

- MICROCIRCULATION –
(CAPILLARY CIRCULATION)
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- OBJECTIVES.

- Describe
the

physiolo
gical
anatomy
of

capillary
circulati
on.

- Identify
the
values
for

normal
capillary
blood
flow.

- Discuss

the

dynamic

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interstiti

al fluid

formatio

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- Correlate this knowledge to

edema
formatio
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- The term Microcirculation refers to the functions of the capillaries and the neighboring lymphatic vessels.
- 5 % of circulating blood volume is present in the capillaries at any given time.
- This takes part into the exchange of nutrients, gases and waste products between the blood & tissues.
- Lymphatic circulation

- The interstitial fluid enter lymphatic capillaries through loose junctions between endothelial cells .
- Lymph flow back to the thoracic duct is promoted by contraction of smooth muscle in wall of lymphatic vessels & contraction of surrounding skeletal muscle .
- Failure of lymphatic drainage can lead to Edema .

- **The Microcirculation**

- Important in the transport of nutrients to tissues
- Site of waste product removal

- Over 10 billion capillaries with surface area of 500-700 square meters
- Solute and fluid exchange
- **Types of capillaries**

Classified according to the size of the pores

- Brain – the pores are very ***tight*** and allow only very small molecules to pass thru.
- Kidney & Intestine - the pores are wider – ***fenestrations***
- Liver - the endothelium is ***discontinuous*** with wide gaps between the cells.
- **EXCHANGE OF SUBSTANCES
ACROSS THE CAPILLARY WALL**

This occurs by.

- Simple diffusion Lipid soluble gases such as O₂ & CO₂ readily diffuse through the endothelial cells.
- Bulk Flow - the most important mechanism for fluid transfer driven by Starlings forces.
- FLUID COMPARTMENT.
- Total Body Water-60% of Body Weight.(42liters) in a 70kg person.

- Classification:-Intracellular fluid- 40%(28 liters)
- Extracellular fluid-20%(14liters)

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Plasma-5%

Intercellular-15%

- PERCENTAGE OF FLUID.

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- *Interstitial fluid*

Interstitial fluid; also known as intercellular fluid and tissue fluid is fluid between the cells of multicellular organisms bathes and surrounds the cells of the body, and provides a means of delivering materials to the cells, intercellular communication, and removal of metabolic waste.

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-It represents the largest portion of the ECF compartment . The plasma and the interstitial fluid intermingle through pores in the blood capillaries which allow water and most dissolved substances except protein to diffuse .

- The exchange of material across the capillaries occurs at high rate by diffusion in both direction.

- Formation of the IF
;The high content of proteins in the plasma accounts for its higher osmotic pressure

compared to that
of the IF which will
attract fluid and
dissolved
substances into the
circulation from
the tissue spaces .
Opposing this force
is the hydrostatic
pressure of the

blood which tends to force fluids out of the circulation and into the tissue spaces, thus equilibrium is always maintained.

Edema; Is the term used to describe an unusual accumulation of interstitial fluid which occurs when an alteration in the balance mentioned earlier occurs . It

could happen due to decrease in plasma albumin concentration leading to a decrease in blood osmolarity thus allowing fluid to escape from the

circulation to the interstitial space.

The rate of filtration at any point along the capillary depends on a balance of forces – **STARLINGS FORCES.**

- **1. Capillary hydrostatic pressure**
Arterial end = 37 mmHg
Venous end = 17 mmHg
- **2. Plasma colloid osmotic pressure**
= 25 mmHg
- **3. Interstitial hydrostatic pressure**
= 0 -1

- **4. Interstitial colloid osmotic pressure = 0 mmHg**
- **Arteriolar end** → fluid moves out into tissue spaces
- **Venous end** → fluid enters into capillaries.
- Any decrease in plasma proteins (hypoproteinemia) or increase in capillary hydrostatic pressure (cardiac failure) causes edema. (abnormal increase in interstitial fluid volume)

- Histamines, bradykinin increases capillary permeability → edema.
- Starling's forces across capillary wall
- What is Edema?
- Accumulation of fluid beneath the skin or in a body cavity
- Palpable swelling produced by expansion of the interstitial fluid volume

- Causes of Edema

- **Increase capillary pressure**

- Increase vascular volume

- Heart failure
 - Kidney disease
 - Pregnancy
 - Environmental heat stress

- Venous obstruction

- Thrombosis
- Liver disease
- **Decrease colloidal osmotic pressure**
 - Increase loss of proteins
 - Nephrotic syndrome
 - Burns
 - Decrease production
 - Starvation, Malnutrition
 - Liver disease
- Edema:
- The abnormal accumulation of fluid in a specific organ vs generalized.
- In capillary: Balance between **hydrostatic pressure** and

oncotic (colloid osmotic) pressure.

- Interstitial hydrostatic pressure:
- Varies from one organ to another:
- Subcutaneous tissue:
Subatmospheric (-2 mmHg)
- Liver, kidney: +
- Brain: As high as 6 mmHg
- Organ specific:
- Brain: Cerebral edema

- Lung: Intra-
alveolar=pulmonary edema,
intra-pleural=pleural effusion

- Peritoneum=ascites
- Severe generalized edema=anasarca
- Reduced oncotic pressure:
- Reduction in production of colloids--- plasma proteins.
- **Liver failure**
- **Malnutrition**
- Increase in loss of colloids--- plasma proteins.

- **Nephrotic syndrome**
- **Catabolic states**
- **Increase capillary hydrostatic pressure:**
 - Venous end: Heart failure, deep venous thrombosis, superior vena cava obstruction etc.
 - Arterial end: Pre-capillary dilatation. Calcium channel blockers.
- **Capillary leaks:**
- **Result of capillary damage:**
- **Pleura: Infections, tumors**

- Alveoli: Inhalation of noxious substance, eg chlorine gas etc
- Diverse causes of edema:
- Anaemia
- Hypothyroidism
- Hormones involved in edema:
- Renin angiotensin aldosterone system: **secondary hyperaldosteronism**

- ADH (Vasopressin)

- ANP
- Jugular venous pressure:
- Elevated **and** pulsating:
- =hypervolemia

- Then edema:
- Due to increased capillary hydrostatic pressure:
- Cardiac failure, or isolated RV (pulm HT)
- Hypervolemia caused by transfusion
- **Generalized edema without hypervolemia:**
- Decreased capillary colloid oncotic pressure: liver, kidney, catabolic states, malnutrition.
- Increased interstitial colloid oncotic pressure: lymphatic.

- Increase in capillary permeability:
Inflammation, toxins, severe
anaemia
- Capillary Circulation.
- Define interstitial fluid with
normal values.
- Define edema, & causes of it.
- References:- Guyton &
Hall, 12th edition.
- Ganong-24th edition.
- Internet.

THANK YOU.