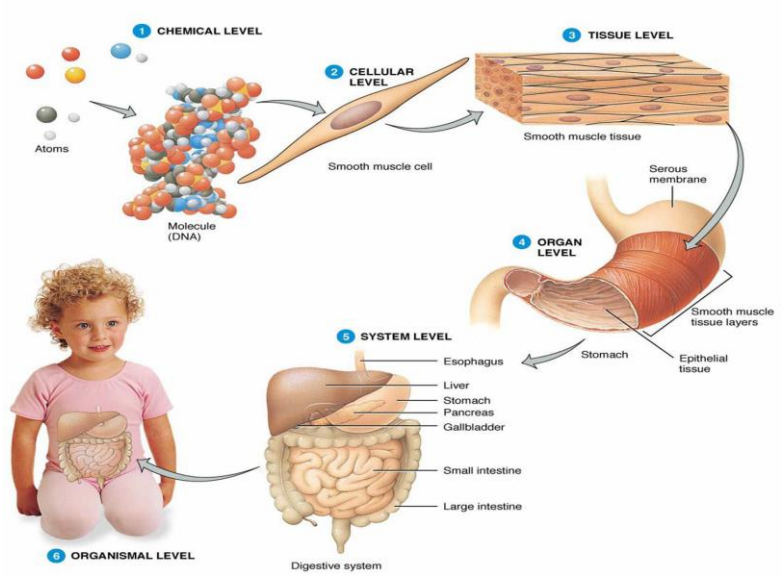
Overview

In the words of the renowned physiologist Knut Schmidt-Nielsen, animal physiology is"*the study of how animals work*." Animal physiologists study the structure and function of the various parts of an animal, and how these parts work together to allow animals to perform their normal behaviors and to respond to their environments. One hallmark of animal physiology is diversity. More than a million different species of animals live on Earth, each of which has acquired through evolution countless unique properties. Each physiological process is a product of the activities of complex tissues, organs ,and systems that can arise through complex patterns of genetic regulation of countless cells. Despite this great diversity, there are many commonalities within physiology—unifying themes that apply to all physiological processes.



Physiology: Past and Present

Modern animal physiology is a discipline concerned with the whole range of processes that affect animal function. Although animal physiology is an experimental science that can trace its roots back more than two millennia to the ancient Greeks, it plays an important role in modern biology as the intellectual glue that holds disparate biological fields together.

Introduction to the cell biology

What is a Cell?
Cells : are the microscopic fundamental units of all living things.
Every living thing has cells: bacteria, protozoans, fungi, plants, and animals are the main groups (Kingdoms) of living things.
Some organisms are made up of just one cell (e.g. bacteriaand protozoans).
But animals, including human beings, are multicellular.
An adult human body is composed of about 100 trillion cells! Each cell has basic requirements to sustain it. and the body's organ systems are largely built around providing the many trillions of cells with those basic needs (such as oxygen, food, and waste removal).

For ease of study, we divide the cell into three main parts:

1. **plasma membrane**
2. **cytoplasm**
3. **nucleus**

Other non-cellula rcomponents in the body include water, macronutrients (carbohydrates, proteins, lipids), micronutrients(vitamins, minerals) and electrolytes. A collection of cells that function together to perform the same activity is known as tissue. Masses of tissue work collectively to form an organ that performs specific functions in the body. Despite this structural organization, all activity boils down to the cell –a complex unit that makes life possible.

Functions of the Human Cell

The function of each organelle has already been discussed but is worth considering in summary: The cell membrane allows substances to enter and leave the cell. While certain substance like oxygen can easily diffuse through the cell membrane, others have to actively transported through the process of endocytosis. Small particles are transported by the process of pinocytosis while larger particles are moved by the process of phagocytosis. These functions can become highly specialized to allow cells to perform specific activities, like the macrophages that phagocytosis invading bacteria to neutralize it. Small and large substances that do not dissolve in the cytoplasm are contained within vesicles. Lysosomes attach to the vesicles and digest this material. The endoplasmic reticulum (ER) and Golgi apparatus synthesize different substances like protein and fats as required by the cell or designated according to its specific function. It utilizes basic nutrient molecules that are either dissolved in the cytoplasm or specific substances contained within vesicles **.**

❖ Cell Membrane

The cell membrane is the outer coating of the cell and contains the cytoplasm, substances within it and the organelle. It is a double-layered membrane composed of proteins and lipids. The lipid molecules on the outer and inner part (lipid bilayer) allow it to selectively transport substances in and out of the cell. Endoplasmic Reticulum:The endoplasmic reticulum(ER) is a membranous structure that contains a network of tubules and vesicles. Its structure is such that substances can move through it and be kept in isolation from the rest of the cell until the manufacturing processes conducted within are completed. There are two types of endoplasmic reticulum –rough (granular) and smooth (a granular).

Cell membrane are composed primarily of phospholipids and proteins.

A. Lipid bilayer

1. Phospholipids have a **glycerol backbone**, which is the hydrophilic (water-soluble) head,
and two **fatty acid tails**, which are hydrophobic (water-insoluble). The hydrophobic tails
face each other and form a bilayer.

2. Lipid-soluble substances (e.g., O2, CO2, steroid hormones) cross cell membranes
because they can dissolve in the hydrophobic lipid bilayer.

3. Water-soluble substances (e.g., Na+, Cl–, glucose, H2O) cannot dissolve in the lipid of the
membrane, but may cross through water-filled channels, or pores, or may be transported
by carriers.

B. Proteins

1. Integral proteins

■ are anchored to, and imbedded in, the cell membrane through **hydrophobic**
interactions.

■ may span the cell membrane.

■ include ion channels, transport proteins, receptors, and guanosine 5′-triphosphate
(GTP)-binding proteins (G proteins).

2. Peripheral proteins

- are *not* imbedded in the cell membrane.
- are *not* covalently bound to membrane components.
- are loosely attached to the cell membrane by **electrostatic** interactions.

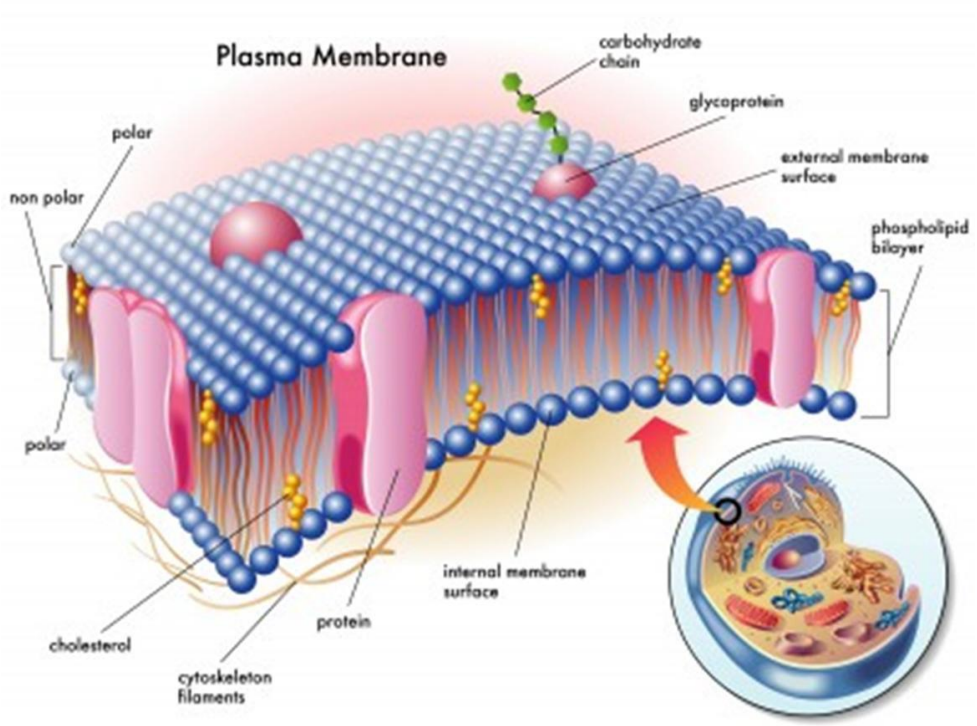


Figure 1 show structure of Cell membrane

Transport across cell membrane

All cells are generally separated from their surrounding environment by plasma membrane. In addition, the eukaryotic cells are compartmentalized by intracellular membranes that form the boundaries and internal structures of various organelles .These biological membranes are semi-permeable in nature that is their permeability properties ensure that the specific molecules and ions readily enter the cell and the waste products leave the cell. These movements of solutes into the cell are mediated through the action of specific transport proteins that are present on the cell membrane. Such proteins are therefore required for movements of ions, such as Na^+ , K^+ , Ca^{2+} , and Cl^- , as well as metabolites such as pyruvate, amino acids, sugars, and nucleotides, and

even water. Transport proteins are also responsible for biological electrochemical phenomena such as neurotransmission.

Cell membrane architecture in transport across cell membrane:

The cell membrane plays an important role in transport of molecules. Because it acts as a semi-permeable barrier, allowing specific molecules to cross while fencing the majority of organically produced chemicals inside the cell. Electron microscopic examinations of cell membranes reveal the development of the lipid bilayer model (fluid-mosaic model). The model consists ofphospholipid, which has a polar (hydrophilic) head and two nonpolar (hydrophobic) tails. These phospholipids are aligned tail to tail so the non-polar areas form a hydrophobic region between the hydrophilic heads on the inner and outer surfaces of the membrane. Permeability of molecules across phospholipid bilayer: Most of the molecule will diffuse across a protein-free lipid bilayer down its concentration gradient, if provided enough time. The diffusion rate is the function of the size of the molecule and its relative solubility in oil. In general, the smaller the molecule and the more soluble in oil (the more hydrophobic or non-polar), the more rapidly it will diffuse across a cell membrane. Small non-polar molecules, such as O2 and CO2, readily dissolve in cell membrane and therefore diffuse rapidly across them whereas small uncharged polarmolecules, such as water or urea, also diffuse across a bilayer, but much more slowly but ethanol diffuses readily. Conclusively it can be said that lipid bilayers are highly

impermeable to charged molecules (ions) by considering its size also because the charge and high degree of hydration of such molecules prevents them from entering the hydrocarbon phase of the bilayer. Thus, these bilayers are 109 times more permeable to water than to even such small ions as Na+ or K **like the below figure .**