. A very simple organic (carbon-containing) molecule is CO_2 – *carbon dioxide* (die- **OX** -eyed). This molecule is the one usually excreted as a waste product by the metabolism of our human body cells.

Our cells typically consume the oxygen (O_2) molecule in the process of making energy. Obviously, O_2 is classified as an *inorganic* molecule, because it does "not" (*in* -) contain any C atoms.

Carbon atoms easily bond together with one another, making long C–C chains. Quite often, hydrogen (H) atoms bond to the sides of these carbon atoms. The resulting molecules are called *hydrocarbons* (**HIGH** -droh- **kar** -buns) – literally, "hydrogen (*hydr*) and carbon" molecules. Most of the organic molecules making up human, animal, and plant bodies include large numbers of hydrocarbons.

When a molecule becomes very "big" (*macro* -), it is described as a *macromolecule* (**MAK** -roh- **mall** -uh-kyewl). One of the most important macromolecules in all living things is the *DNA molecule* . (Chapter 4 will provide much more information about chemical bonding, DNA, and other types of macromolecules essential for biology.)

Organelles

Located just above the macromolecules (the top of the chemical level), are the organelles. The word, organelle, literally means "little organ." Hence, an organelle is a "little organ"-like structure that carries out specific functions within the cell. The cell, like an individual atom, contains a central "kernel" or nucleus. In the case of the cell, however, the nucleus is a rounded, kernellike organelle.

Study suggestion: Picture an oval kernel of corn. The cell nucleus of all humans, plants, and animals holds a large amount of the macromolecule, DNA. *Genes* (jeans) are particular sections of a DNA molecule. Their chief function is directing protein synthesis (the making of proteins) within the cell.

Patterns of Life Practice Test

1. A level of biological organization represents:

   (a) Some level of complexity below an organism

   (b) A particular layer within an Ancient Egyptian pyramid

   (c) A certain amount of size and complexity of body structures, along with the inter-relationships between them and various non-body structures

   (d) An almost complete lack of Biological Order

2. The lowest living level of biological organization is:

   (a) The organelle

   (b) The cell

   (c) Several types of subatomic particles

   (d) The ecosystem

3. The chemical level of organization includes:

   (a) Organelles, cells, and communities

   (b) Subatomic particles, atoms, and organs

   (c) Atoms, molecules, and subatomic particles

   (d) Every living level of biological organization

4. The cell nucleus represents the:

   (a) Organelle level

   (b) Tissue level

   (c) Organ system level

   (d) Molecule level

5. A molecule is a combination of two or more atoms held together by:

   (a) Chemical bonds

   (b) Genes

   (c) Hydrocarbon fragments

   (d) Electron–proton connections

6. A tissue is best defined as:

   (a) The smallest living level of biological organization

   (b) A collection of similar cells, plus the intercellular material between them

   (c) The intercellular material between cells, and not the cells themselves

   (d) A collection of similar cells, not including anything else

7. A collection of two or more organs, which together perform some complex body function:

(a) Organism

(b) Tissue

(c) Organ system

(d) Population

8. Snowshoe hares, bobcats, and arctic foxes all living in the same cold northerly area make up:

(a) A population

(b) A community

(c) An organ system

(d) An ecosystem

9. An ecosystem:

(a) Exists at a level below the community

(b) Only focuses upon the members of a particular population

(c) Includes non-living factors in the physical environment

(d) Never can be more complex than the organisms it contains

10. Ecological relationships are similar to homeostasis in that they:

(a) Can always be diagrammed in an S-shaped pattern

(b) Represent a relative constancy of the mammal's internal environment

(c) Are restricted to the organism level and below

(d) Maintain a rough balance or equilibrium over time