Chapter 14 Adapted form Tortora 10th ed.

LECTURE OUTLINE

A. Introduction (p. 424)
   1. The heart is the pump of the cardiovascular system; its function is to propel blood through the estimated 100,000 km of blood vessels.
   2. Cardiology is the study of the normal heart and diseases associated with it.

B. Location and Surface Projection of the Heart (p. 425)
   1. The heart is a hollow, cone-shaped organ that is about the size of a person’s closed fist.
   2. The heart is about 12 cm long, 9 cm wide, and 6 cm thick.
   3. It is located between the lungs in the mediastinum.
   4. About two thirds of the heart’s mass lies to the left of the body’s midline.
   5. The apex is the lower, pointed end and the base is the broader, upper portion.
   6. The heart has an anterior surface and an inferior surface; the right border faces the right lung and the left border faces the left lung.
   7. Surface projection refers to outlining the shape of an organ on the surface of the body; the heart can be projected to the anterior surface of the chest by locating the following landmarks:
      i. superior right point
      ii. superior left point
      iii. inferior left point
      iv. inferior right point

C. Pericardium (p. 427)
   1. The pericardium is a sac that surrounds and protects the heart.
   2. The pericardium consists of two major layers:
      i. outer fibrous pericardium which prevents overstretching of the heart, provides protection, and anchors the heart in the mediastinum.
      ii. deeper serous pericardium, which itself consists of two sublayers:
         a. outer parietal layer, which is fused to the fibrous pericardium
         b. inner visceral layer or epicardium
            - between these two sublayers is the pericardial cavity that contains pericardial fluid, a lubricating fluid that reduces friction between the layers as the heart moves.

D. Layers of the Heart Wall (p. 428)
   1. The wall of the heart consists of three layers:
      i. outer epicardium composed of mesothelium and connective tissue
      ii. thick, middle myocardium composed of cardiac muscle tissue
      iii. inner endocardium composed of connective tissue covered by endothelium that is continuous with the endothelium of the blood vessels.

E. Chambers of the Heart (p. 428)
   1. The two superior chambers are the right and left atria, each having an anterior appendage called an auricle that allows an atrium to hold a larger volume of blood.
2. The two inferior chambers are the right and left ventricles.
3. Connective tissue separates the muscle tissue of the atria from the muscle tissue of the ventricles.
4. The surface of the heart has three major grooves:
   i. **coronary sulcus**
   ii. **anterior interventricular sulcus**
   iii. **posterior interventricular sulcus**
5. The right atrium receives deoxygenated blood from three veins:
   i. **superior vena cava (SVC)** brings blood from most parts of the body superior to the heart
   ii. **inferior vena cava (IVC)** brings blood from all parts of the body inferior to the diaphragm
   iii. **coronary sinus** receives blood from most of the vessels draining the wall of the heart
6. The anterior right atrial wall has internal muscular ridges called **pectinate muscles**.
7. The interior of the heart has an **interatrial septum** that separates the atria; this septum has an oval depression called the **fossa ovalis**.
8. The inner surface of each ventricle has an irregular surface of ridges and folds called **trabeculae carneae**.
9. The **interventricular septum** separates the two ventricles.
10. Blood in the right atrium flows into the right ventricle.
11. The right ventricle pumps blood into the **pulmonary trunk** which divides into the right and left pulmonary arteries.
12. Oxygenated blood returns from the lungs via four **pulmonary veins** that empty into the left atrium; there are two pulmonary veins (one superior and one inferior) draining blood from each lung.
13. Blood in the left atrium flows into the left ventricle.
14. The left ventricle pumps blood into the **ascending aorta**.
15. The ascending aorta gives rise to the right and left **coronary arteries** which deliver blood to the walls of the heart.
16. The ascending aorta is continuous with the arch of the aorta, which is followed by the **descending aorta** (which consists of the thoracic aorta and the abdominal aorta).
17. Branches of the aorta deliver blood throughout the systemic circulation.
18. During fetal life the temporary ductus arteriosus connects the pulmonary trunk with the aorta; shortly after birth this blood vessel normally closes, leaving a remnant called the **ligamentum arteriosum**.
19. The walls of the atria are relatively thin whereas the walls of the ventricles are relatively thick; the wall of the left ventricle is much thicker than that of the right ventricle.

F. **Fibrous Skeleton of the Heart** (p. 432)
1. The heart wall contains dense connective tissue that forms the **fibrous skeleton of the heart** which consists of:
   i. four **fibrous rings** (that support the four heart valves):
      a. **right atroventricular fibrous ring**
      b. **left atroventricular fibrous ring**
      c. **pulmonary fibrous ring**
      d. **aortic fibrous ring**
   ii. **right fibrous trigone**
G. Heart Valves (p. 432)
1. Four valves prevent backflow of blood in the heart and are composed of dense connective tissue covered by endocardium.
2. There are two atrioventricular (AV) valves:
   i. tricuspid valve located between the right atrium and the right ventricle
   ii. bicuspid (mitral) valve located between the left atrium and the left ventricle
3. Chordae tendineae and their associated papillary muscles ensure that the cusps of the AV valves permit blood to flow into the ventricles but prevent backflow of blood into the atria.
4. There are two semilunar (SL) valves (each consisting of three semilunar cusps):
   i. pulmonary semilunar valve located between the pulmonary trunk and the right ventricle
   ii. aortic semilunar valve located between the aorta and the left ventricle
5. The cusps of the SL valves permit ejection of blood from the ventricles but prevent backflow of blood into the heart.

H. Circulation of Blood (p. 435)
1. The heart pumps blood into two closed circuits:
   i. systemic circulation
   ii. pulmonary circulation
2. The left side of the heart is the pump for the systemic circulation; it receives oxygenated blood from the lungs and then pumps this blood into the aorta which subsequently branches into systemic arteries that carry this blood to all organs except the lungs’ alveoli.
3. In tissues, arteries branch into arterioles and subsequently into systemic capillaries where nutrients, wastes, gases, etc. are exchanged between the blood and the surrounding cells.
4. Capillaries merge to deliver deoxygenated blood into systemic venules which subsequently merge to form systemic veins that carry this blood to the right atrium of the heart.
5. The right side of the heart is the pump for the pulmonary circulation; it receives deoxygenated blood returning from the systemic circulation and pumps it into the pulmonary trunk which subsequently branches into pulmonary arteries that carry this blood to the pulmonary capillaries where the blood becomes oxygenated.

Coronary Circulation:
6. The flow of blood through the blood vessels that penetrate the myocardium is called the coronary (cardiac) circulation.
7. Right and left coronary arteries, which deliver oxygen and nutrients, are branches of the ascending aorta:
   i. the left coronary artery divides into:
      a. anterior interventricular branch or left anterior descending (LAD) artery
      b. circumflex branch
   ii. the right coronary artery divides into:
      a. posterior interventricular branch
b. **marginal branch**

8. The myocardium contains many **anastomoses** that provide alternate routes for blood to reach a particular tissue.

9. Blood draining out of the myocardium has collected carbon dioxide and wastes, and it flows into the **coronary sinus** whose principal tributaries are:
   - great cardiac vein
   - middle cardiac vein
   - small cardiac vein
   - anterior cardiac vein

I. **The Cardiac Conduction System** (p. 436)

1. During embryonic development about 1% of the cardiac muscle fibers become **autorhythmic cells**, allowing them to perform two major functions:
   - act as a **pacemaker** to set the rhythm for contraction of the entire heart
   - form the **conduction system** to conduct action potentials throughout the myocardium; the components of the conduction system are:
     - sinoatrial (SA) node which initiates each heartbeat and thus is the heart’s pacemaker
     - atrioventricular (AV) node
     - atrioventricular (AV) bundle or bundle of His
     - right and left bundle branches
     - Purkinje fibers

2. The nervous system and various hormones may increase or decrease the pace of contractions (but the nervous system does not initiate contractions).

3. An **electrocardiogram** (ECG or EKG) is a recording of the heart’s electrical activity; during each cardiac cycle a **P wave**, **QRS wave** and **T wave** are recorded.

J. **Cardiac Cycle (Heartbeat)** (p. 440)

1. The **cardiac cycle** comprises all the events associated with one heartbeat.

2. In a normal cardiac cycle, the two atria contract while the two ventricles relax.

3. Subsequently, the two ventricles contract while the two atria relax.

4. **Systole** is the contraction phase of a heart chamber; **diastole** is the relaxation phase of a heart chamber.

5. The cardiac cycle consists of three major phases:
   - relaxation period
   - atrial systole (contraction)
   - ventricular systole (contraction)

K. **Heart Sounds** (p. 440)

1. **Auscultation** (listening to sounds) of the heart with a stethoscope reveals two major alternating **heart sounds**, described as **lubb** and **dupp**, that are heard due to blood turbulence caused by closing of the AV valves and semilunar valves, respectively.

2. Heart sounds are best heard at the surface of the chest in locations that differ slightly from the actual locations of the valves.

L. **Exercise and the Heart** (p. 441)

1. **Aerobic** exercise can improve the health of the cardiovascular system.

2. Prolonged training will increase maximal cardiac output, reduce blood pressure, increase ability to dissolve blood clots, etc.; improvements in lung function, psychological well-being, etc. are also observed.
M. Development of the Heart (p. 442)
1. The heart is a derivative of mesoderm and begins to develop before the end of the third week of gestation.
2. The first event, which occurs in the cardiogenic area, is the formation of a pair of cardiogenic cords which develop into endocardial tubes; these tubes then unite to form the primitive heart tube.
3. The primitive heart tube then develops into five regions:
   i. sinus venosus (becomes part of the right atrium, coronary sinus and SA node)
   ii. atrium (becomes part of the right atrium and left atrium)
   iii. ventricle (becomes the left ventricle)
   iv. bulbus cordis (becomes the right ventricle)
   v. truncus arteriosus (becomes the ascending aorta and the pulmonary trunk)
4. Subsequently, the interatrial septum develops (with a temporary opening called the foramen ovale; the latter closes after birth to become the fossa ovalis) and the interventricular septum develops.
5. The heart valves form between the fifth and ninth weeks.

N. Key Medical Terms Associated with the Heart (p. 449)
1. Students should familiarize themselves with the glossary of key medical terms.