

# Animal Structure and Function -



## VERTEBRATE PHYSIOLOGY...

structure & function of cells, tissues, & organs of verts  
hierarchy: cell --> tissue --> organ --> organism

VERTs have a number of **similarities**.....

all have basic body plan & same sort of organs  
skeleton - with bony skull (cranium) surrounding brain  
jointed bones - ball & socket, hinge, & pivot joints  
vertebrate column around the dorsal nerve cord  
internal tube called coelom (mouth to anus)

- a) **thoracic cavity** -holds heart & lungs of verts
- b) **abdominal cavity** -holds stomach, intestines & liver

**evolutionary innovations of CHORDATES:** basic body plan  
bilateral symmetry, cephalization, notochord & spinal  
cord, gill slits, tail, a fully lined body cavity thoracic and  
abdominal cavities, gut tube (coelom), and segmented  
development (myomeres).

## **model vertebrate is ourselves - the human**

- a warm blooded vert that regulates its internal temperature at some constant value.  
cold blooded verts - do not (snakes, lizards, etc...)
- has hair instead of scales & feathers
- has birthing process instead of laying eggs
- human has about 165 different kinds of cells in its body

**Campbell readings:** C40 (818-841), C41 (844-849), C42 (879-883;  
893-895), C44 (922-926), & C45 (953-956).

## 4 Fundamental tissue of verts -

epithelial	connective	muscle	nerve
ectoderm	mesoderm	mesoderm	ectoderm

**EPITHELIAL** - prevents dehydration (loss of H<sub>2</sub>O)

- permeability barrier - sensory surfaces - secretory layer
- typed by shape: squamous, cuboidal, columnar, stratified

**CONNECTIVE** - bind and support other tissues

**Adipose tissue** - fat, which pads & insulates body

**Blood** - matrix (not solid) fluid of RBC & WBC's = transport  
...plasma (H<sub>2</sub>O, salts, dissolved proteins)

...transports substances to tissues

...WBC (lymphocytes/leukocytes - macrophages)

**Fibrous connective** dense matrix collagen fibers, ...forms

...tendons - attach muscles to bone

...ligaments - join bones together at joints

**Cartilage** - strong, but flexible skeletal material at bone end

...collagen fibers embedded in rubbery matrix

**Bone** - rigid connective tissue

...collagen fibers embedded in Ca-salts = hardness

**Loose connective** - loose weave of fiber proteins

...binds & packs- holding organs & tissue in place

## **MUSCLE Tissue** - made from mesoderm

contains proteins : actin & myosin = in filament forms

3 kinds: a) **smooth**.... non-striated

b) **skeletal**.... striated

assembled into fibers called myofibrils

c) **cardiac**.... striated, but branched

## **NERVE Tissue** - cells that conduct electrical impulses

2 kinds a) neurons

b) glial cells - surround, support, insulates, & protects neurons

**ORGANS** - systems made of the 4 types of tissue above, which catalyze a physiological process (specific function)

### **The ORGAN SYSTEMS.....** Table (web)

a. digestive

b. respiratory

c. cardiovascular

d. lymphatic & immune

e. excretory

f. endocrine

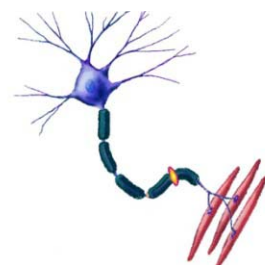
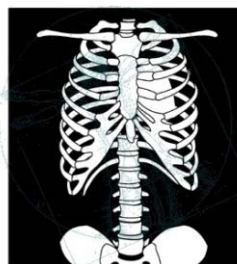
g. reproductive

h. nervous

i. muscular

j. skeletal &

k. integumentary



## **METABOLIC RATE:**



### **Animal Bioenergetics...**

energy costs.... to do vertebrate physiology

energy costs.... to walk, run, swim, or just to be...

**BASAL METABOLIC RATE** - total energy used per unit time measured in **calories** - amt of heat energy raise 1g H<sub>2</sub>O 1°C determined by **O<sub>2</sub> consumption**.

equipment = **respirometer**, stress test & cycle ergometer, swimming flume, etc

minimal = that required for functions of life

maximal = peak metabolic activity - Olympic swimmer

influenced by variables that make up science of Physiology  
age, sex, body size, temp, food level, time of day,  
size of organism, hormonal balance, available O<sub>2</sub>

**BMR** - **endotherms** @ rest w/o stress

an animal that derives its body heat from its own metabolism ex : humans

males 1,600 - 1,800 Kc/d

females 1,300 - 1,500 Kc/d

Lance Armstrong = 6,500Kc/d & 10,000Kc/d for mountains  
heart is 1/3 larger, @ rest = 32 bpm & @ max = 200 bpm,  
w stroke volume of 200 (2x avg)

**SMR** - standard metabolic rate - **ectotherms** @ given temp  
an animal that warms itself by absorbing heat from its surroundings

# HOMEOSTATIC MECHANISMS...

Animals regulate their internal environment

**HOMEOSTASIS**... maintenance of a steady state internal environment (constancy) in face of a changing external environment

**Physiological Compensation**... short term physiological adjustments or adaptations to environmental changes, i.e., homeostatic compensation

**Internal "milieu"** - (claude bernard - Fr. 1880's)  
the interstitial fluids filling spaces between cells  
the milieu exchanges nutrients w blood

## Constancy of human milieu

body temp	39° C + 1° C
pH	7.4 + 0.1
blood sugar	0.1%

## Homeostatic Regulation:

is mechanisms that cells have evolved to remain constant

A homeostatic Regulator - 3 parts \*

<b>receptor</b> ....	detects a change	<b>thermometer</b>
<b>controller</b> ...	processes info = response	<b>thermostat</b>
<b>effector</b> ...	produce the response	<b>heater</b>

## Examples of Homeostatic Regulations:

1. Room temperature controllers - see model  
& **Hypothalamus** regulation of body temperature

2. **pH regulation of the blood**

pH 7.4 +/- 0.1 a shift of 0.4 pH unit = death

'**Andromeda Strain**' - space microbe infects people -  
die by blood clotting ; growth curve of virus-microbe  
has narrow pH range. (see web)

Only 2 survived.....

a crying baby = alkalosis - blows off CO<sub>2</sub> lowers acidity  
& drunk = acidosis - bleeding stomach ulcers

### Carbonic anhydrase



Hb pick up H<sup>+</sup> ions buffering blood

if pH blood drops [H<sup>+</sup> ↑] then H<sub>2</sub>CO<sub>3</sub> → H<sub>2</sub>O + CO<sub>2</sub>

3. **Calcium homeostasis** (in blood - range is 9 to 11 mg%)

Ca<sup>2+</sup> needed for nerve function, muscle contraction,  
blood clotting, etc.

#### antagonistic hormones

**thyroid** --> **calcitonin** hormone - lowers Ca levels  
causes Ca to be deposited in bone  
reduces intestinal absorption of Ca  
reduce Ca uptake by kidney

**parathyroid** --> **parathyroid hormone** - raises Ca levels  
stimulates release Ca from bone  
increase Ca uptake by intestine & kidney

#### 4. Blood Glucose balance

pancreas makes **insulin** and **glucagon**  
antagonistic hormones

#### 5. Osmoregulation - water balance of organism

**osmosis** - net movement of water hypotonic to hypertonic  
**terrestrial animal**.... gain water water from food & drink  
lose water by urinating, defecating, & evaporation

**aquatic animals**....

**osmoconformer**... internal [solute] same as environment

**osmoregulator**... internal [solute] maintain constant level

#### fresh water vs. seawater fish

**FW fish** - internal solutes greater... thus gains water thru its  
body surface, its gills, and food

compensates does not drink water

excretes large amounts dilute urine

gills take up lost ions [Na, Cl, K]

**SW fish** - internal solutes less... thus constantly loses water

compensates drinks SW

pumps ions [Na, Cl, K] out via gills

urinates ions



**Other marine vertebrates - birds & sharks**

