Prelab Questions

1. What are nasal conchae?

2. Describe the pharynx.

3. What are the differences in bronchi and bronchioles?

4. What is the derivation (etymology) of the word lung?

5. Compare the terms alveolus and alveolar sac.
Exercises

The objective of this lab is to learn respiratory anatomy and physiology from:
A. A short introduction to gross and microscopic respiratory anatomy.
B. Illustrations from your textbook, lab charts and the Anatomy and Physiology Coloring Book, if you wish to purchase it.
C. Models
D. A.D.A.M. Interactive Anatomy software.
E. Use of microscope slides to learn normal and abnormal respiratory histology.
F. Using spirometers to measure some lung volumes and capacities.

Please note that every structure you are responsible for has a unique number assigned to it. Most, but not all, of these numbers are used on the model photos displayed in this guide.

1. The upper respiratory passages (page 847-851 in your text). Find the following structures, except the pseudostratified epithelium, on the oral/nasal cavities model and the human head section model:
   a. A cartilaginous and bony nasal septum (1) divides the nasal cavity (2) into right and left halves. These structures (1&2) are not labeled on the photographs.
   
   b. Each opening into the nasal cavity (nostril) is called the external naris (3) (NAIR-is) (nares is plural)
   
   c. The anterior part of the nasal cavity is the nasal vestibule (4). It is lined with skin, and growing from this skin are coarse nasal hairs that act as air filters.
   
   d. The nasal cavity (5), located posterior to the nasal vestibule, is the main part of the nasal cavity. Extending from each lateral wall of the nasal cavity proper are three bony shelves called the superior, middle and inferior nasal conchae (6) (turbinates). These conchae extend toward the nasal septum, and divide the nasal cavity proper into three passageways called meatuses (7) (mē-ĀT-ū-sēs). These meatuses cause air to swirl in the cavity, thus exposing more of the air to the sticky nasal mucosa. Pseudostratified ciliated columnar epithelium (8) lines the mucosa of the nasal cavity proper. This epithelium contains cilia and goblet cells that work together to filter the air. As inspired air passes over this epithelium, the sticky mucus traps inhaled particles. The beating of the cilia then moves the mucus and particles back toward the throat where they are swallowed. The nasal cavity also humidifies air, warms air, and contains receptors for olfaction (smell) in its roof.
   
   e. The internal nares (9) (NAIR-ēz) are passageways on either side of the nasal septum; they connect the nasal cavity to the pharynx (throat).
f. The **hard palate (10)** is a bony structure that forms the floor of the nasal cavity and the roof of the oral cavity. Do you know the two bones that form it?

g. Posterior to the hard palate is the **Soft palate (11)**. This muscular structure curves downward along the anterior wall of the upper throat. It ends as a nipple-like projection called the **uvula (12)** (ÜV-ūla).

h. The **Pharynx (13)** (FAIR-inks), or throat, is a funnel shaped five-inch long passageway that extends from the internal nares downward to the esophagus (tube to the stomach) and larynx (voice box). Though it is one tube, it is divided into three sections.

   The upper part, lying behind the nasal cavity, is the **nasopharynx (14)**. There are two prominent features of the nasopharynx. The **pharyngeal tonsil (15)** (adenoid) lies in the posterior wall of the nasopharynx. On its lateral walls are small openings into the **auditory (Eustachian) tubes (16)**. These small tubes connect the nasopharynx to the middle ear and help to equalize air pressure on either side of the eardrum. Like the nasal cavity proper, **pseudostratified ciliated columnar epithelium** lines the nasopharynx.

   The middle part of the pharynx, located behind the oral cavity, is the **oropharynx (17)**. It extends from the soft palate downward to the level of the hyoid bone. The oral cavity opens into the oropharynx through an arch-like opening. If you open your mouth and look through this opening, you will see the posterior wall of the oropharynx. While you are looking, you may see the **palatine tonsils (18)**; they are located on either side just behind the arch-like opening. Further down, at the base of the tongue, are two **lingual tonsils (19)**. The oropharynx is line with **nonkeratinized stratified squamous epithelium (20)**.

   The inferior part of the throat is the **laryngopharynx (21)** (la-RING-o-FAIR-inks). It begins at the level of the hyoid bone and connects the rest of the pharynx to the larynx and the esophagus. **Nonkeratinized-stratified squamous epithelium** lines the laryngopharynx. Both the oropharynx and the laryngopharynx are common passageways for air, food, and drink.
Figure 1. Large Oral/Nasal Cavity Model
2. The larynx (22) (LAIR-inks), or voice box, contains the vocal cords. Its skeletal support consists of several pieces of cartilage. (pages 851-853 in your text)

Find the following structures on the larynx model and the sagittal view of the bronchial tree model.

a. The largest part of the larynx is the thyroid cartilage (23). It is closed in the front but open in the back.

b. A smaller cartilage located just below the thyroid cartilage is the cricoid cartilage (24) (crī-coyd). It is smaller in front, but it extends further up in the back.

c. The arytenoid cartilages (25) (air-ū-TEA-noyd) are small, paired triangular cartilages that connect to the upper, posterior edge of the cricoid cartilage. The vocal folds (26) (vocal cords) attach to them. They pivot outward (laterally) to tighten the cords and produce sound.

d. The corniculate cartilages (27) (cor-NIC-ū-lāte) are small, horn-like cartilages that attach to the top of the arytenoid cartilages. They connect to the vestibular folds (28) (ventricular folds or false vocal cords). These folds are located above the vocal folds. They do not make sound but they do help to open and close the glottis (29), the opening past the vocal folds.

e. The epiglottis (30) (ep-ū-GLOT-ūs) is a spoon-shaped cartilage that acts as a lid to close off the glottis when swallowing.

f. The thyrohyoid (THIGH-rō-HI-oyd) membrane (31) connects the thyroid cartilage to the hyoid bone. The cricothyroid (CRY-kō-THIGH-royd) ligament (32) connects the cricoid cartilage to the thyroid cartilage.

g. The hyoid bone (33) is a horseshoe shaped bone located just above the thyroid cartilage. Certain tongue muscles attach to the hyoid bone.
Figure 3. Larynx Model, anterior view
Figure 4. Larynx Model, posterior view
Figure 5. Bronchial Tree Model, sagittal view of larynx
3. The **trachea** (34) (TRĀ-kē-ŭh) or windpipe extends from the cricoid cartilage of the larynx into the chest where it divides and passes air to and from the lungs. (pages 855 & 856 in your text) It is composed of the following structures:
   a. The **tracheal cartilages** (35) are C-shaped hyaline cartilage struts that support the trachea and keep it open. The cartilages do not continue posteriorly and an elastic **tracheal membrane** (36) connects their open ends. Embedded in the tracheal membrane is a **trachealis** (trāk-ē-alice) **muscle** (37). This muscle can constrict the trachea. **Annular ligaments** (38) connect the tracheal cartilages to each other.
   b. The **respiratory epithelium** (39) consists of a mucous membrane with **pseudostratified ciliated columnar epithelium**. This epithelium has mucus producing goblet cells and cilia. The mucus traps inhaled particles and the cilia move the trapped particles upward toward the throat. Since the cilia slowly move the particles upward, some people use the term **mucociliary escalator** (40) to describe this cleaning mechanism.

4. **Lung anatomy** (pages 857-860 in your text)
   Find the following structures on the Right and Left Lung and the Thoracic Organs model:
   a. The tip of the lung, called the **apex** (41), extends to just above the first rib, or to just behind the clavicle.
   b. The **base** (42) (diaphragmatic surface) of the lung is strongly concave. It follows the curvature of the dome-shaped **diaphragm** (43), the main muscle of respiration.
   c. Deep **fissures** (44) divide each lung into **lobes** (45). The **right lung** (46) has an **oblique fissure** (47) that passes diagonally down its front, and a **horizontal fissure** (48). These two fissures produce **superior** (49), **middle** (50) and **inferior** (51) lobes in the right lung. The **left lung** (52) has only an **oblique fissure** (53), dividing it into **superior** (54) and **inferior lobes** (55).
   d. Each lung lobe has a number of smaller compartments called **lobules**
   e. On the medial edge of the left lung is a deep indentation called the **cardiac notch** (56). This notch accommodates the left facing apex of the heart.
   f. The medial surface of each lung has a slit-shaped area, called the **hilus** (57) (HĪ-lūs), where vessels and bronchi enter and exit.
   g. Enclosing each lung is a potential space called the **pleural cavity** 58. Why is the pleural cavity a potential space? The **parietal** (pā-RĪ-ŭ-tūl) **pleura** (59) forms the outer wall of the pleural cavity and the **visceral** (VĪS-ŭ-rūl) **pleura** (60) forms its inner wall. The mediastinum separates the two pleural cavities.
Figure 6. Right and Left Lung Models
Figure 7. Thoracic Organs Model
5. **Lung Airways (61)** (pages 856&857)

Use the Bronchial Tree and Lung Lobule models to find the following structures:

a. The **bronchi (62)** (BRONG-kī) (sing, bronchus) are the larger cartilaginous airways that enter the lungs and supply them with air. They divide like the branches of a tree, thus the term **respiratory tree (63)**. There are three major types of bronchi.

1) The **primary (mainstem) bronchi (64)** are divisions of the trachea that transport air to each lung. For this reason, they are also called pulmonary bronchi. Note that the right one is shorter, larger in diameter, and more vertical than the left one.

2) The **secondary (lobar) bronchi (65)** are divisions of the primary bronchi. Note that there are three in the right lung and two in the left lung, you will know why later.

3) The **tertiary (segmental) bronchi (66)** are divisions of the secondary bronchi. They supply air to lung segments (bronchopulmonary segments).
Figure 8. Bronchial Tree Model, anterior view
Figure 9. Bronchial Tree Model, posterior view
Use pages 860&861 in your text, and the Lung Lobule Model to find the following structures:

a. The bronchioles (67) (BRONG-kē-oles) are small muscular airways that are usually one millimeter or less in diameter. If the trachea is the “trunk” of the respiratory tree and the bronchi are the “limbs” of the tree, the bronchioles are the “twigs” at the ends of the branching limbs. Since they are so small and they can constrict and dilate, they are resistance airways. Their constriction is bronchoconstriction and their dilation is bronchodilation. Thus, bronchioles control airflow in the lungs. What does asthma have to do with bronchioles?

b. The terminal bronchioles (68) are the airways that conduct air to small lung compartments called lobules. The branching of the larger bronchioles forms them, and they average about 0.5 mm in diameter. These are on the lobule model, but they are not labeled on the photograph.

c. The branching of terminal bronchioles forms respiratory bronchioles (69) within the lung lobules. They deliver air to the small chambers where gas exchange occurs. Because they are thin enough for blood gasses to pass through their walls, they are themselves capable of carrying on some gas exchange. These are on the lobule model, but they are not labeled on the photograph.

d. The small, bubble-like chambers where gas exchange occurs are alveoli (70) (al-VĒ-ŭ-lī); one chamber is called an alveolus (71) (al-VĒ-ŭ-lus). At the end of each respiratory bronchiole, numerous alveoli form grape-like clusters called alveolar sacs (72). An alveolar duct (73) supplies air to each alveolar sac. Think of the alveolar duct as a hallway in a hotel and each alveolus as a room off the hallway. Because of their large surface area, most gas exchange occurs in the alveolar sacs.

e. Wrappings of elastic fibers (74) form the outer walls of the alveoli. These fibers stretch on inhalation then recoil on exhalation and are largely responsible for exhalation during resting ventilation.

**Structures 75 & 77-80 are not on the lobule model, just use your text.**

f. Squamous cells called Type I (alveolar) cells (75) form the bulk of the alveoli, thus the wall of each alveolus is extremely thin. Lung capillaries (76) cover the outside of the alveoli.

g. The alveolar cells and their basement membrane plus the capillary endothelial cells and their basement membranes form a 0.5-micrometer thick respiratory membrane or RM. Gas exchange (77) occurs across the RM as $O_2$ diffuses from the alveolar air to the blood and $CO_2$ diffuses from the blood to the alveolar air.
h. **Type II (septal) cells (78)** are scattered along the alveolar. They secrete a phospholipid, protein mixture called the **surfactant (79)**. The surfactant prevents the attractive forces (surface tension) of water from causing alveolar collapse. If an individual lacks enough surfactant, it takes a lot of effort and perhaps treatment to keep the alveoli open.

i. **Type III (dust) cells (80)** are alveolar macrophages that patrol the inside of the alveolus and phagocytize dust particles and microbes that were not removed by the mucociliary escalator.

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**Figure 10. Lung Lobule Model**
6. **Histology** – Refer to page 860&862 in your text, and the histological lab chart for help.
Use the slide of normal lung tissue to identify alveoli, bronchioles, and branches of the pulmonary arteries and veins. How would you distinguish a cross-section of an artery and a vein?
Exam the slide of emphysemic lung tissue and compare it to the slide of normal lung tissue. What are some obvious differences?

7. **Spirometry – measurement of lung volumes**
Use spirometers to reinforce your knowledge of lung volumes and capacities. Instructions for use of the spirometers will be given in lab.

A.D.A.M. Interactive Anatomy - Respiratory System

**Nasal Bones**
**Anterior view**
1. Select layer #46

2. Identify the following bones:
   a) nasal bones
   b) maxilla
   c) vomer

3. Select layer #59 and identify the following bones:
   a) perpendicular plate of the ethmoid
   b) perpendicular plate of vomer or just vomer
   c) middle nasal concha
   d) inferior nasal concha

**Lower Respiratory Tract**
**Anterior view**
1. Select layer #254 and center the image so that the larynx and upper trachea are in view. Identify the following:
   a) epiglottis
   b) hyoid bone or body of hyoid bone
   c) thyroid cartilage
   d) tracheal ring cartilages

2. Select layer #255 and identify the following:
   a) epiglottis
   b) cricoid cartilage

3. Select layer #256 and identify the following:
   a) arytenoid cartilages
   b) corniculate cartilages
4. Reposition the image in the middle of the chest, point between the cartilage rings and identify the trachea. Also, identify the following:
   a) right main (primary) bronchus
   b) left main (primary) bronchus
   c) costal parietal pleura of right pleural cavity
   d) diaphragmatic surface (base) of lower lobes of both lungs

**Lung Anatomy**

**Anterior view**
1. Select layer # 162 and identify
   a) superior, middle and lower lobes of right lung
   b) horizontal fissure of right lung
   c) oblique fissure of right lung
   d) apex of right lung
   e) parietal pleura
   f) diaphragmatic parietal pleura
   g) diaphragm
   h) cardiac notch of left lung

**Sagittal Head Section**

**Medial view**
1. Stay in layer "0" and identify the following:
   a) vestibule of nose
   b) nasal cavity proper
   c) superior, middle and inferior nasal conchae
   d) pharyngeal tonsil
   e) pharyngeal orifice of auditory tube
   f) nasopharynx
   g) oropharynx
   h) lingual tonsil (Where you first point may say genioglossus muscle. Just keep pointing and clicking and you will identify this tonsil.)
   i) laryngopharynx
   j) vestibular (ventricular) fold
   k) vocal fold (vocal cord)
   l) cartilage of epiglottis

**Lateral View of Right Lung**

**Lateral view**
1. Reposition image over thorax
2. Select layer #145 and identify the following:
   a) superior, middle and inferior lobes of right lung
   b) apex of right lung
   c) horizontal and oblique fissures of right lung
   d) diaphragm
   e) parietal pleura
Respiratory Focus Questions

1. Name the external opening into nasal cavity. ______________________
2. Name the bony structures in the nasal cavity that extend from the lateral walls of nasal cavity and form the passageways called the meatuses. ______________________
3. Name the conical, finger-like, muscular process hanging down from the soft palate. ______________________
4. Name the passageway from the posterior part of the nasal cavity into the nasopharynx. ______________________
5. Name the superior part of pharynx. ______________________
6. Name the tube leading to the middle ear from the superior part of the pharynx. ______________________
7. Name the tonsil in posterior wall of the superior part of pharynx. ______________________
8. Name the middle part of pharynx. ______________________
9. Name the inferior part of pharynx. ______________________
10. Name the tonsils in fold between oral cavity and oropharynx. ______________________
11. Name the tonsil at base of the tongue. ______________________
12. Name the tongue bone. ______________________
13. Name the largest laryngeal cartilage. ______________________
14. Name the cartilage inferior to cartilage 13. ______________________
15. Name the ladle-shaped cartilages on superior border of above cartilage. ______________________
16. Name the small horn-like cartilages that articulate with the cartilages 15. ______________________
17. What is the proper name for vocal cords? ______________________
18. Name the cartilaginous lid that closes the opening into the larynx. ______________________
19. Describe the general shape of tracheal cartilages. ______________________
20. Name the branches of the trachea that transmit air to lungs.

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21. Name the branches of the airways in question 20 that transmit air to the lung lobes.
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22. Name the branches of the airways in question 21 that transmit air to the bronchopulmonary segments.
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23. Name the small, muscular airways that branch off of the tertiary bronchi.
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24. Name the first airways to exchange gases.
____________________________________________________________________________________

25. Name the blind-end tubes that lead to alveoli and alveolar sacs.
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26. Name the cells within alveoli that secrete surfactant.
____________________________________________________________________________________

27. What other name is used for the alveolar macrophages?
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28. Name the top of lung.
____________________________________________________________________________________

29. Name the bottom of lung.
____________________________________________________________________________________

30. Name the depression where structures enter and exit the lung.
____________________________________________________________________________________

31. What lung has only one fissure?
____________________________________________________________________________________

32. Which lung has a horizontal fissure?
____________________________________________________________________________________

33. Which lung has a cardiac notch?
____________________________________________________________________________________
    Why does this lung have the cardiac notch?
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34. Name the pleural membrane that covers the surface of the lung and extends into the fissures between the lobes?
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35. Name the pleural membrane that lines the inner surface of the thoracic wall and extends over the diaphragm and mediastinum.
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36. Name the potential space that lies between the above membranes.
____________________________________________________________________________________

37. Name the main muscle of respiration.
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38. Name the rib muscles used during eupnea.
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39. Name the epithelium lining most of the nasal cavity, larynx below the vocal folds, trachea, bronchi, and most bronchioles.
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