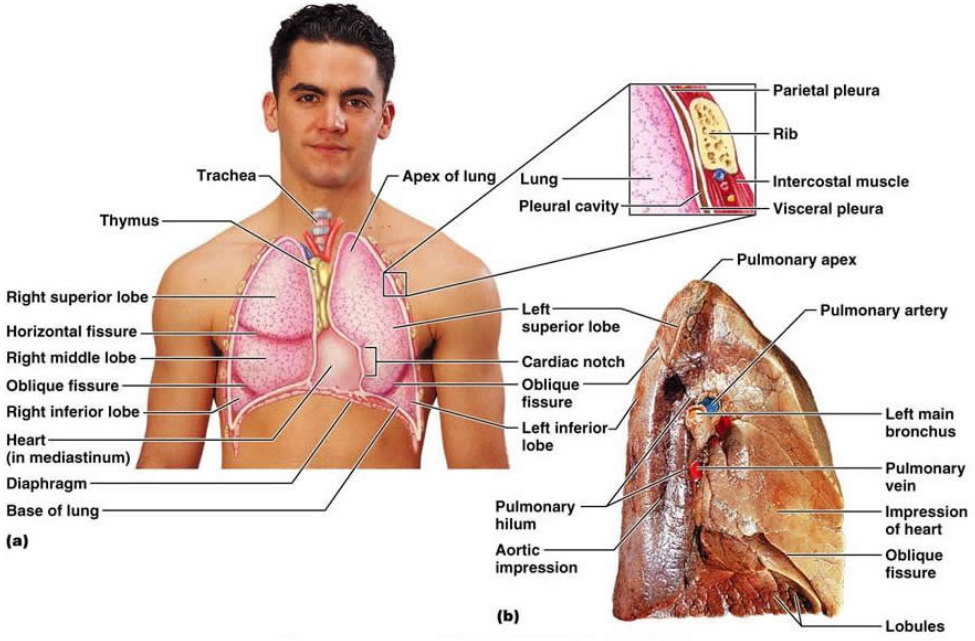
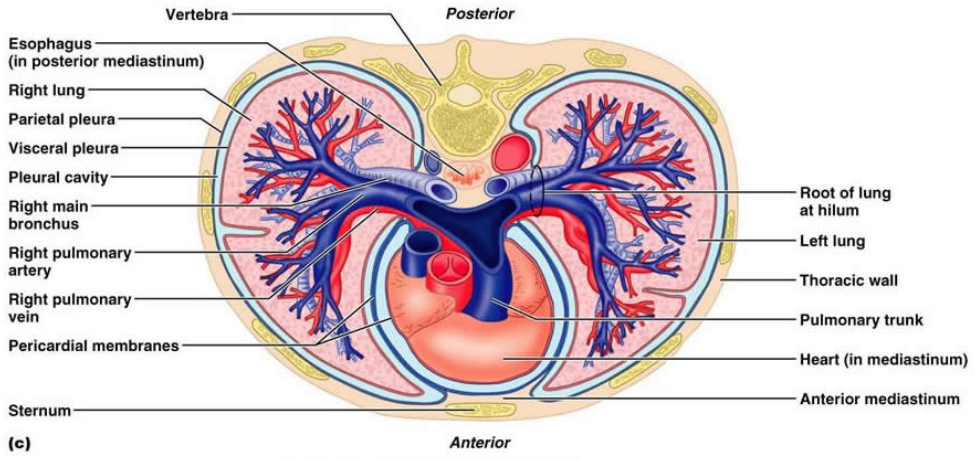
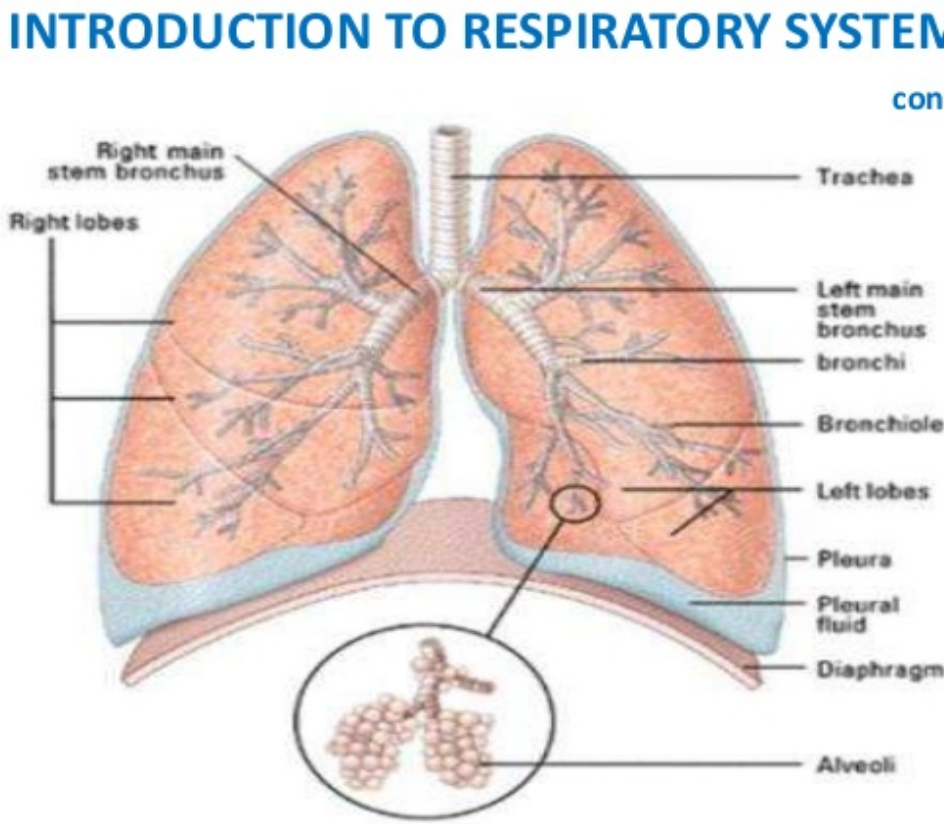
HNN325 WEEK ONE: CARE OF THE PT WITH RESPIRATORY DYSFUNTION

Anatomy of thoracic cavity and respiratory tract







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Mechanics of breathing

→ Action of breathing in and out is due to changes of pressure within the thorax in comparison with the outside (external respiration).
→ When we **inhale** the intercostal muscles (between the ribs) and diaphragm contract to expand the chest cavity, the diaphragm flattens and moves downwards and the intercostal muscles move the rib cage upwards and out.
→ This increase in size decreases the internal air pressure and so air from the outside (at a now higher pressure than inside the thorax) rushes into the lungs to equalize the pressures.
→ When we **exhale** the diaphragm and intercostal muscles relax and return to their resting positions, this reduces the size of the thoracic cavity thereby increasing the pressure and forcing air out of the lungs.

Role of visceral and parietal pleura in maintaining negative pleural pressure

→ Pleural pressure (PPL) is the pressure surrounding the lung within the pleural space.
→ During quiet breathing the PPL is negative (below atmospheric pressure)
→ The pleural is a thin membrane which invests the lungs and lines the walls of the thoracic cavity.
→ During development the lungs grow into pleural sacs until they are completely surrounded by them
→ **visceral pleura** is pleura that covers the lung
→ **parietal pleura** is pleura that covers the chest wall/ribs
→ These two sides are continuous and meet at the hilum of the lung
→ The 2 faces of the pleural membrane are directly opposed to one another and the entire potential space within the pleura contains only a few milliliters of serous pleural fluid.
→ The size of the lung is determined by the difference between the alveolar pressure, pleural pressure or transpulmonary pressure. (the bigger the difference - the bigger the lung)
→ Due to gravity, in an upright individual the PPL at the base of the lung is greater (less neg) than at its apex; when the individual lays on his back – the PPL becomes greatest along his back.
→ Since alveolar pressure is uniform throughout the lung, the top of the lungs generally experience a greater transpulmonary pressure and therefore are more expanded and less compliant then the bottom of the lung.
→ During active expiration, the abdo muscles contract to force up the diaphragm and the resulting pleural pressure can become positive. Positive PPL may temporarily collapse the bronchi and cause limitation of airflow.

Normal stimulus for breathing

→ The rise in co2 levels in the blood drives to take a breath in order to expel it from the body
→ Chemoreceptors in the hypothalamus (resp centre)
→ Baroreceptors in circulation

Principles of gas exchange at the alveolar level

→ Diffusion occurs when molecules move from an area of high concentration (of that molecule) to an area of low concentration
→ This occurs during gaseous exchange as the blood in the capillaries surrounding the alveoli has a lower oxygen concentration of oxygen than the air in the alveoli which has just been inhaled
→ Both alveoli and capillaries have walls which are only one cell thick and allow gases to diffuse across them
The same happens with Carbon Dioxide (CO2), the blood in the surrounding capillaries has a higher concentration of CO2 than the inspired air due to it being a waste product of energy production. Therefore CO2 diffuses the other way, - from capillaries into the alveoli where it can be exhaled

Arterial Blood Gas Analysis → → →

→ Generally sampled from the radial artery
→ Test is particularly painful and requires local anesthetic

Arterial Blood Gas:		
Parameter	**Patient Value**	**Normal Adult Range**
pH	7.07*	7.35 – 7.45
PaO_2	59 mmHg (7.8 kPa)*	
$PaCO_2$	25 mmHg (3.3 kPa)*	35 – 45 (4.6 – 6.0)
Bicarbonate	7 mmol/L*	22 – 26
Base Excess	-22 mmol/L*	-2 – +2
Lactate	0.8 mmol/L	< 2.0
Venous Biochemistry:		
Parameter	**Patient Value**	**Normal Adult Range**
Sodium	133 mmol/L*	135 – 150 mmol/L
Potassium	6.2 mmol/L*	3.4 – 5.0
Chloride	94 mmol/L*	100 – 110
Urea	25.9 mmol/L*	3.0 – 8.0
Creatinine	271 μmol/L*	50 – 120
Total Bilirubin	13 μmol/L	< 20
Albumin	42 G/L	35 – 50
Alanine Aminotransferase	360 U/L*	< 35
Aspartate Aminotransferase	612 U/L*	< 40
γ-Glutamyl Transferase	52 U/L*	< 40
Alkaline Phosphatase	123 U/L	35 – 135
Creatine Kinase	335 U/L*	30 – 140
Calcium (corrected)	2.65 mmol/L*	2.15 – 2.60
Magnesium	1.52 mmol/L*	0.7 – 1.10
Phosphate	3.91 mmol/L*	0.8 – 1.50
Glucose	10.5 mmol/L*	3.0 – 5.4
Ketones	6.6 mmol/L*	< 0.5

HNN325 WEEK TWO: CARE OF THE PT WITH SYSTEMIC INFLAMMATORY RESPONSE SYNDROM (SIRS) AND SHOCK STATES

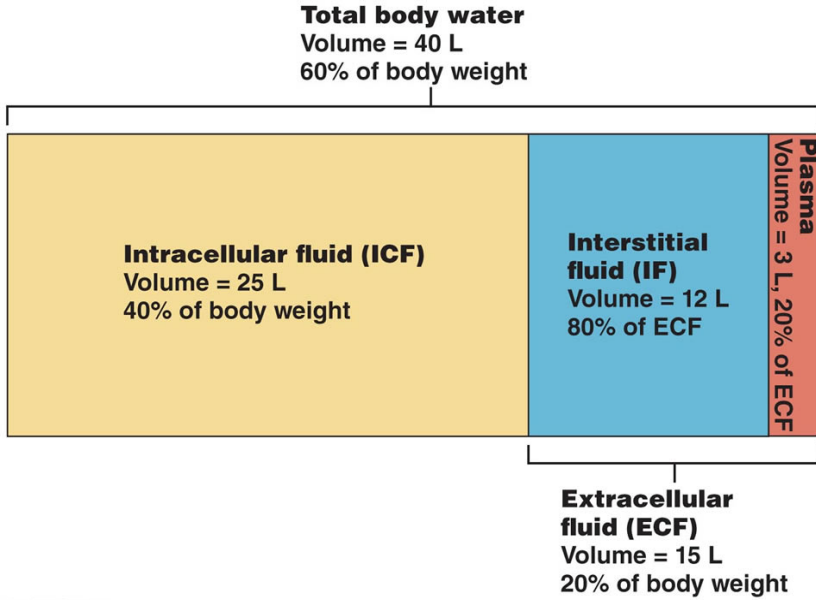
Principles of fluid movement

Describe the distribution of fluids in the body

1. Intracellular fluid compartment (ICF) – 40% of body weight
2. Extracellular fluid compartment (ECF) (outside of the cells)- 20% of body weight

INCLUDES;

→ Intravascular fluid (blood vessels/heart)
→ Interstitial fluid (in tissues not cells)



Outline the composition of the fluid in each compartment of the body

Water is contained within numerous organs and tissues in the body. These fluids can be lumped into larger collections which can be discussed in a physiologically meaningful way. These collections are referred to as compartments.

ICF = 23litres
ECF = 19litres
* Based on average adult 70kg *

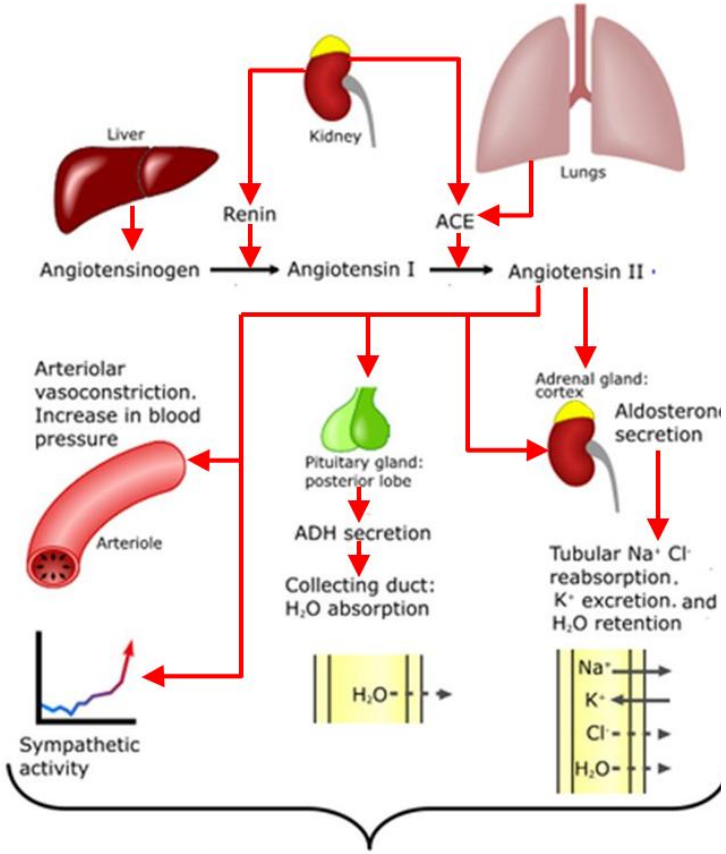
Main Electrolytes

→ Sodium – Main electrolyte, ECF, Nerve Impulses and Regulate acid-base balance
→ Chloride – 2nd most important, Gastric secretions and Regulate acid-base balance
→ Potassium – Mainly located within cells, cardiac/neuromuscular function, VITAL nerve conduction, cardiac conduction and skeletal/smooth muscle formation
→ Calcium – Nerve Impulses, muscle contractions, blood clotting and bone formation
→ Phosphate – Nerve muscle function, red blood cell function, bone formation, cell metabolism and metabolism of fat and protein
→ Magnesium – ICF metabolism, nerve conduction and cardiac function

NERVE IMPULES ARE ELECTRICAL THUS ELECTROLYTES ARE VITAL

Describe the regulation of body fluids by the renal and endocrine systems.
Including:
Aldosterone: Increases the retention of sodium and chloride ions as well as water by the kidneys. These factors combined result in an increase in the level of body fluid and an increase in BP.
Anti-diuretic hormone: ADH regulates the composition or the urine by acting on the distal convulted tubule (part of the nephron in kidneys) and increase the sodium ion reabsorption and potassium secretion, thus, maintaining electrolyte balance of the urine.
Nautrietic peptides: Natriuresis is the process of excretion of abnormally large amounts of sodium in urine. There are 3 naturally occurring protein hormones that cause natriuresis. They are called A-type, B-type and C-type natriuretic peptide (small protein molecules). These peptides lower the concentration of sodium in the blood, which tends to lower blood volume because the sodium takes water with it into the urine.

Renin-angiotensin-aldosterone system (RAAS)
→ Kicks in when low blood pressure or low sodium (low fluid volume, where sodium goes water follows)
→ Begins with liver → Liver releases angiotensinogen → in response to that, kidney releases an enzyme called renin. Angiotensinogen + Renin react forming Angiotensin I.
→ Angiotensin I is released in the bloodstream. When it gets to lungs, lungs release ACE. Angiotensin I + ACE meet = Angiotensin II.
→ Angiotensin II works on level of adrenal glands and kidneys.
→ Angiotensin II gets to adrenal glands and creates aldosterone. Aldosterone (end product).
→ Aldosterone help BP regulation → increase reabsorption of sodium (increasing fluid thus increasing BP) → Also decreases potassium.
→ Vasoconstriction in arterioles → increases BP



Describe the processes of osmosis, diffusion and active transport

Osmosis: When fluid moves from an area of high concentration to low concentration through a semi-permeable membrane

Diffusion: The passive movement of molecules or particles along a concentration gradient or from higher regions to regions of lower concentration.

Filtration: Relies on pressure. Two types of pressure – oncotic pressure and hydrostatic pressure.

Active transport: The movement of ions or molecules across a cell membrane into a region of higher concentration, assisted by enzymes requiring energy. Moves sodium out of the cell and potassium in to the cell. Aim is that Potassium is higher in the cell and Sodium is high outside the cell.

Places where this takes place

Osmosis → Occurs anywhere in the body where there is water for example; blood, kidneys and stomach

Diffusion → Occurs at gas exchange at the alveoli **–** oxygen from air to blood, carbon dioxide from blood to air.

Active Transport → Small intestine during digestion of food. Kidneys use it by moving urea and nitrogen from the blood. Low concentration of urea in the blood to a higher concentration in the kidneys.

Explain capillary exchange (starlings law of capillaries)

→ Capillary exchange is the movement of resp gases (oxygen and carbon dioxide) and nutrient and waste molecules between the plasma and the interstitial fluid by a variety of active ans passive means; O2 and nutrients tend to move to the interstitial fluid while CO2 and wastes tend to move to the plasma.

→ Starlings law of capillaries:

<u>Fluid Composition</u>

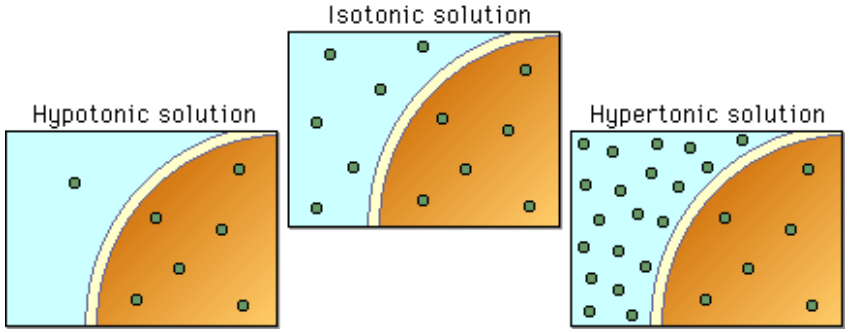
Tonicity: Normal firmness or functional readiness in body tissues and organs

Osmolality: Defined as the number of osmoles of solute per kg of solvent → 280osm

Osmolarity: The concentration of osmotically active particles in solution which may be quantively expressed as osmoles of solute per litre of solution.

Define the terms isotonic, hypertonic and hypotonic and their effects on fluid movement in the body

Isotonic: One in which its effective osmole concentration is the same as solute concentration of another solution with which it is compared.
TYPE: 0.9% Saline (N/S), ringers solution, Lactated Ringers, 5% dextrose in water and 5% Dextrose in 0.225% Saline.
STAY WHERE I PUT IT



Hypotonic: Lesser concentration. Low concentration of solutes in its surroundings so in an attempt to balance concentrations water enters cell causing swelling.
TYPE: 0.45% Saline and 5% Dextrose in Water (this is technically **isotonic**, but once the dextrose is absorbed then it acts on the body as if it were hypotonic).
GO OUT OF THE VESSEL
Hypertonic: Greater concentration. Higher concentration of solutes on the outside of the cell. When the cell is immersed into a hypertonic solution water flows out of cell in order to maintain balance in concentration.
TYPE: 10% dextrose in water, 3% saline, 5% dextrose in 0.45% saline and 5% dextrose in 0.9% saline.
ENTER THE VESSEL

Describe difference between a crystalloid and colloid solution

Crystalloids are small molecules and are able to pass through the blood vessel membrane and colloids are large molecules that are not able to pass through the blood vessel membrane.

Systemic Inflammatory Response Syndrome (SIRS)

→ Similar to the pathophysiologic properties with minor differences in inciting cascades.
→ Considered one of the body's self-defense mechanisms
→ Occurs when there is an imbalance in inflammatory mediators

3 STAGES

STAGE I → Following an insult, local cytokine is produced with the goal of inciting an inflammatory response, thereby promoting wound repair and recruitment of the reticular endothelial system
STAGE II → Small quantities of local cytokines are released into the circulation to improve the local response. This leads to growth factor

potent cause).
*If we have increased CO2 in out bodies (eg. Pt RR very low like 4). CO2 is a potent vasodilator and will increase the CBF. If pt increases RR to 30, they are getting rid of more CO2 thus CO2 reduces causing vasoconstriction = lower CBF
* Same occurs with Hydrogen ions = Vasodilation
* O2 opposite effect –decrease in O2 causes vasodilation to increase blood flow to brain
* 1 degree temp rise causes 6% increase in ICP
* BP or MAP drops below 50-70mmHg there will be decreased CBF

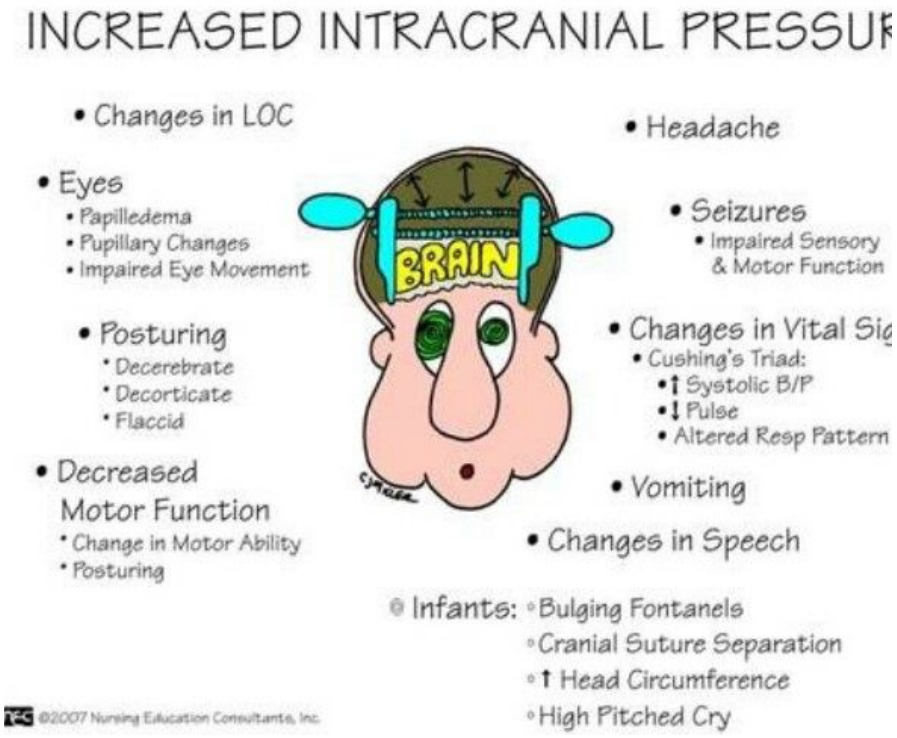
Define and describe autoregulation in the brain
A mechanism that maintains constant cerebral perfusion despite what happens in the systemic circulation. 3 metabolic factors affect cerebral blood flow = carbon dioxide (main stimulus for vasodilation = increasing CBF), hydrogen ion and O2 concentration.

The Monro-Kellie hypothesis
→ The pressure-volume relationship between ICP, volume of CSF, blood, and brain tissue, and cerebral perfusion pressure (CPP).
→ Rigid cavity which cannot expand or contract
→ contains 3 elements: brain 80%, blood 12% and CSF 8% - these 3 contribute to ICP
→ maintain a state of equilibrium
→ It is proposed that one of these elements increases and volume of the others must decrease in order to maintain normal pressure within the cranial cavity.
→ If there is an increase in one of the components there is a reciprocal compensation of one of the other compononents – brain tissue is the most restricted in ability to compensate
→ Compensation of CSF – displaces into the spinal subarachnoid space and increase reabsorption of CSF.
→ Compensation of blood – There is a little amount of blood in the cerebral circulation, most blood contained in the brain is in the venous portion. Therefore compensatory mechanism is venous compression and displacement of venous blood down into the spinal column.
→ Normal pressure in cranial cavity is usually <15mmHg
→ Transient increases occur in pressure such as when we cough or sneeze or strain (not harmful)
→ Sustained increases in ICP can result in significant ischaemic changes and damage to neural tissue (eg. Tumours, brain oedema,

bleeding/ruptured aneurysm)
→ Increase in blood volume due to dilated blood vessels, obstruction to venous outflow or decreased reabsorption of CSF will increase CSF volume = increased ICP

Increased Intracranial Pressure (ICP)
→ ICP is pressure in the intracranial cavity. Coughing, sneezing and bending over can increase ICP however sustained increased ICP can result in tissue ischaemia and damage to delicate neural tissue.

Causes
→ cerebral oedema (Most frequent)
→ Neuro trauma
→ abcesses
→ Stroke
→ Inflammation
→ Haemorrhage



Compensatory methods in the brain when ICP occurs
Pressure and chemical autoregulation are compensatory mechanisms in which cerebral arterioles change in diameter to maintain cerebral blood flow when ICP increases.
PRESSURE AUTOREGULATION
→ Stretch receptors within small blood vessels of the brain causes smooth muscle of the arterioles to contract
→ Increased arteriole pressure stimulates these receptors, leading to vasoconstriction (When arterial pressure is low, stimulation of these receptors decreases, causing relaxation and vasodilation)
CHEMICAL AUTOREGULATION