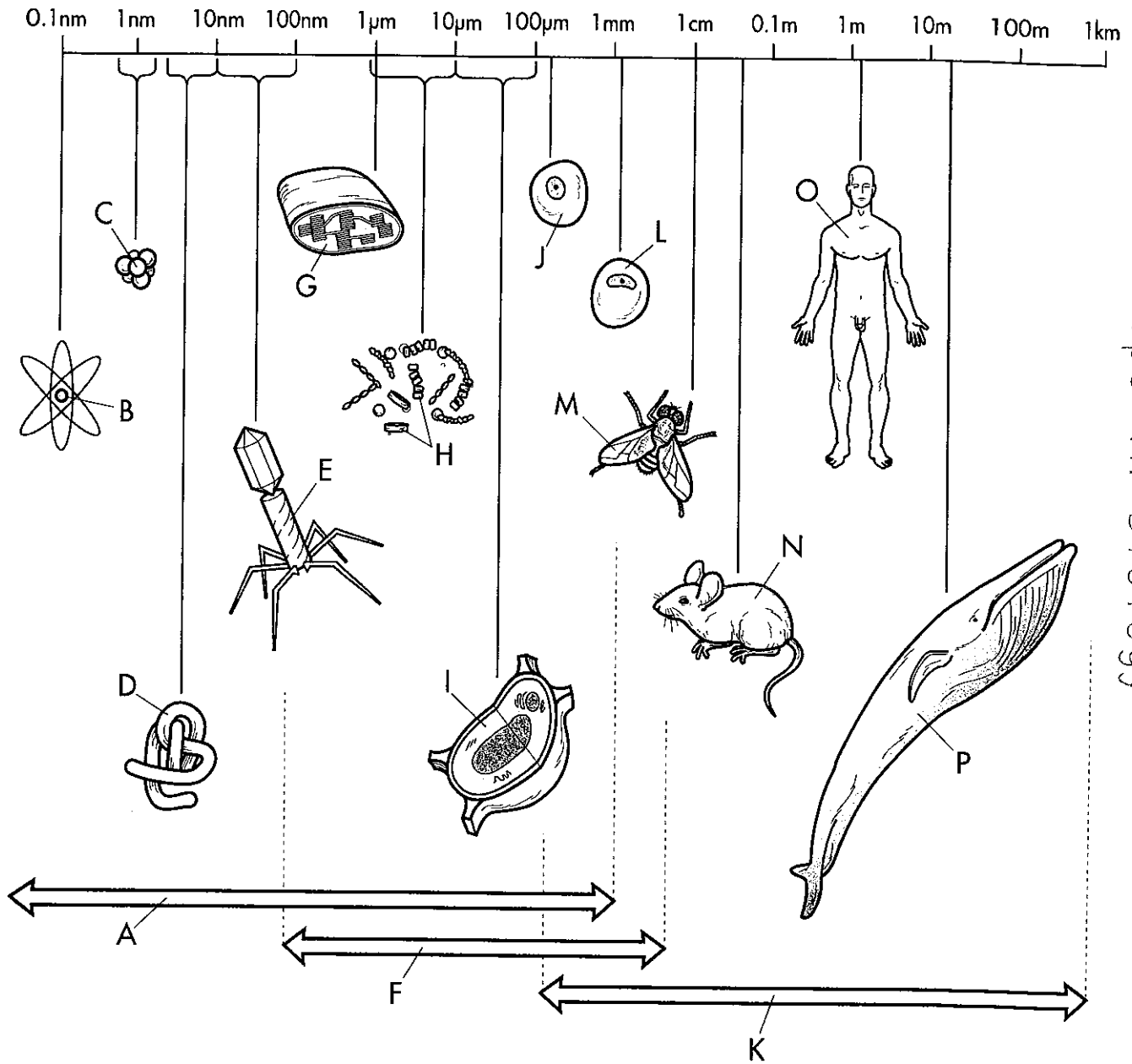


# Size Relationships in Biology



## Size Relationships in Biology

- Electron Microscope Range.....A
- Atom .....B
- Small Molecule .....C
- Folded Protein .....D
- Virus.....E

- Light Microscope Range.....F
- Chloroplast.....G
- Bacteria .....H
- Plant/Animal Cell.....I
- Human Egg Cell .....J

- Unaided Eye Range.....K
- Frog Egg Cell.....L
- Insect .....M
- Rodent .....N
- Human.....O
- Whale.....P

## Chapter 1-3: Size Relationships in Biology

Organisms vary considerably in size. In this plate, we survey some members of the biological kingdom and point out how they relate to one another in size.

This plate displays thirteen different organisms, each of which is placed along the meter scale to show its size and relationship to other biological specimens. We will examine the specimens in three groups.

We will move from the smallest organism, which is on the left, to the largest. We begin with specimens that are too small to be viewed with any instrument, and those that can only be viewed with the **electron microscope (A)**. The arrows that group the different sized organisms should be colored in bold reds, greens, or blues.

Atoms cannot be seen under electron microscopes. An **atom (B)** measures approximately 0.1 nanometers (nm) in diameter, and a nanometer is a billionth of a meter. (So an atom is a ten-billionth of a meter in diameter.) The smallest specimen that can be viewed with an electron microscope is a **small molecule (C)**. Such a molecule measures approximately 1 nm (one-billionth of a meter) in diameter. An amino acid and a glucose molecule are examples. Slightly larger specimens are large, **folded proteins (D)**. Proteins can range in size from about 4 nm to about 10 nm in diameter, as the bracket indicates.

Within the size range of 10 to 100 nm are the **viruses (E)**. In the diagram, you can see a complex virus known as a bacteriophage. Its details are easily visible through the electron microscope. Viruses are inert particles that have the ability to replicate.

Thus far we have examined several specimens that are visible only through the electron microscope. We now turn to biological specimens that are visible with the light microscope. Continue your coloring as you read the paragraphs below.

The range of sizes of objects that is visible with the aid of the **light microscope (F)** is indicated by the arrow. The range starts at objects that are approximately 100 nm. Included in this is the **chloroplast (G)**, which is the photosynthetic organelle of the plant. Chloroplasts are approximately 1 micrometer ( $\mu\text{m}$ ) in diameter; a micrometer is one millionth of a meter.

As the diagram shows, **bacteria (H)** range in size from slightly less than 1  $\mu\text{m}$  to about 10  $\mu\text{m}$ . They are smaller than **plant and animal cells (I)**, which range from approximately 10 to 100  $\mu\text{m}$ . Note that the electron microscope can be used to view these samples, and it is often used to view the submicroscopic structures in plant and animal cells.

Also within the realm of the light microscope is the **human egg cell (J)**. This cell measures approximately 125  $\mu\text{m}$  in diameter and is almost large enough to be seen by the naked eye.

We now move to those biological specimens that can be visualized with the unaided eye. Continue your reading below as you note the various size relationships among biological objects.

The range of the **unaided eye (K)** is indicated by the arrow, which should be colored a dark color. Within this realm is the **frog egg cell (L)**. This specimen is slightly more than a millimeter (mm) in diameter. (A millimeter is a thousandth of a meter.)

The next specimen we will look at is the **insect (M)**. Although the insect is larger than the frog egg cell, the size of insects varies considerably. The insect we display is approximately a centimeter (cm) in length. The next largest organism on our chart is the **rodent (N)**, which is approximately 5 cm in length.

Now we examine the **human (O)**. The average human is taller than a meter. A meter is equivalent to 39.37 inches, or slightly larger than three feet. The human we show is approximately five feet in height, or about 1.2 m.

The largest biological organism presented is the **whale (P)**. Notice the enormous size of this animal relative to the other biological specimens. The animal is roughly 25 m in length, or approximately 75 feet. The whale is among the largest organisms known to inhabit Earth.

## Chapter 1 Coloring Book

### **1-3 Size relationship in Biology**

- a. Smallest organisms can only be viewed with this:
- b. Can atoms be seen with an electron microscope?
- c. How big is an atom?
- d. How big is a molecule (that can be seen with an electron microscope)?
- e. What are examples of molecules this size?
- f. How big are folded proteins?
- g. How big are viruses?
- h. What is the range of the light microscope?
- i. Are bacteria smaller or larger than plant or animal cells?
- j. Can a human egg be seen with a light microscope?
- k. Do you need a light microscope to see a frog egg?
- l. What is the largest organism known to inhabit the Earth?