10 major organ systems in a vertebrate

1 Integumentary	Skin	**Protect** the body from the external environment
2 Musculoskeletal	Skeletal muscle, bones, tendons, ligaments	**Support** of the body, allow voluntary movement of the body; facial expressions
3 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
4 Nervous	Brain, spinal chord, peripheral nerves	Provide **communication** between cells of the body through electrical signals and the release of neurotransmitters into small gaps between certain cells
5 Immune	White blood cells, thymus, lymph nodes, spleen, tonsils, adenoids	**Defend** the body against pathogens and abnormal cells
6 Cardiovascular	Heart, blood vessels, blood	**Transport** molecules throughout the body in bloodstream
7 Respiratory	Lungs, pharynx, trachea, bronchi	Bring O_2 into the body and eliminate CO_2 from the body
8 Urinary	Kidneys, ureters, bladder, urethra	Filter the blood to regulate acidity, blood volume and ion concentrations (**Osmoregulation**); **excrete** wastes
9 Gastrointestinal	Mouth, oesophagus, stomach, small intestine, large intestine, liver, pancreas, gallbladder	Break down food and absorb it into the body (**assimilation**)
10 Reproduction	Gonads, reproductive tracts and glands	Generate **offspring**

BMS107 Lecture Summaries

Vertebrates have
- Backbone
- an endoskeleton – paired limbs, cranium
- Complex organ systems – e.g. a closed circulatory system

Lecture 1: Intro

Physiology – The study of the normal functioning of a living organism and its component parts including physical and chemical processes. Anatomy AND function

Anatomy – can be seen, is the structure of the organism.

Physiological processes – regulated to maintain internal conditions. Obeys physical and chemical laws

Physiological state – part of its phenotype which is influenced by nature over generations

Vertebrate body plan – multicellular, bilateral symmetry, triploblastic (3 types of tissues as embryos via gastrulation – form ecto, endo and mesoderms), Coelom,

Multicellular – enables vertebrates to expand in size, increases surface area:volume ratio

Bilateral symmetry – cut in half, roughly symmetrical either side

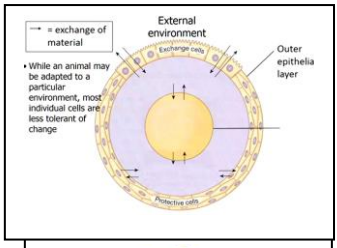
Triploblastic – 3 types of tissues (germ layers) as part of embryonic development. They become organs as embryo develops (fertilised egg, 4 cell stage, morula and blastula.). The formation is called gastrulation where blastula turns into gastrula (ectoderm, mesoderm and endoderm).

ECTODERM	MESODERM	ENDODERM
• Epidermis of skin and its derivatives (including sweat glands, hair follicles) • Epithelial lining of mouth and rectum • Cornea and lens of eye • Nervous system • Adrenal medulla • Tooth enamel • Epithelium of pineal and pituitary glands	• Notochord • Skeletal system • Muscular system • Muscular layer of stomach, intestine, etc. • Urinary system • Circulatory and lymphatic systems • Reproductive system (except germ cells) • Dermis of skin • Lining of body cavity • Adrenal cortex	• Epithelial lining of digestive tract • Epithelial lining of respiratory system • Lining of urethra, urinary bladder, and reproductive system • Liver • Pancreas • Thymus • Thyroid and parathyroid glands

Coelom – body cavity/gastro intestinal system, lined by endoderm. 2 types protostome and deuterostome. “tube within a tube”.

Chordata phylum similarities as embryo – notochord, cephalisation, ventral heart, pharageal slits, dorsal nerve chord, tail extending past anus

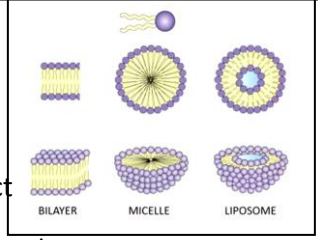
Vert similarities – vertebral column (surrounds notochord and nerve cord)



Lecture 2: Body composition and cell membranes

BC – glycogen, phosphorus, calcium, water, potassium, sodium, protein and fat plus mg/cl/fe/zn/cu

Only cells in contact with external env are epithelial cells. Most cells are protected by extracellular fluid.



TBW – intracellular fluid (66% TBW) and extracellular fluid (33% TBW)

Extracellular fluid – Plasma (20% ECF, in blood) and Interstitial (80% ECF, out of blood)

Specialist ECF compartments – lymph, cerebrospinal, synovial, serous, secretions of GI tract

Solute – substance that is dissolved Solvent – liquid Solution – mix of the solute and solvent

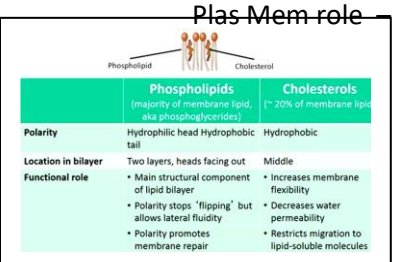
Electrolytes	Non-electrolytes
• Dissociate into charged ions in water	• Do not dissociate in water
• Ionic bonds	• Covalent bonds
• Solutions of electrolytes can conduct electricity	• Solutions of non-electrolytes are not electrically-charged
• Include inorganic salts, inorganic and organic acids and bases, some proteins	• Mostly organic molecules
Na^+ Cl^-	O =C = O O = O
Electrolyte = a charged solute	

Osmolarity – total number of particles in a litre of solution

Most electrolytes are higher in conc outside the cell, except for K^+ and proteins

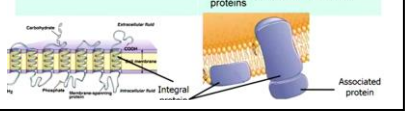
Plasma cell membrane surrounds the cell, regulating the intra and extracell fluid

Plas Mem role – isolation, regulation, communication and structural support

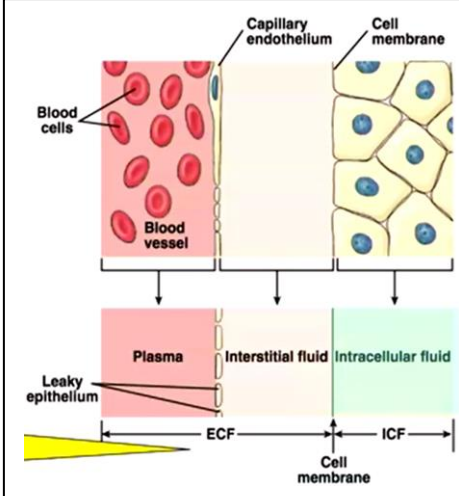


	Phospholipids (majority of membrane lipid, aka phosphoglycerides)	Cholesterols (~ 20% of membrane lipid)
Polarity	Hydrophilic head Hydrophobic tail	Hydrophobic
Location in bilayer	Two layers, heads facing out	Middle
Functional role	• Main structural component of lipid bilayer • Polarity stops ‘flipping’ but allows lateral fluidity • Polarity promotes membrane repair	• Increases membrane flexibility • Decreases water permeability • Restricts migration to lipid-soluble molecules

Integral proteins (membrane spanning)	Peripheral proteins (associated)
• Tightly bound in phospholipid layer • Extend into/through layers • Include membrane channels and transporters	• Attach loosely to integral proteins or phospholipid head • Can be removed without disrupting membrane integrity (flexibility) • Include enzymes and structural proteins



Membrane	Protein	Lipid	Cholesterol
Red blood cell	49%	43%	8%
Myelin membrane around nerve cells (sphingolipids)	18%	79%	3%
Inner mitochondrial membrane	76%	24%	0%

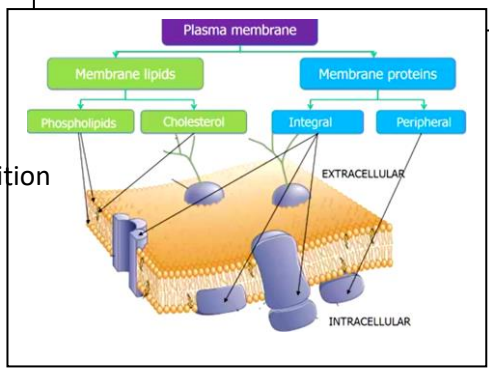


Plas Mem structure – 'fluid-mosaic', phospholipid bilayer (hydrophobic tail, hydrophilic head), dynamic and fluid structure

Polarity promotes membrane repair and prevents them flipping around

Membrane Protein function – structural, enzymes, receptor, transport

Glycocalyx – part of Plas Mem structure. Carbohydrate molecules that line outside of the cell. Attach to lipids OR proteins. Cell recognition and allows for fertilisation, immune response to bacteria.

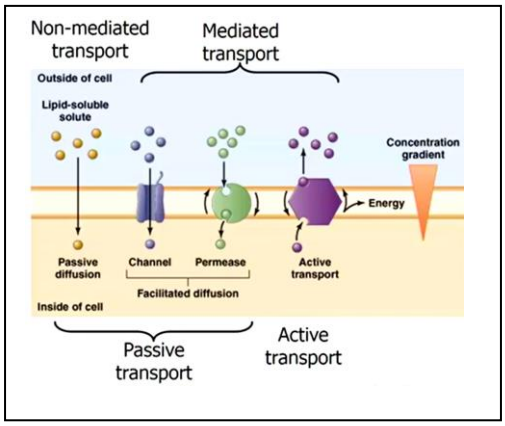


Mem heterogeneity – significant structural variation between different parts of a membrane.

Homeoviscous adaption – changing of membrane position and lipid composition

Membranes important for fat movement. Fat breaks down via bile. Goes into phospholipid membrane layers for transport in a hydrophilic capsule, into our blood to be moved.

Lecture 3: Movement across membranes



Plasma mem – selective permeability (O2 and CO2 permeable) (ions and proteins etc impermeable)

Diffusion properties – passive process using momentum of individual molecules via collision/kinetic energy. High conc to low conc (conc gradient). Rate is dependent on the amount of conc difference. Nett movement of molecules until equal concentration is met (equilibrium). Rapid over short distanced, slow over long distance (double distance = 4x longer time).

Epithelia – Protective Ep, Echange Ep, Transporting Eo, Ciliated Ep and Secretory Ep (Exocrine – secrete to external env and Endocrine – secrete to internal env)

Diff is directly related to temperature – high temp, molecules have more kinetic energy and more diff. Not as significant in warm-blooded animals as consistent temperature

Diff is related to molecule size – Large move slower than small molecules due to impermiability and friction with environment

Diff can occur in an open system or across a partition. Partition if it is permeable to that particular molecule.

Simple Diffusion – rate depends on ability of mol to pass through membrane (hydrophobic pass easily, hydrophilic not as easy). Small/lipid soluble mol pass through easily, large/less soluble require processes or do not pass through. Non polar lipid soluble mol can transfer through the central lipid core of a membrane. Proportional to surface area of membrane – larger SA = faster diffusion. Proportional to the thickness of membrane (thick = slow).

Mediated Transport – protein into membrane allowing mol to pass the lipid bilayer

Ficks Law

Describes the diffusion coefficient of a solute that is influenced by its structural properties

$$\frac{dQ_s}{d_t} = D_s \times A \times \frac{dC}{dX}$$

dQs/dt = rate of diffusion of a solute (s), or amount of solute (s) moved per unit of time (t)
Ds = diffusion coefficient of the solute
A = diffusion area
dC/dX = concentration gradient (i.e. difference in solute concentration per unit distance)

Many biological systems are limited by the rate of diffusion, so increase surface area to enable *e.g. absorption* to occur