Hyperemia, Congestion, and Edema
- **Hyperemia**
  - Acute, actively increased blood flow
  - Tissues look red (erythema)

- **Congestion**
  - Chronic, passively reduced outflow
  - Tissues look pale or blue (cyanosis)

- **Edema**
  - Water build-up in interstitial spaces and cavities
  - Hydrodynamic transudate is dilute, protein-poor
  - Inflammatory exudate is concentrated, protein rich
Hyperemia

• Increased flow of blood into tissue
• Local process of arteriole dilation greater than venule dilation
• Appearance of blood flow is RED
• Normal physiological examples:
  ▪ Exercise
  ▪ Blushing
  ▪ Erection
  ▪ Inflammatory response (rubor)
Hyperemia, injury
Congestion

- Impaired venous outflow from tissue
- Local increases in venous pressure
- Central congestive heart disease increases diastolic (venous) blood pressure (BP)
- Right-side failure congests portal drainage, liver, generalized edema
- Left-side failure congests pulmonary drainage, lungs, hypoxemia
CONGESTION

NORMAL

Arteriole

Venule

CONGESTION
cyanosis/hypoxia

Decreased
outflow

(e.g., local
obstruction,
congestive
heart failure)
Hepatic congestion
Nutmeg liver
Edema

• Localized or generalized accumulation of fluid in interstitial spaces
  ▪ Anasarca: severe, generalized edema
    • *ana* = throughout, *sark* = flesh
    • Most commonly used to describe fetal or neonatal whole-body, subcutaneous swelling

• Effusions into body cavities
  ▪ Hydrothorax: within thorax, around lungs; also pleural effusion
  ▪ Hydropericardium: Fluid in the pericardial sac
  ▪ Hydroperitoneum or ascites: Fluid in the peritoneal cavity

Note: (extravagate: to move out of the vasculature)
Fluids—water

- Approximately 60% of lean body weight is water
- Two thirds of the body's water is intracellular
- Remainder of water is extracellular, mostly the interstitium (or third space) that lies between cells
- About 5% of total body water is in plasma
Factors affecting intravascular and interstitial water movement

• Concentration of solutes
  ▪ Albumin and other proteins (huge difference)
  ▪ Sodium and other ions (small difference)

• Hydrostatic pressure
  ▪ Higher on arteriolar side
  ▪ Lower on venular side
  ▪ Lowest in interstitium

• Blood volume → decreased b.p.
  ▪ Water intake/deprivation
  ▪ Water loss from skin or gut
    • Perspiration, vomiting, diarrhea
  ▪ Blood loss; acute hemorrhage
Fluid transit

Note: (Wikipedia)- Oncotic pressure, or colloid osmotic pressure, is a form of osmotic pressure exerted by proteins, notably albumin, in a blood vessel's plasma (blood/liquid) that usually tends to pull water into the circulatory system. It is the opposing force to capillary filtration pressure and interstitial colloidal osmotic pressure.
The movement of water and low molecular weight solutes such as salts between the intravascular and interstitial spaces is controlled primarily by the opposing effect of vascular hydrostatic pressure and plasma colloid osmotic pressure.
If the movement of water into tissues (or body cavities) exceeds lymphatic drainage, fluid accumulates.

An abnormal increase in interstitial fluid within tissues is called edema.
Trivial and life-threatening edema
Pitting edema
FIGURE 4-2 Pathways leading to systemic edema from primary heart failure, primary renal failure, or reduced plasma osmotic pressure (e.g., from malnutrition, diminished hepatic synthesis, or protein loss from nephrotic syndrome).
Anasarca
Appearance of edema

- Swollen tissues (not cells—fluid is outside the cells)
- Heavy tissues
- Wet tissues
- Widening of fascial planes or interlobular septa
- Filled cavities
Pulmonary edema
Responses to edema

• Skin: swells according to elasticity
  ▪ dependent edema: distribution affected by gravity (ankles, sacrum)
  ▪ dependent = hanging down in this context

• Brain: compresses without room to swell

• Lung: alveoli fill preventing gas exchange
Causes of edema

- Increased hydrostatic pressure
- Decreased plasma osmotic pressure
- Increased capillary permeability
- Lymphatic obstruction
- Sodium (and water) retention
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<th>Pathophysiologic Categories of Edema</th>
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<td><strong>INCREASED HYDROSTATIC PRESSURE</strong></td>
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<td>Impaired venous return</td>
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<td>Congestive heart failure</td>
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<tr>
<td>Constrictive pericarditis</td>
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<td>Ascites (liver cirrhosis)</td>
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<td>Venous obstruction or compression</td>
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<td>Thrombosis</td>
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<td>External pressure (e.g., mass)</td>
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<td>Lower extremity inactivity with prolonged dependency</td>
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<td>Heat</td>
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TABLE 4-1 -- Pathophysiologic Categories of Edema (con)

REDUCED PLASMA OSMOTIC PRESSURE (HYPOPROTEINEMIA)
  Protein-losing glomerulopathies (nephrotic syndrome)
  Liver cirrhosis (ascites)
  Malnutrition
  Protein-losing gastroenteropathy

LYMPHATIC OBSTRUCTION
  Inflammatory
  Neoplastic
  Postsurgical
  Postirradiation

Elephantiasis--lymphedema
Peau d’orange and post-mastectomy lymphedema

FIGURE 1. Erythema, edema, and peau d’orange—all classic signs—are seen in a woman with inflammatory breast cancer.
### INFLAMMATION

- Acute inflammation
- Chronic inflammation
- Angiogenesis

### SODIUM RETENTION

- Excessive salt intake with renal insufficiency
- Increased tubular reabsorption of sodium
- Renal hypoperfusion
- Increased renin-angiotensin-aldosterone secretion

Ascites is the accumulation of excess fluid within the peritoneal cavity. It is most frequently encountered in patients with cirrhosis and other forms of severe liver disease.
Ascites

The accumulation of ascitic fluid represents a state of total-body sodium and water excess, but the event that initiates this imbalance is unclear.
Effusions

- Extravascular fluid collections can be classified as follows:
  - **Transudate**: extravascular fluid collection that is basically an ultrafiltrate of plasma with little protein and few or no cells. Fluid appears grossly clear.
  - **Exudate**: extravascular fluid collection that is rich in protein and/or cells. Fluid appears grossly cloudy.

- Effusions into body cavities can be further described as follows:
  - **Serous**: a transudate with mainly edema fluid and few cells.
  - **Serosanguinious**: an effusion with red blood cells.
  - **Fibrinous (serofibrinous)**: fibrin strands are derived from a protein-rich exudate.
  - **Purulent**: numerous PMN's are present. Also called "empyema" in the pleural space.
### Transudate
- Protein < 30 g/dL
- LDH < 200 u
- Often bilateral
- **Colour**
  - Usually clear, serous
- **Common causes**
  - Cardiac failure
  - Nephrotic syndrome
  - Hepatic cirrhosis
  - Hypoalbuminaemia (malnutrition, chronic disease, malabsorption)
- **Unusual causes**
  - Pericardial constriction
  - Meig's syndrome (ovarian fibroma associated with right pleural effusion)
  - Myxoedema

### Exudate
- Protein > 30 g/dL (or pleural/serum protein ratio > 0.5)
- LDH > 200 u (or pleural/serum ratio > 0.6)
- Often unilateral
- **Colour**
  - Serous (TB, RA)
  - Cloudy (infection)
  - Bloody (cancer, PE, TB)
  - In parapneumonic effusions, if pH < 7.2, high probability that effusion is infected (empyema)
- **Common causes**
  - Bacterial pneumonia
  - Carcinoma (primarily bronchial or secondary)
  - Mesothelioma
- **Unusual causes**
  - TB
  - Haemothorax
  - Pancreatitis
  - Sub-phrenic abscess
  - Autoimmune disease
  - Chylothorax (from a leaking thoracic duct [trauma, neoplasia]—only left sided)
  - Yellow nail syndrome (abnormal lymph drainage leading to yellow nails, pleural effusion and lymphoedema)
Pleural effusions and edema
Pleural Exudate
Pleural effusion