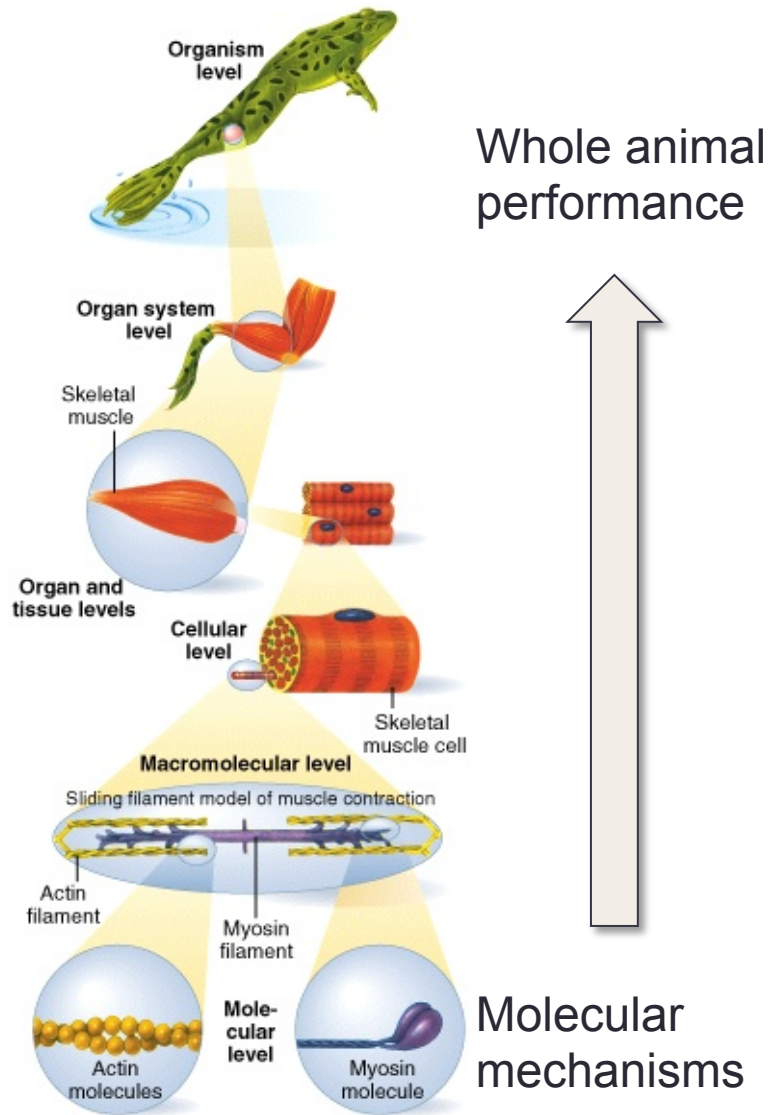


What is Physiology?



Physiology is one of biology's most integrative disciplines

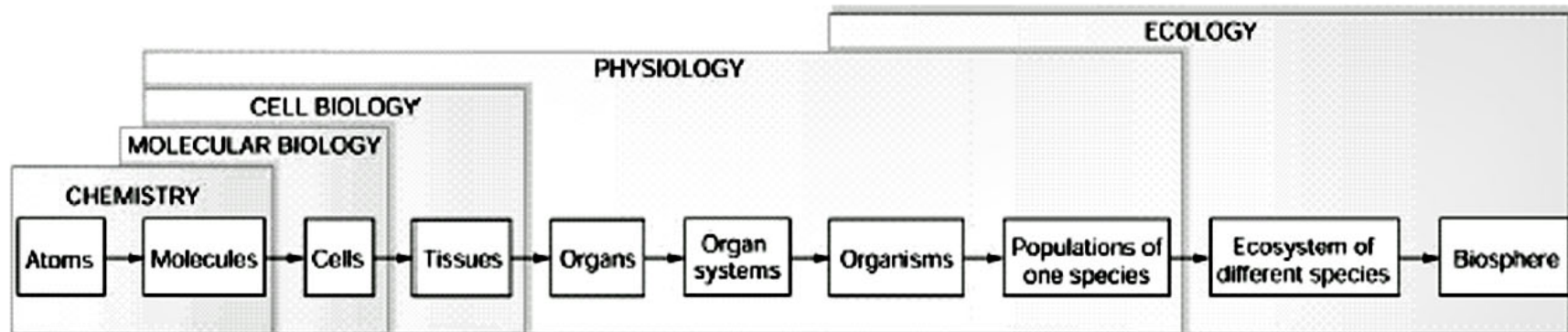
The goal of physiology is to explain the physical and chemical factors for the origin and progression of life

Asks *how do organisms work*: how do they function and what are the mechanisms

Study of mechanisms separates it from related fields

Various fields in science defined by their “level” of focus

Physiology integrates across many disciplines and levels of biological organization



Environmental Physiology – how physiological systems respond and adapt to changing environments

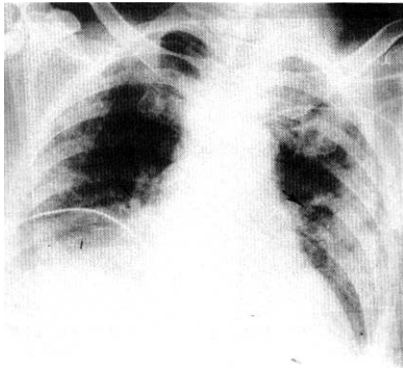
Comparative Physiology – diversity of how physiology works in various organisms. **Mechanisms** and **evolutionary origins**

Medical Physiology or Pathophysiology – abnormal physiology as a result of disease

Compare and contrast

Pathophysiology

Congestive heart failure due to insufficient O₂ supply



Impaired lung function eventually leads to death



Comparative Physiology

Animals can live at altitudes of 5000m with O₂ levels less than 1/2 sea level O₂



Northern elephant seal can breath-hold dive for over an hour!



Hierarchical organization of the body

Cells



Tissues



Functional units



Organs



Organ Systems



Organism

Differentiated into 4 general categories

1) muscle 2) nerve, 3) epithelial, 4) connective cells

Hierarchical organization of the body

Cells: There are over 200 distinct kinds in humans, grouped into four broad categories.

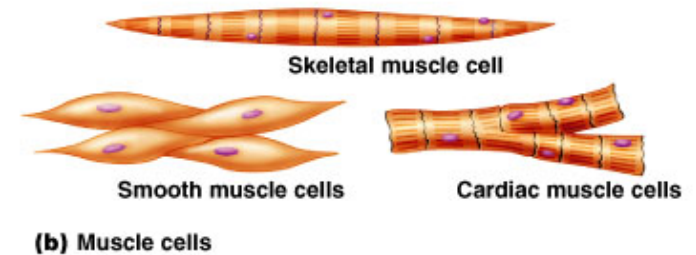
1) **Muscle cells:** specialized for contraction for movement

Subtypes:

Skeletal, movement of limbs and skin

Cardiac, movement of heart

Smooth, dilation of blood vessels



2) **Nerve cells:** generate and propagate electrical signals

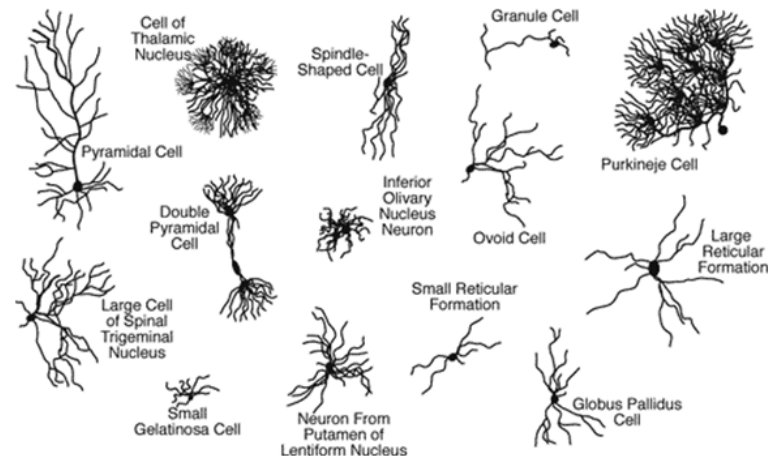
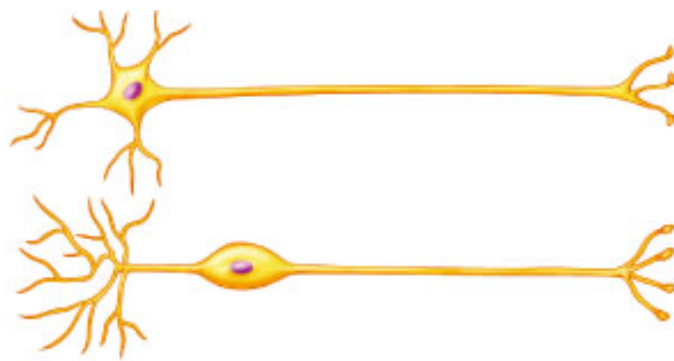


Fig 1-2

Hierarchical organization of the body

3) **Connective tissue cells**: the most diverse cell type, they often provide physical support to other structures.
e.g. bone, collagen, cartilage, fat cells

4) **Epithelial cells**: barrier function, often involved in secretion and absorption

Epithelial tissue = sheet of cells with an underlying basement membrane (non-cellular)

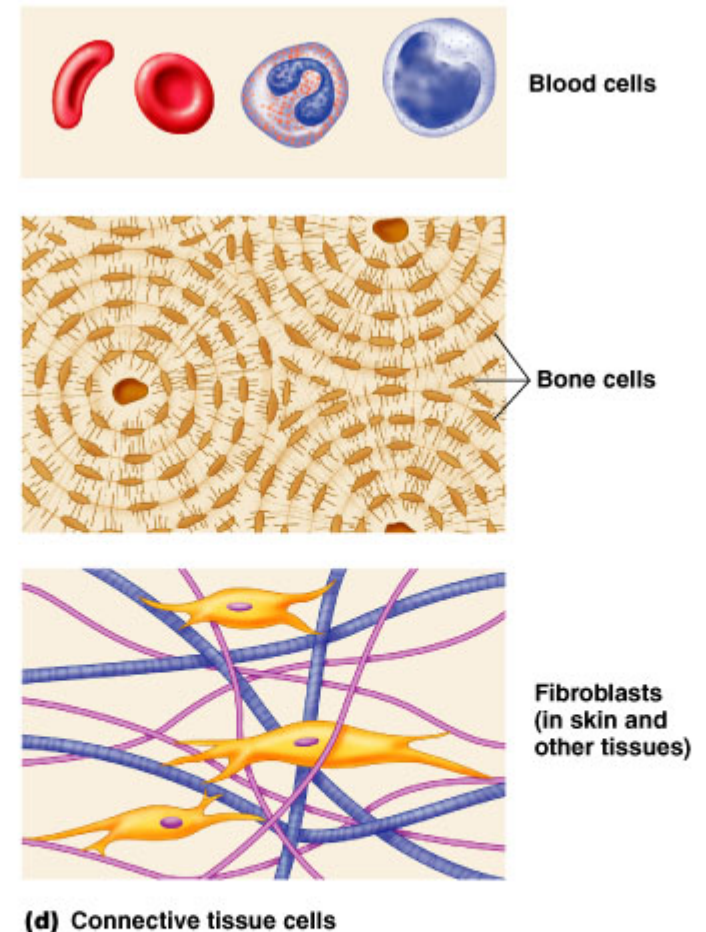
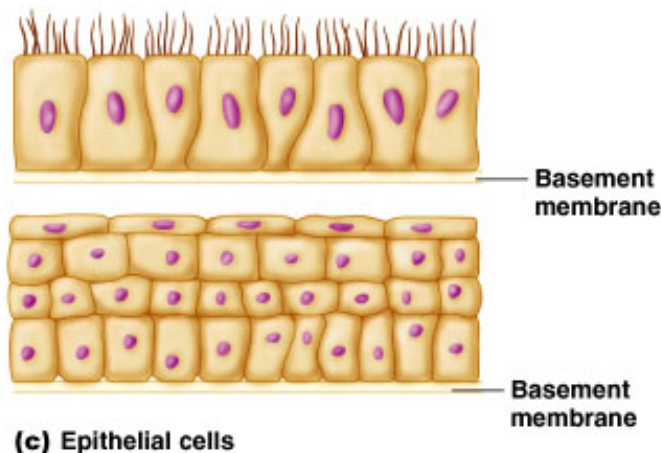
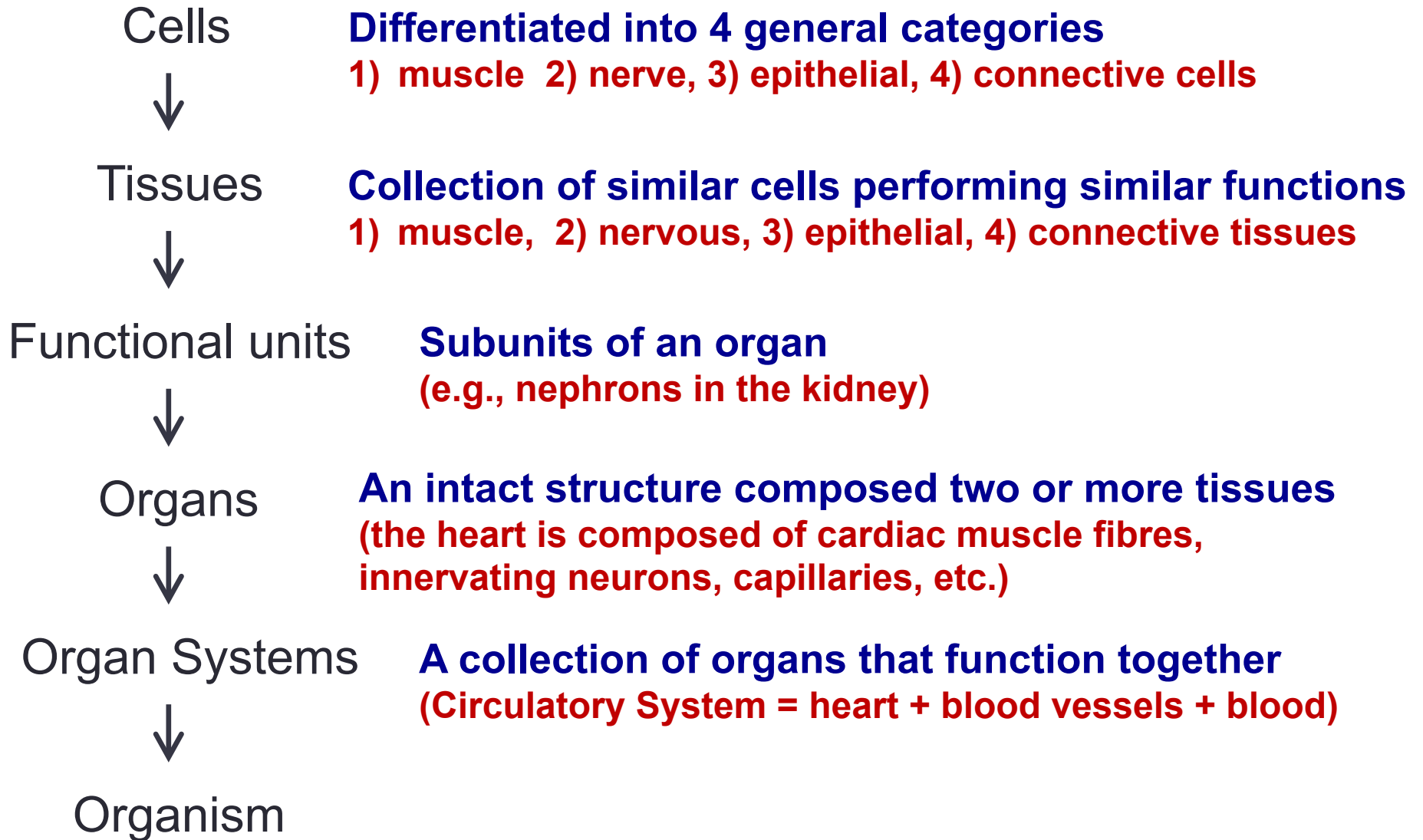


Fig 1-2

Hierarchical organization of the body



Hierarchical organization of the body

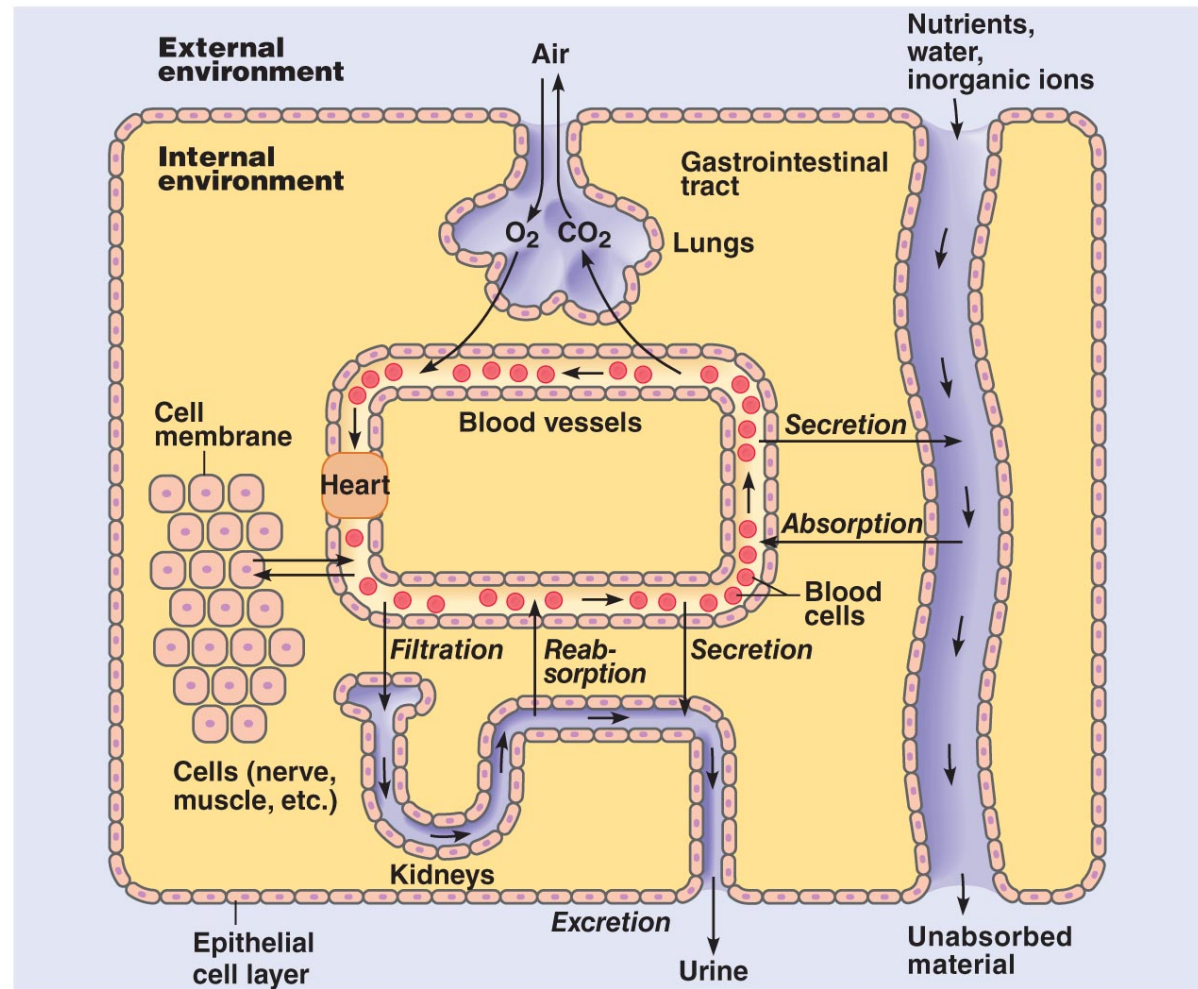
Organ Systems: A collection of organs that work together to accomplish a particular task

TABLE 1.1 Organ Systems

System	Some organs/tissues within system	Function
Endocrine	Hypothalamus, pituitary gland, adrenal gland, thyroid gland, parathyroid glands, thymus, pancreas	Provide communication between cells of the body through the release of hormones into the bloodstream
Nervous	Brain, spinal cord, peripheral nerves	Provide communication between cells of the body through electrical signals and the release of neurotransmitters into small gaps between certain cells
Musculoskeletal	Skeletal muscle, bones, tendons, ligaments	Support the body; allow voluntary movement of the body; allow facial expressions
Cardiovascular	Heart, blood vessels, blood	Transport molecules throughout the body in the bloodstream
Respiratory	Lungs, pharynx, trachea, bronchi	Bring oxygen into the body and eliminate carbon dioxide from the body
Urinary	Kidneys, ureters, bladder, urethra	Filter the blood to regulate acidity, blood volume, and ion concentrations; eliminate wastes
Gastrointestinal	Mouth, esophagus, stomach, small intestine, large intestine, liver, pancreas, gallbladder	Break down food and absorb it into the body
Reproductive	Gonads, reproductive tracts and glands	Generate offspring
Immune	White blood cells, thymus, lymph nodes, spleen, tonsils, adenoids	Defend the body against pathogens and abnormal cells
Integumentary	Skin	Protects the body from the external environment

*Highly simplified
view of the
overall body plan
of humans and
other mammals*

The internal
environment is
very stable, even
when the external
environment
changes

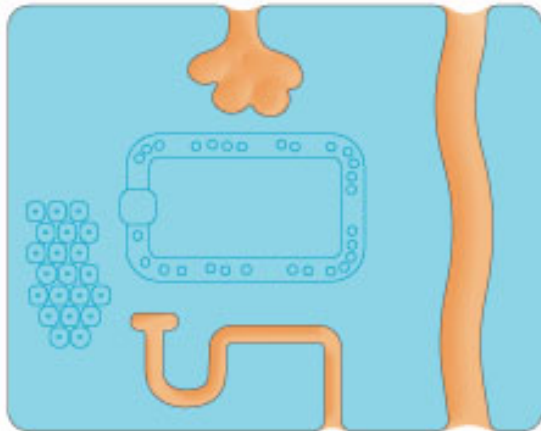


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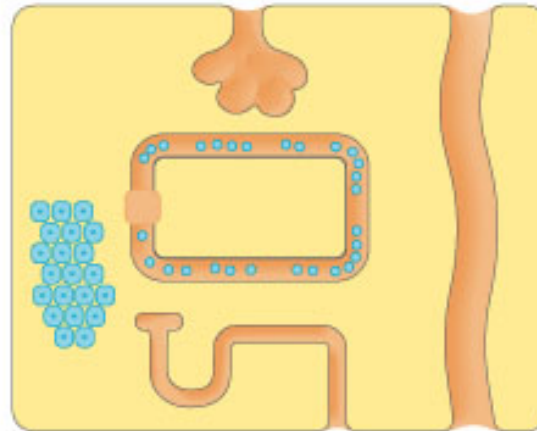
Fig 1-4

= HOMEOSTASIS, a defining feature of physiology

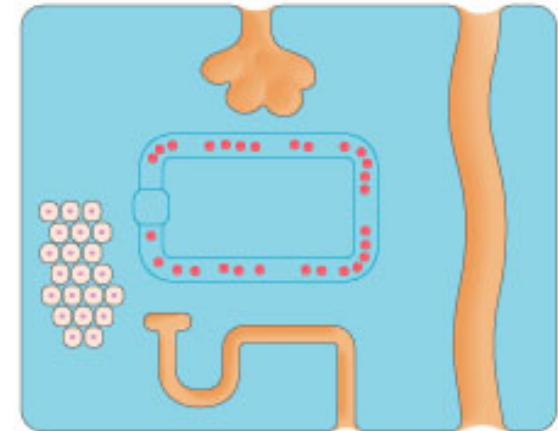
The Internal Environment – Lots of water!



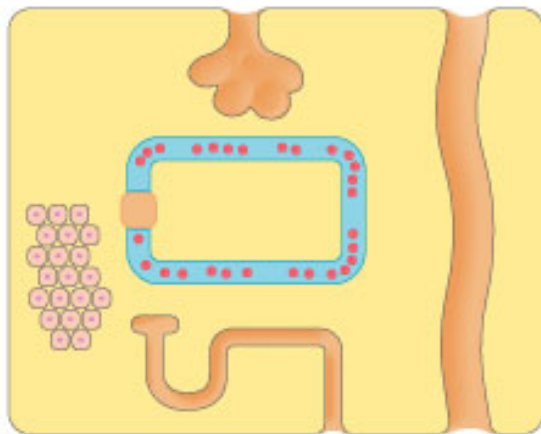
(a) Total body water (TBW)



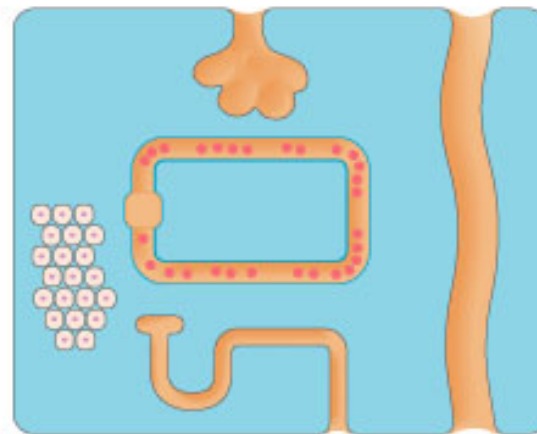
(b) Intracellular fluid (ICF)



(c) Extracellular fluid (ECF)



(d) Plasma



(e) Interstitial fluid (ISF)

Body fluid	Volume (L)
TBW	42
ICF	28
ECF	14
Plasma	3
ISF	11

(f) Distribution of TBW

The Internal Environment – Lots of water!

Total Body Water =	Intracellular H ₂ O	28 L	ICF	2/3
	Interstitial H ₂ O	11 L	ECF	1/3
	Plasma H ₂ O	3 L		
		<hr/>		
		42 L	or 60% body weight	

Extracellular Fluid (ECF) is rapidly transported by the circulation and mixes between blood and tissues by moving across capillary walls

ECF bathes tissues and makes up the internal milieu of the body

Proper cellular function depends on tight control of ECF components

Homeostasis

A Defining Feature of Physiology



Claude Bernard
(1813-1878)

"The stability of the internal environment [the *milieu intérieur*] is the condition for a free and independent life."



Walter
Cannon
(1871-1945)

Cannon was the first to formally propose the features of homeostasis:

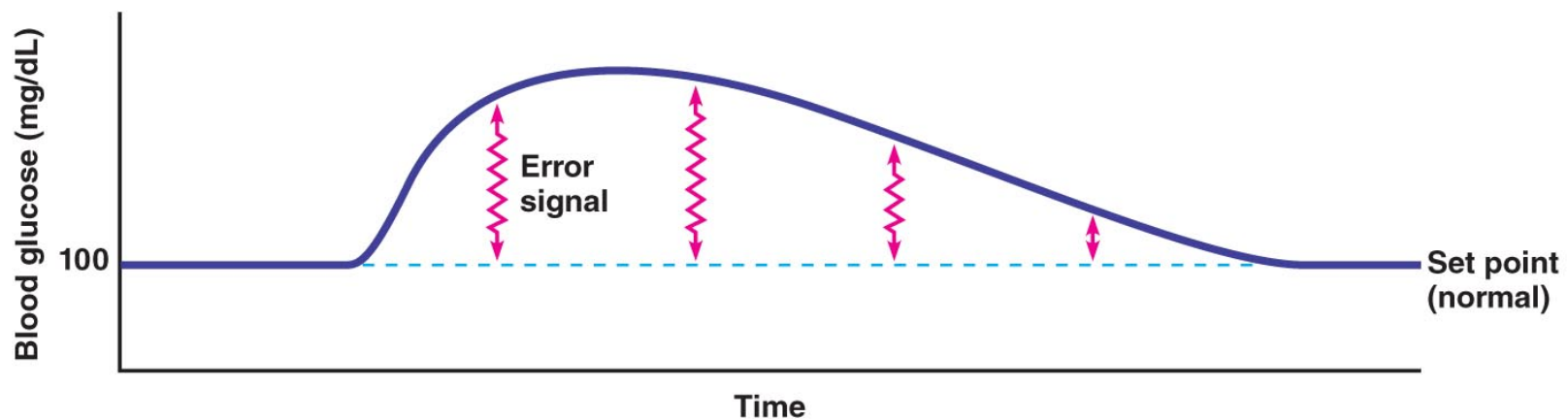
1. Homeostasis does not occur by chance, it is the result of actions of a coordinated regulatory system
2. The regulatory system that maintains homeostasis consists of cooperating mechanisms that act simultaneously or successively
3. The tendency toward change is opposed by physiological responses that resist change ("NEGATIVE FEEDBACK")

Negative Feedback

When a regulated variable changes, the change ('error signal') is detected and the regulatory system responds to oppose the change and buffer the internal environment



(c)



(d)

Fig 1-6

Negative Feedback

Components of a negative feedback loop:

1. Sensor
2. Integrating center
3. Effector

(in this example, the sensor and integrating center are the same)

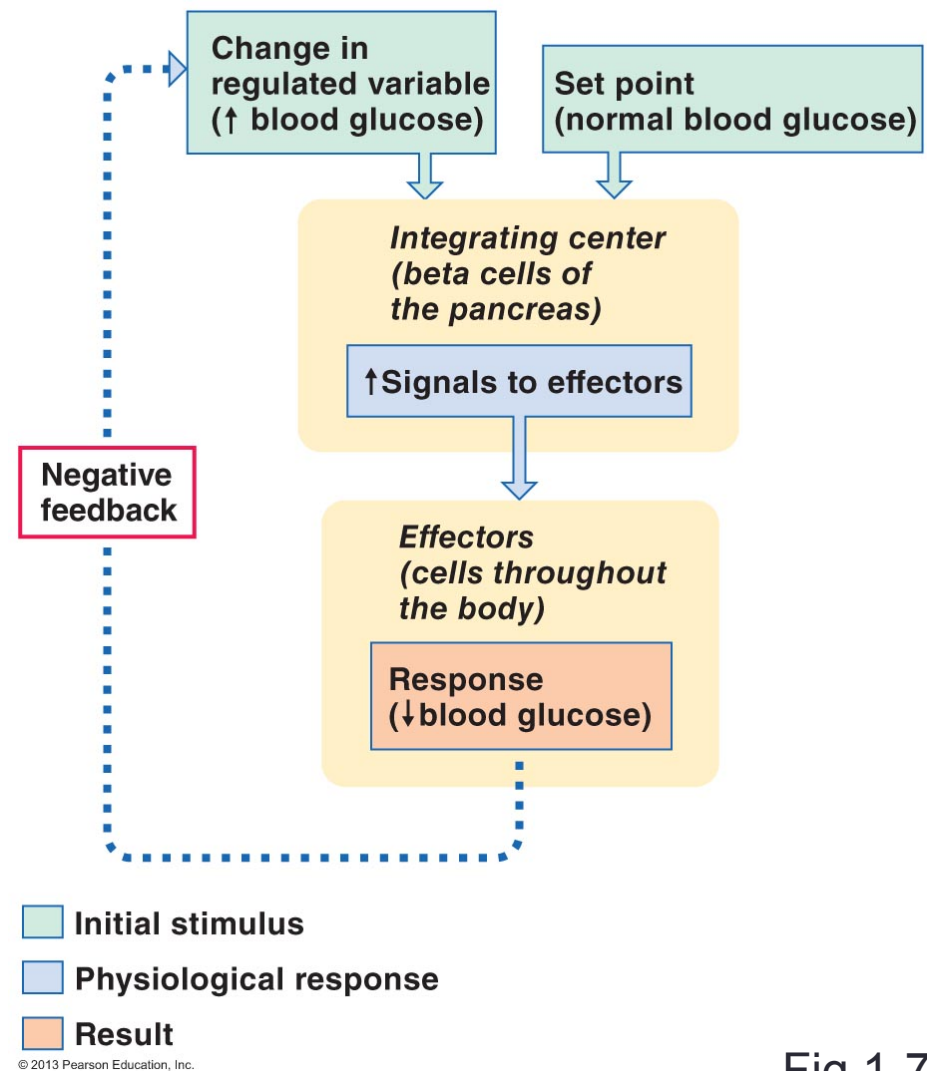


Fig 1-7

Thermoregulation

- How do you maintain body temperature?



Thermoregulation

