Fluid & Electrolyte Management

THE "BODY WATER COMPARTMENTS"

- Cell membranes contain pores and various transport proteins which regulate exchange between the internal (intracellular) and external (interstitial) environment.

- This "exchange" serves numerous functions, including maintenance of electrolyte (pH & salt) concentrations for normal cell function.

When the ability of cells to regulate exchange is impaired,

the cell, the system and the organism are in trouble.

- Perfusion and exchange are seriously impaired, when body fluids are lost at an accelerated rate (pathological loss).

- The average human body is approximately 55% water.

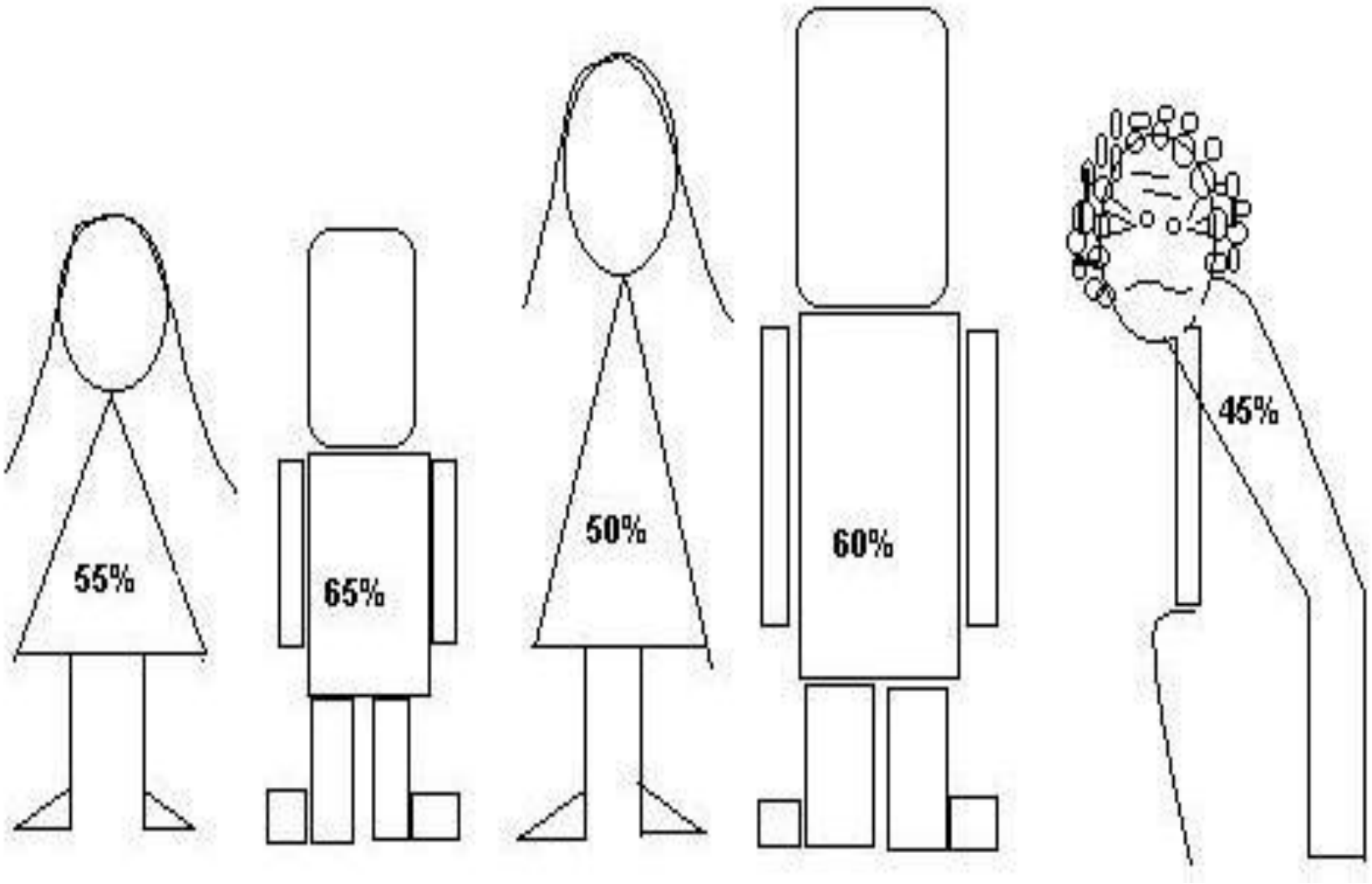
- Water content tends to be higher in males.

- The average adult male might be 60% water while the average adult female might be around 50% water.

- Females have lower water content as they generally have a higher fat content and lower muscle mass

- Youths generally have higher water content than adults.

Our water content decreases as we age.



- The major body water compartments are:

  a. Extracellular fluid.

     i. Interstitial fluid (between cells)

     ii. plasma.

  b. Intracellular fluid

Body water compartments in a 75 kg male - remember, 60% (or 45 kg) of his body will be water

45 kg of water = 45 L of water

ECF = 33% of body water
approx. 15 kg or L of water

ECF = ISF + plasma

SOME OTHER MINOR ECF COMPARTMENTS

iv cerebrospinal fluid (CSF)

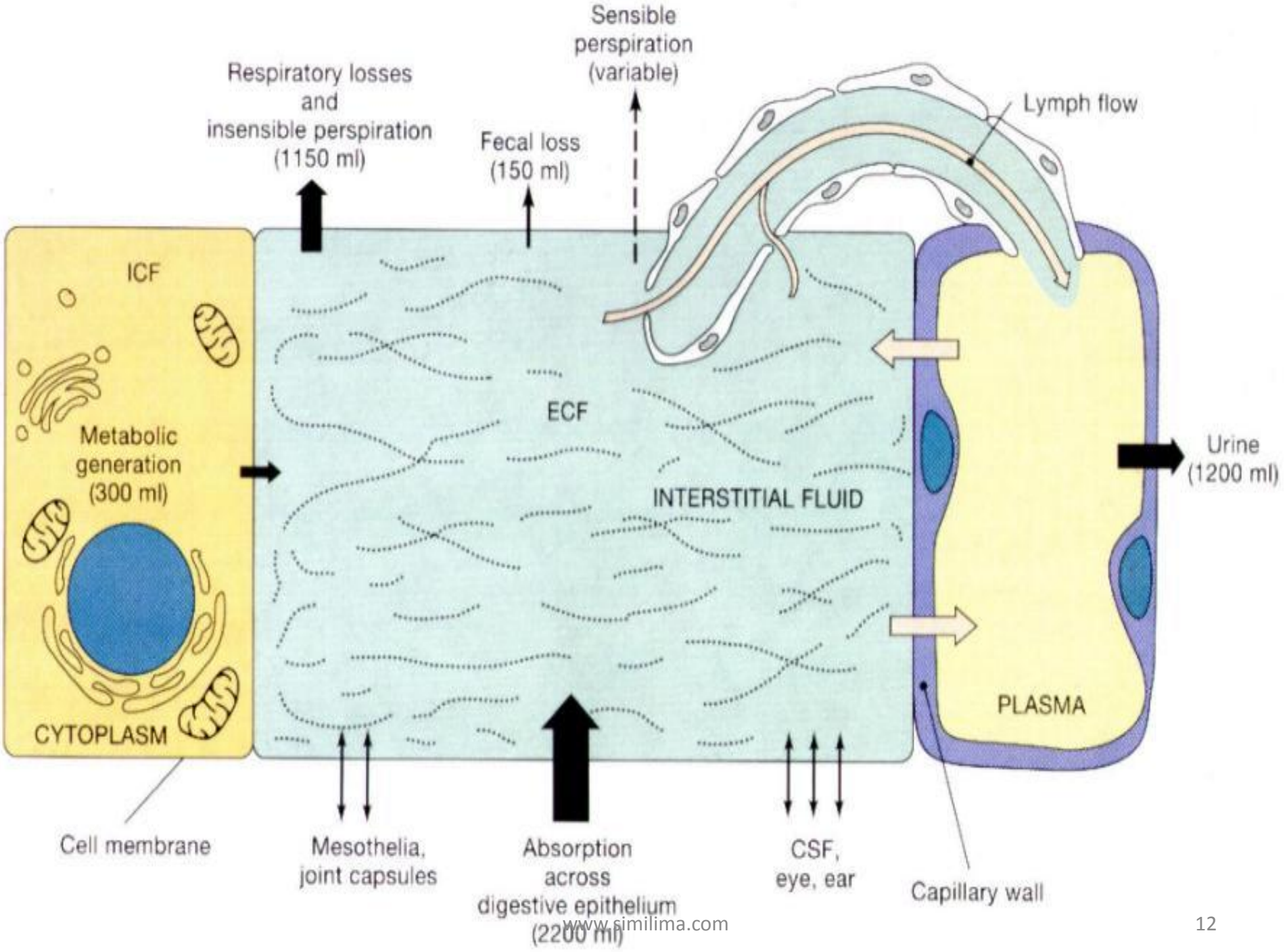
v. fluid in pleural, pericardial and peritoneal spaces

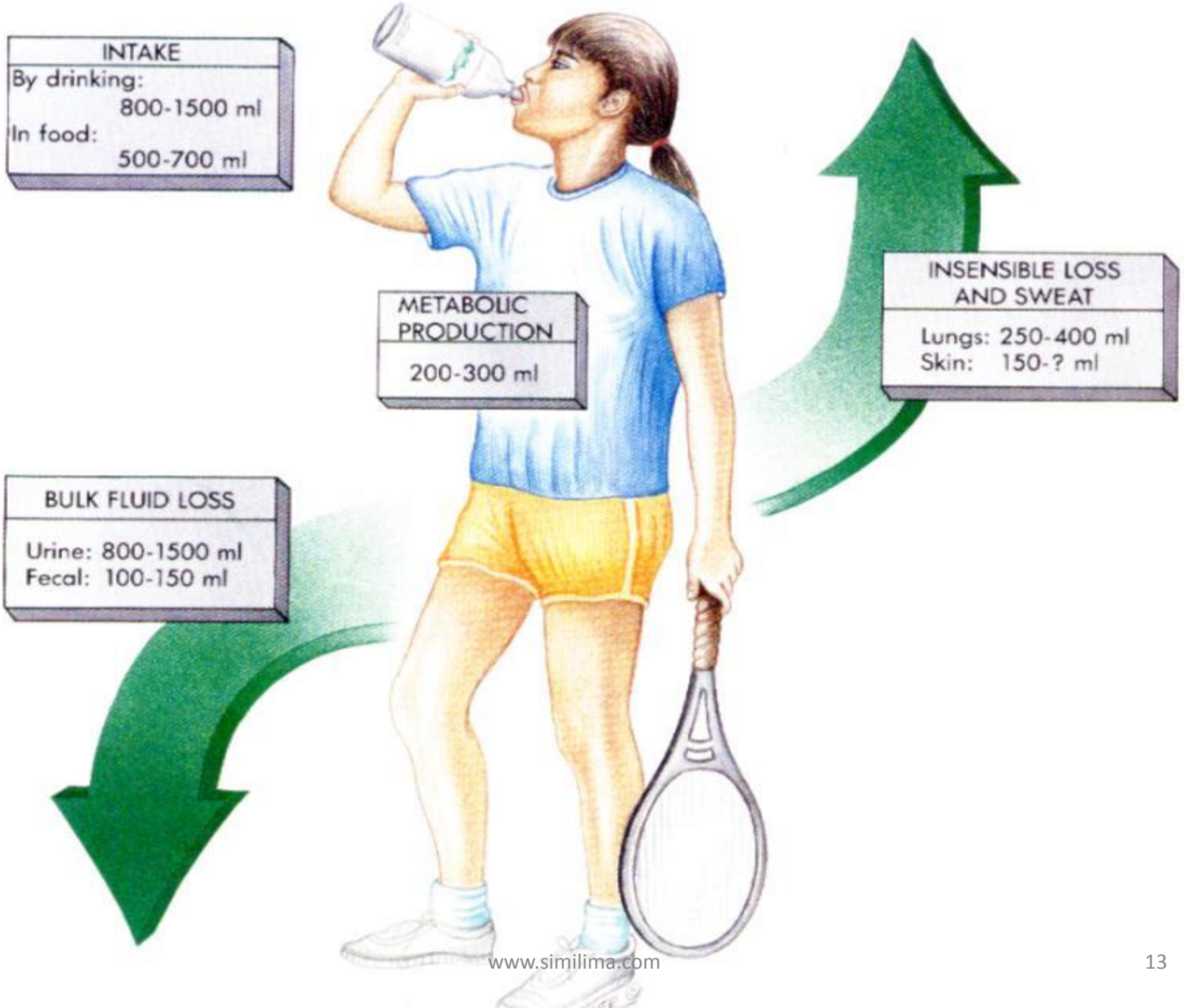
vi. aqueous humor of the eyeball

vii. gastrointestinal fluids

viii. plasma filtrate in the kidney

ix. urine in the ureters and bladder

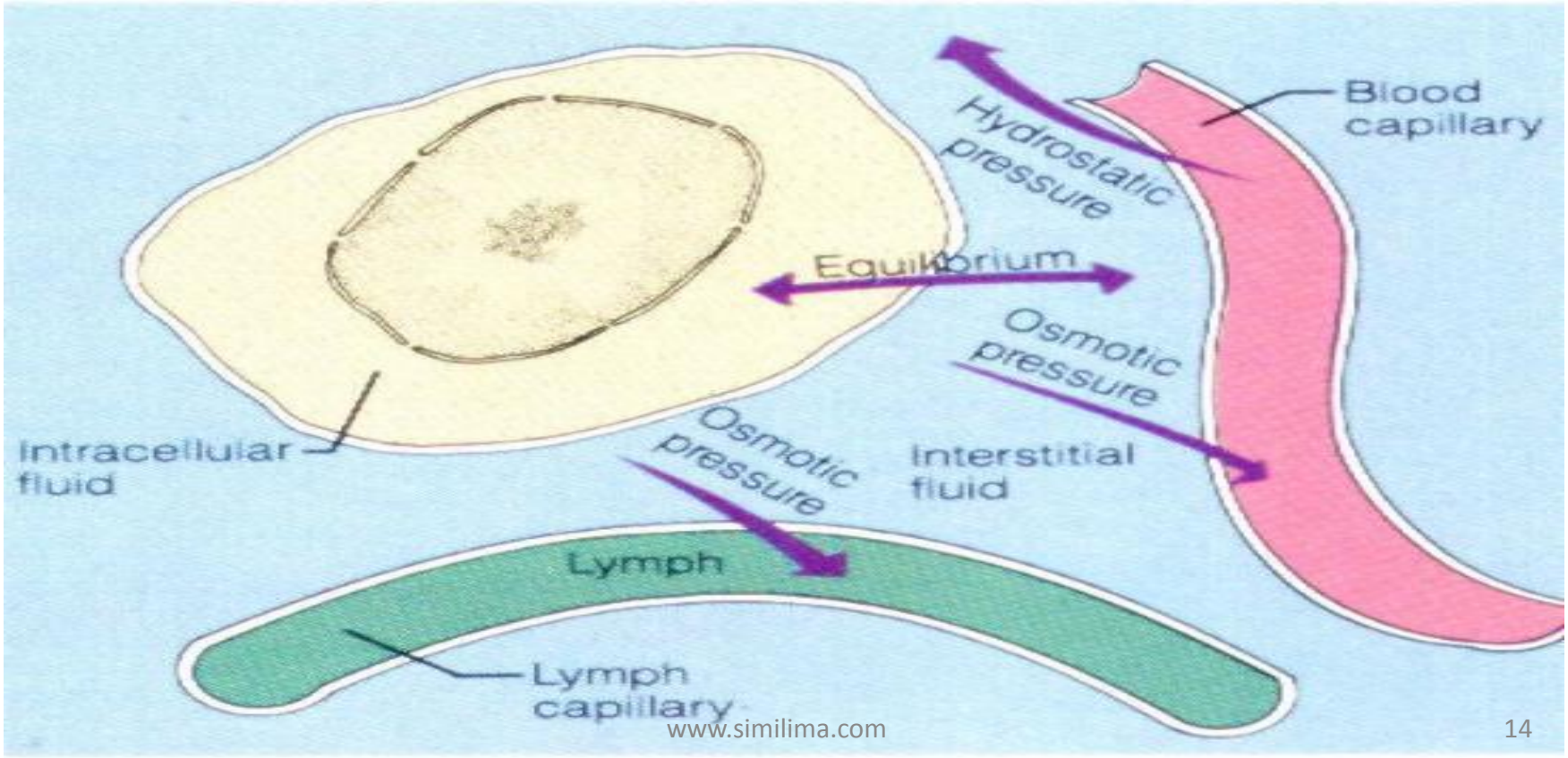

Sensible perspiration (variable)
Respiratory losses and insensible perspiration (1150 ml)
Fecal loss (150 ml)
Lymph flow
ICF
ECF
INTERSTITIAL FLUID
PLASMA
Metabolic generation (300 ml)
Urine (1200 ml)
CYTOPLASM
Cell membrane
Mesothelia, joint capsules
Absorption across digestive epithelium (2200 ml)
CSF, eye, ear
Capillary wall


INTAKE
By drinking:
800-1500 ml
In food:
500-700 ml
METABOLIC PRODUCTION
200-300 ml
INSENSIBLE LOSS AND SWEAT
Lungs: 250-400 ml
Skin: 150-? ml
BULK FLUID LOSS
Urine: 800-1500 ml
Fecal: 100-150 ml

b. Intracellular fluid (ICF)

ICF is the fluid found inside all cells .

ICF comprises approximately 2/3rds of total body water.



Normal changes in TBW & ECF

- All babies are born with an excess of TBW, mainly ECF, which is removed
  - Adults are 60% water (*20% ECF*, 40% ICF)
  - Term neonates are 75% water (*40% ECF*, 35% ICF) : lose 5-10 % of weight in first week

Normal changes in Renal Function

- Adults can concentrate or dilute urine very well, depending on fluid status

- Neonates are not able to concentrate or dilute urine as well as adults - at risk for dehydration or fluid overload

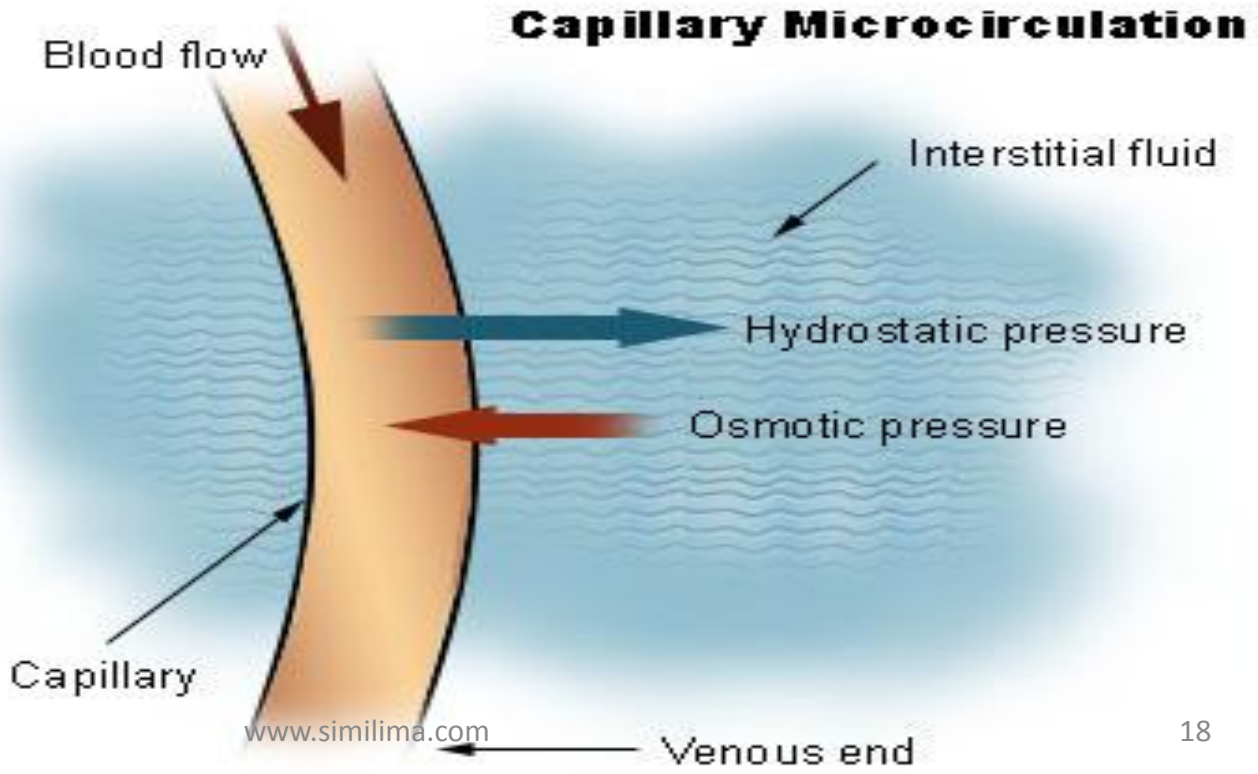
- Renal function matures with increasing:
  - gestational age
  - postnatal age

Insensible water loss (IWL)

- "Insensible" water loss is water loss that is not obvious : through skin (2/3) or respiratory tract (1/3)
  - depends on gestational age (*more preterm: more IWL*)
  - depends on postnatal age (*skin thickens with age: older is better --> less IWL*)
  - also consider losses of other fluids: Stool (diarrhea/stomy), NG/OG drainage, CSF (ventricular drainage), etc

Formation of tissue fluid

- Hydrostatic pressure is generated by the pumping force of the heart. It pushes water out of the capillaries.



Regulation of Body water & Electrolytes

- The need for an uninterrupted supply of water, electrolytes and an energy source are particularly important in infants and young children because of their high total body water& basal metabolic rate and poor kidney funtion

- When a child is unable to take oral fluids, appropriate IV fluids must be given to prevent dehydration and electrolyte imbalance.

- When infants and children experience excessive fluid losses, they become dehydrated.

- Left untreated this can lead to an altered level of consciousness, vascular collapse, renal failure and death.

1.Regulation of Sodium and Water Balance

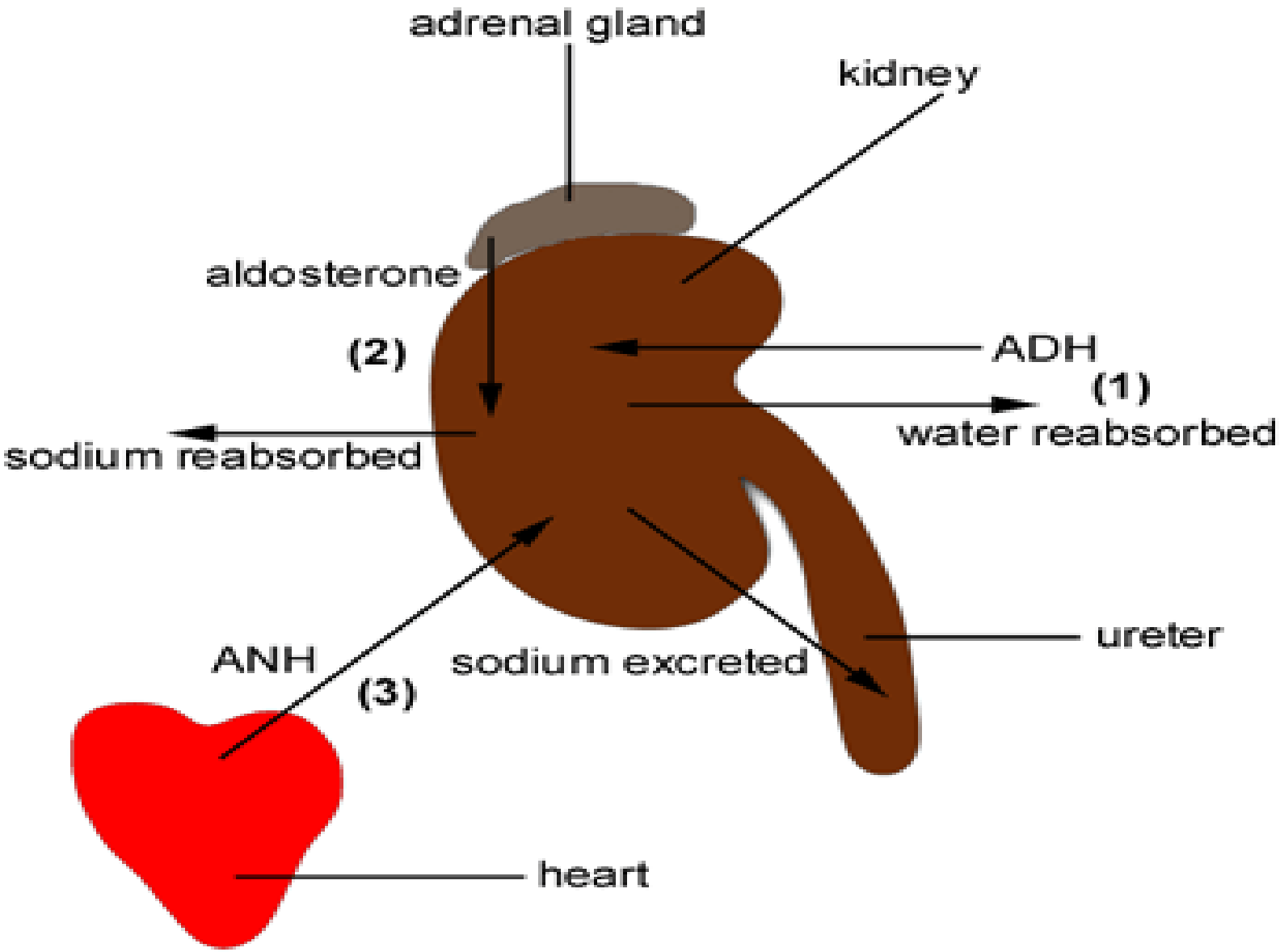
At the level of the kidney

(1) ADH (antidiuretic hormone) from the **posterior pituitary** acts on the kidney to promote water reabsorption, thus preventing its loss in the urine.

- **(2) Aldosterone** from the adrenal gland acts on the kidney to promote sodium reabsorption, thus preventing its loss in the urine.

(3) ANH (atrial natriuretic hormone) from the atrium of the heart acts on the kidney to promote sodium excretion so that it is excreted in the urine.

Regulation of Sodium and Water Balance



- Thirst mechanism- regulated by the hypothalamus in response to the ECF volume & osmolality

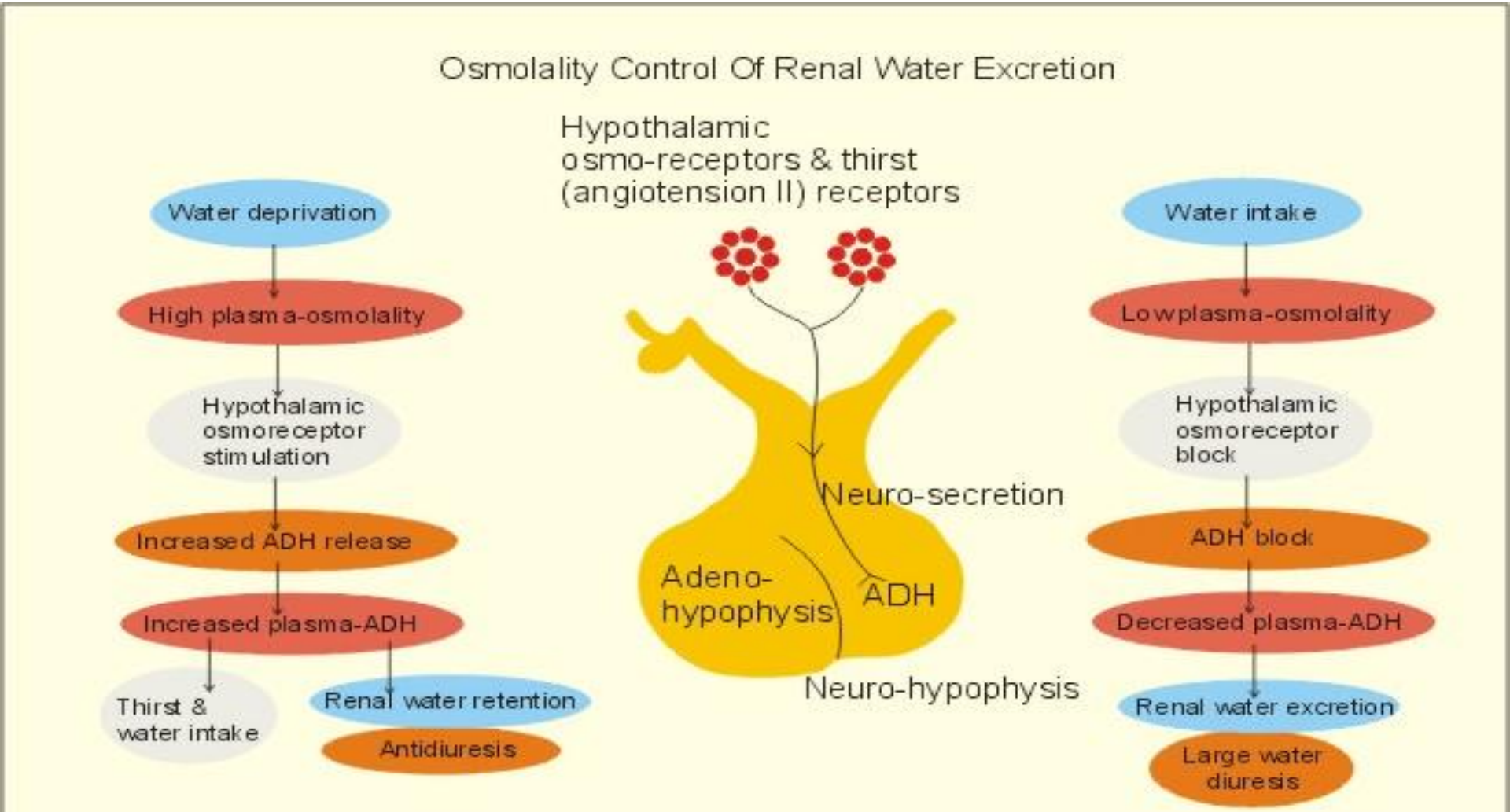


Fig. 24-6 ADH and thirst systems maintain osmolality within narrow limits

AMc

ODEMA

- Soft tissue swelling due to abnormal

  expansion of interstitial fluid volume

- Edema fluid is a plasma transudate that accumulates when movement of fluid from vascular to interstitial space is favored.

- Detectable generalized edema in the adult

  reflects a gain of 3 L,renal retention of salt

  and water is necessary for edema to occur.

  Distribution of edema can be an important guide to cause.

LOCALISED ODEMA

- Limited to a particular organ or vascular bed.

- It can be easily distinguished from generalized edema

UNILATERAL LIMB ODEMA

- venous or lymphatic obstruction (e.g.,deep venous thrombosis, tumor obstruction,primary lymphedema).

- Stasis edema of a paralyzed lower extremity may also occur.

UNILATERAL FACIAL ODEMA

- Allergic reactions (“angioedema”)

- superior vena caval obstruction are causes of localized facial edema

Bilateral lower extremity edema may have localized causes.

- inferior vena caval obstruction,
- compression due to ascites,abdominal mass.

LOCALISED ODEMA

- Ascites (fluid in peritoneal cavity)
- hydrothorax (in pleural space) may also present as isolated localized edema
- Odema due to inflammation or neoplasm

Generalized oedema

- Bilateral lower extremity swelling, more pronounced after standing for several hours.

- Pulmonary edema are usually cardiac in origin.

- Periorbital edema noted on awakening often results from renal disease and impaired Na excretion.

- Ascites and edema of lower extremities and scrotum are frequent in cirrhosis or CHF

- In *CHF*,diminished cardiac output and < arterial blood volume result in both decreased renal perfusion and increased venous pressure

With resultant renal Na retention due to

renal vasoconstriction,intrarenal blood

flow redistribution,direct Na-retentive

effects of norepinephrine and angiotensin II

IN CIRRHOSIS

- The arteriovenous shunts lower effective renal perfusion, resulting in Na retention.

Ascites accumulates when increased intrahepatic vascular resistance produces portal hypertension.

Reduced serum albumin and increased abdominal pressure also promote lower extremity edema.

In Nephrotic syndrome

- massive renal loss of albumin lowers plasma oncotic pressure,promoting fluid transudation into interstitium;

- lowering of effective blood volume stimulates renal Na retention.

In acute and chronic renal failure

- edema occurs if Na intake exceeds kidney's ability to excrete Na secondary to marked reductions in glomerular filtration.

- Severe hypoalbuminemia [25 g/L (2.5 g/dL)] of any cause (e.g.,nephrosis,nutritional deficiency states,chronic liver disease) may lower plasma oncotic pressure sufficiently to cause edema

- Idiopathic oedema ,a syndrome

  of recurrent rapid weight gain and edema in women of reproductive age;

- Hypothyroidism ,in which myxedema is typically located in the pretibial region;

- *Drugs* as glucocorticoids,estrogens,thiozolidinediones, and vasodilators;

- pregnancy; refeeding after starvation.