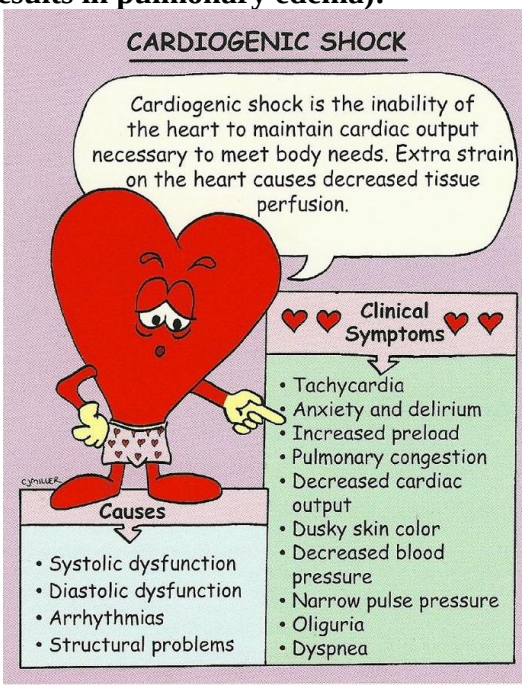
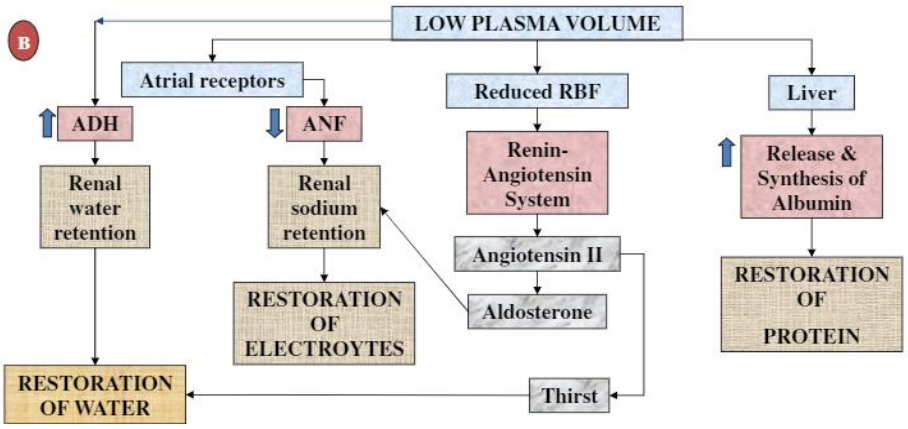
Unit IV – Problem 9 – Physiology of Shock

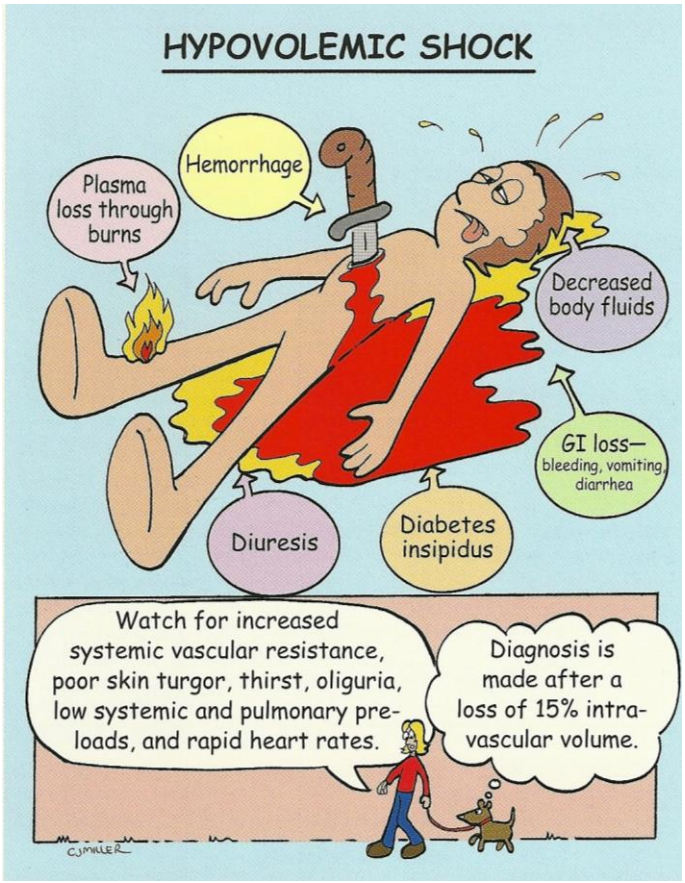
- **What is shock?**
  - **It is inadequate tissue perfusion and less delivery of oxygen to the tissues (deoxygenated state: in which metabolic demands are exceeding the provided oxygen).**
  - Notice that oxygen is transported by hemoglobin (97%) and dissolved in plasma (3%). Oxygen is required for energy production (generating 36 ATPs through aerobic metabolism).
  - Anaerobic metabolism will result in metabolic acidosis (with compensatory kussmal breathing: rapid and deep) and reduction in the generation of ATP.
  - Catecholamines (epinephrine and norepinephrine) will be released to compensate for hypoglycemia associated with shock.
- **Mention the types of shock and explain them.**
  - **Cardiogenic shock (results in pulmonary edema):**



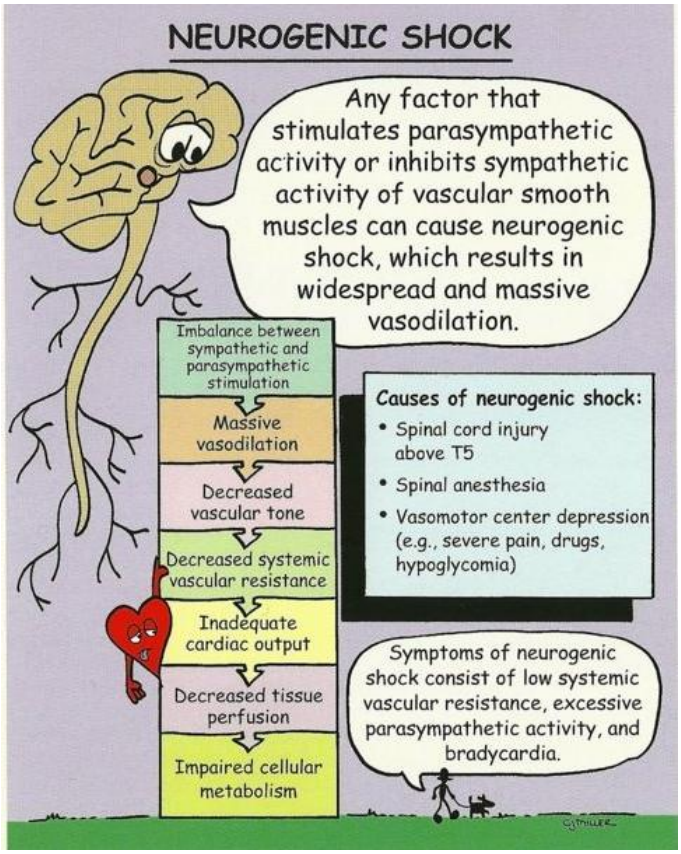
    - ✓ It is caused by cardiac pump failure which occurs in cases such as:
      - ❖ Myocardial infarction (MI).
      - ❖ Heart valve dysfunction.
      - ❖ Heart arrhythmias.
    - ✓ When cardiogenic shock occurs, compensatory mechanisms will be activated:
      - ❖ *Renin-angiotensin II- aldosterone system*: it is activated within 10 minutes to 1 hour. It will cause absorption of sodium and water. In addition, it will lead to constriction in peripheral arteries.
      - ❖ *Baroreceptors* will sense the drop in blood pressure thus they will elicit powerful sympathetic stimulation which will be activated within 30 seconds to few minutes. This will result in vasoconstriction by acting on α1 and α2 receptors. Therefore, systemic vascular resistance will increase (preventing the flow of blood to the periphery).
      - ❖ *Posterior pituitary gland will release antidiuretic hormone (vasopressin)* within 10 minutes to 1 hour. This will result in more retention of free water thus increasing blood volume.
      - ❖ *Central nervous system ischemic response*: resulting in more powerful sympathetic stimulation.
      - ❖ *Reverse stress-relaxation of the circulatory system.*



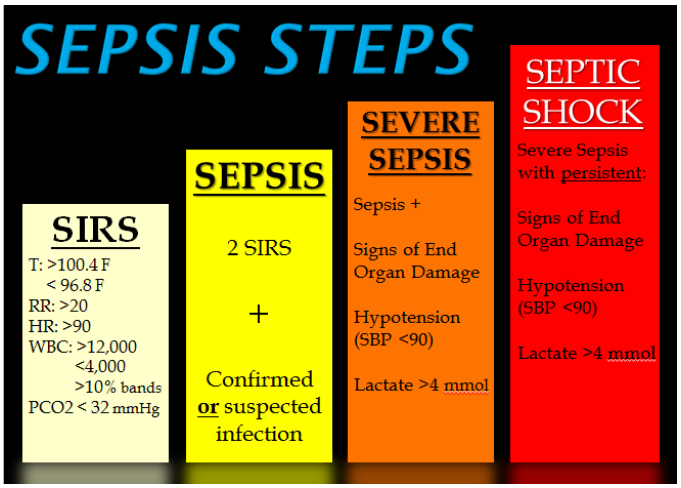
- **Hypovolemic shock:**



  - ✓ <u>It is caused by:</u>
    - ❖ Hemorrhage (e.g. from abortion or trauma).
    - ❖ Loss of plasma (e.g. intestinal obstruction, severe burns).
    - ❖ Dehydration (e.g. excessive sweating, diarrhea, vomiting, excessive loss of fluids by kidneys and inadequate intake of fluids).
  - ✓ As a result, cardiac output will decrease and the compensatory mechanisms mentioned above will be activated.
- **Neurogenic shock:**
  - ✓ <u>Misbalance within the autonomic nervous system caused by:</u>
    - ❖ Deep general anesthesia.
    - ❖ Spinal anesthesia.
    - ❖ Brain damage.
  - ✓ Massive vasodilation (flow of blood to the periphery) will result in a decrease in vascular tone (e.g. systemic vascular resistance will decrease) and eventually this will lead to loss of cardiac output.



- **Anaphylactic shock:**
  - ✓ Caused by: antigen-antibody reactions.
  - ✓ Basophils and mast cells will release histamine which will cause increase in vascular capacity, dilation of arterioles and increase in capillary permeability with loss of fluid and proteins.
- **Septic shock:**



  - ✓ Bacterial infection widely disseminated to many areas in the body, with the infection being borne through blood from one tissue to the other and resulting in extensive damage.
  - ✓ Typical causes include:
    - ❖ Peritonitis caused by spread of infection from uterus and fallopian tubes.
    - ❖ Peritonitis resulting from rupture of the gastrointestinal system.
    - ❖ Generalized infection of the body resulting from spread of skin infection.
    - ❖ Generalized gangrenous infection.
    - ❖ Infection spreading into the blood from kidneys or urinary tract.

- **What are the stages of shock?**
  - **Compensated stage**: represented by the previously mentioned compensatory mechanisms.
  - **Decompensated stage**: feedback that will further depress the cardiac output:
    - ✓ Cardiac depression: when blood pressure drops → coronary flow drops → resulting in less myocardium perfusion. This is mostly noticed after hours when cardiac function deteriorates by 40%.
    - ✓ Vasomotor failure: ↓ cardiac output → ↓ perusion of vasomotor center → eventually resulting in its failure.
    - ✓ Blockage of very small vessels (sludged blood): decreased blood flow causes acidosis which diffuses into local blood vessels. Intravascular acidosis causes sludged blood.
    - ✓ Increased capillary permeability: due to prolonged hypoxia and this will further reduce blood volume and worsens shock.
    - ✓ Release of toxins by ischemic tissue.
    - ✓ Cardiac depression caused by endotoxin and generalized cellular deterioration.
  - **Irreversible stage**: all forms of known therapy are inadequate to save the person's life!