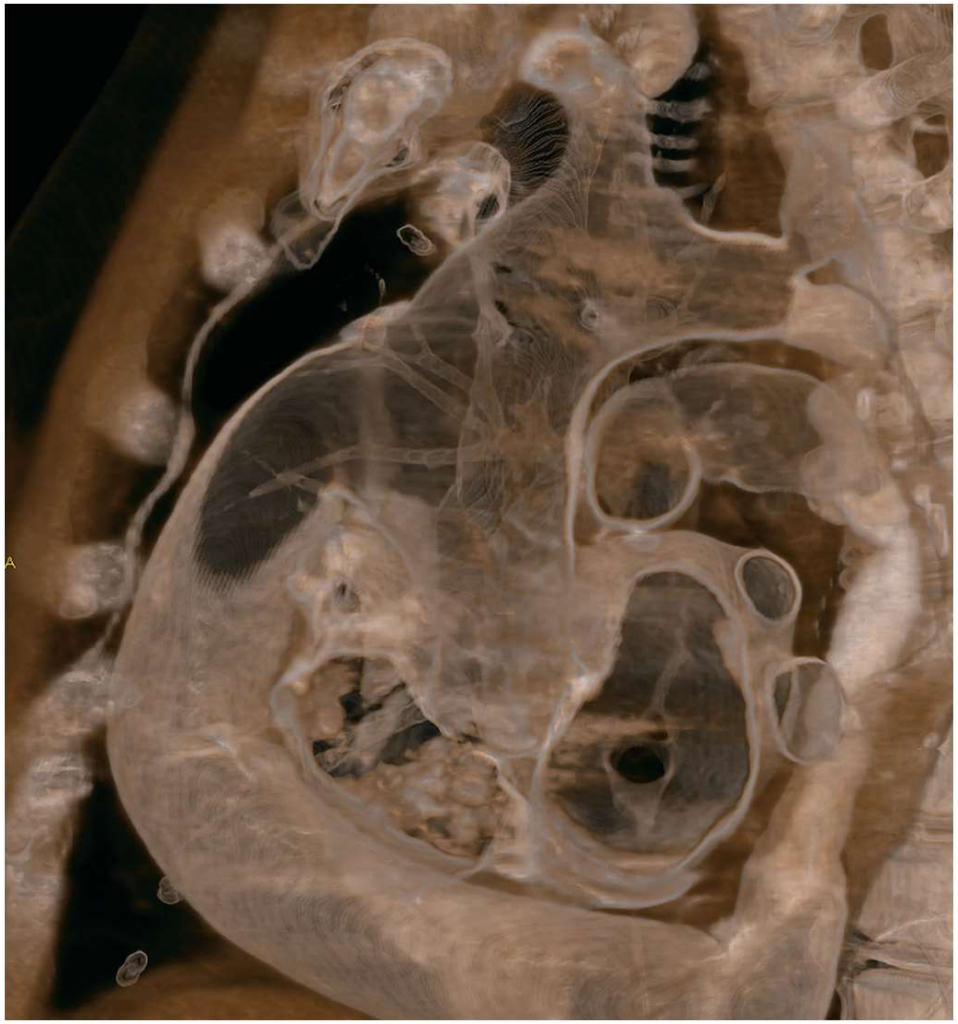
Chapter 20

Pathophysiology of the Heart



Coronary Artery Disease

- **coronary artery disease** (CAD) – a constriction of the coronary arteries
  - usually the result of **atherosclerosis** – accumulation of lipid deposits that degrade the arterial wall and obstruct the lumen
  - endothelium damaged by hypertension, virus, diabetes or other causes
  - monocytes penetrate walls of damaged vessels and transform into macrophages
    - absorb cholesterol and fats to be called **foam cells**
      - look like fatty streak on vessel wall
      - can grow into atherosclerotic plaques (**atheromas**)
  - platelets adhere to damaged areas and secrete platelet-derived growth factor
    - attracting immune cells and promoting mitosis of muscle and fibroblasts, and the deposition of collagen
- bulging mass grows to obstruct arterial lumen

Affects of Atheromas

- causes **angina pectoris**, intermittent chest pain, by obstructing 75% or more of the blood flow
- immune cells of atheroma stimulate inflammation – may rupture – traveling clots or fatty emboli may result
- cause coronary artery spasms due to lack of secretion of nitric oxide (vasodilator)
- inflammation transforms atheroma into a hardened complicated plaque called **arteriosclerosis**

Risk

- major risk factor for atherosclerosis is excess of low-density lipoprotein (LDL) in the blood combined with defective LDL receptors in the arterial walls
  - protein-coated droplets of cholesterol, neutral fats, free fatty acids and phospholipids
- most cells have LDL receptors that take up these droplets from blood by receptor-mediated endocytosis
  - dysfunctional receptors in arterial cells accumulate excess cholesterol
- familial hypercholesterolemia
  - dominant gene makes no receptors for LDL
    - heterozygous individual suffer heart attacks by 35
    - homozygous individuals suffer heart attacks by 2
- unavoidable risk factors - heredity, aging, being male
- avoidable risk factors – obesity, smoking, lack of exercise, anxious personality, stress, aggression, and diet

Prevention and Treatment

- treatment
  - coronary bypass surgery
    - great saphenous vein
  - balloon angioplasty
  - laser angioplasty

Angina and Heart Attack

- **angina pectoris** – chest pain from partial obstruction of coronary blood flow
  - pain caused by ischemia of cardiac muscle
  - obstruction partially blocks blood flow
  - myocardium shifts to anaerobic fermentation producing lactic acid stimulating pain
- **myocardial infarction** – sudden death of a patch of myocardium resulting from long-term obstruction of coronary circulation
  - atheroma (blood clot or fatty deposit) often obstruct coronary arteries
  - cardiac muscle downstream of the blockage dies
  - heavy pressure or squeezing pain radiating into the left arm
  - some painless heart attacks may disrupt electrical conduction pathways, lead to fibrillation and cardiac arrest
    - silent heart attacks occur in diabetics & elderly
  - MI responsible for about half of all deaths in the United States

Congestive Heart Failure

- **congestive heart failure** (CHF) - results from the failure of either ventricle to eject blood effectively
  - usually due to a heart weakened by myocardial infarction, chronic hypertension, valvular insufficiency, or congenital defects in heart structure.
- **left ventricular failure** – blood backs up into the lungs causing pulmonary edema
  - shortness of breath or sense of suffocation
- **right ventricular failure** – blood backs up in the vena cava causing systemic or generalized edema
  - enlargement of the liver, ascites (pooling of fluid in abdominal cavity), distension of jugular veins, swelling of the fingers, ankles, and feet
- eventually leads to total heart failure