

OVERVIEW of the RESPIRATORY SYSTEM

The respiratory system consists of passageways that filter incoming air and carry it into the lungs. Here in the microscopic air sacs, exchanges take place between the external atmospheric air and the internal body environment.

In this and several plates to follow, we review the respiratory system in gross anatomy and detail. This plate presents an overview of the system. Many of the structures seen in this system have been encountered in previous plates, and we review them here and place them in perspective.

Begin the plate by coloring the main title Overview of the Respiratory System. The plate consists of a single anterior view of the head and thoracic cavity. Certain structures are designated with lowercase letters because they belong to other systems. The uppercase letters are reserved for portions of the respiratory system. As you read about the structures, color their titles and locate and color the structures. Use light and dark colors as we move along.

On entering the body, air passes through the first organ of the upper system, the **nasal passage (A)**. A light color should be used for this passageway. Within the nasal passage, outcroppings of bone from the lateral wall divide the main passageway into smaller passageways. These outcroppings are called **nasal conchae (A₁)**. The arrows pointing to the nasal conchae should be colored in a dark color such as a red, green, or blue.

The upper respiratory system also contains a number of air-filled spaces between the maxillary, frontal, ethmoid, and sphenoid bones of the skull. These spaces are called sinuses. The diagram shows the **frontal sinus (B₁)** and the **sphenoid sinus (B₂)**. Air is "conditioned" in these spaces.

In this section of the head, we also see features of the digestive system. The **tongue (a)** is a large muscular organ filling most of the space of the oral cavity. The oral cavity leads to a major passageway called the **pharynx (C)**, which serves both the respiratory and digestive systems. The **esophagus (b)** leads from the pharynx to the stomach.

As we enter the neck area we encounter the passageways leading to the lungs. We shall examine these in more detail in upcoming plates. Pale colors should be used for these structures.

Below the pharynx, we encounter the first portion of the passageway leading to the lungs, the **larynx (D)**. The bracket outlining this structure should be colored, and a pale color may be used for the structure itself. The flaplike epiglottis guards the entry to the larynx, and several cartilages make up the walls of the larynx.

Leading from the larynx is the windpipe, more correctly known as the **trachea (E)**. The trachea is continuous with the larynx. The rings that you note in the plate contain cartilage, and you may use a dark color to highlight them.

The trachea extends in front of the esophagus into the thoracic cavity, then splits to form two passageways called bronchi. On the visual right (the anatomical left) is the **left mainstem bronchus (F₁)**, and at your visual left (the anatomical right) is the **right mainstem bronchus (F₂)**. The same color used for the trachea should be used here to designate the continuity of the tube. The arrow may be colored in a bold color.

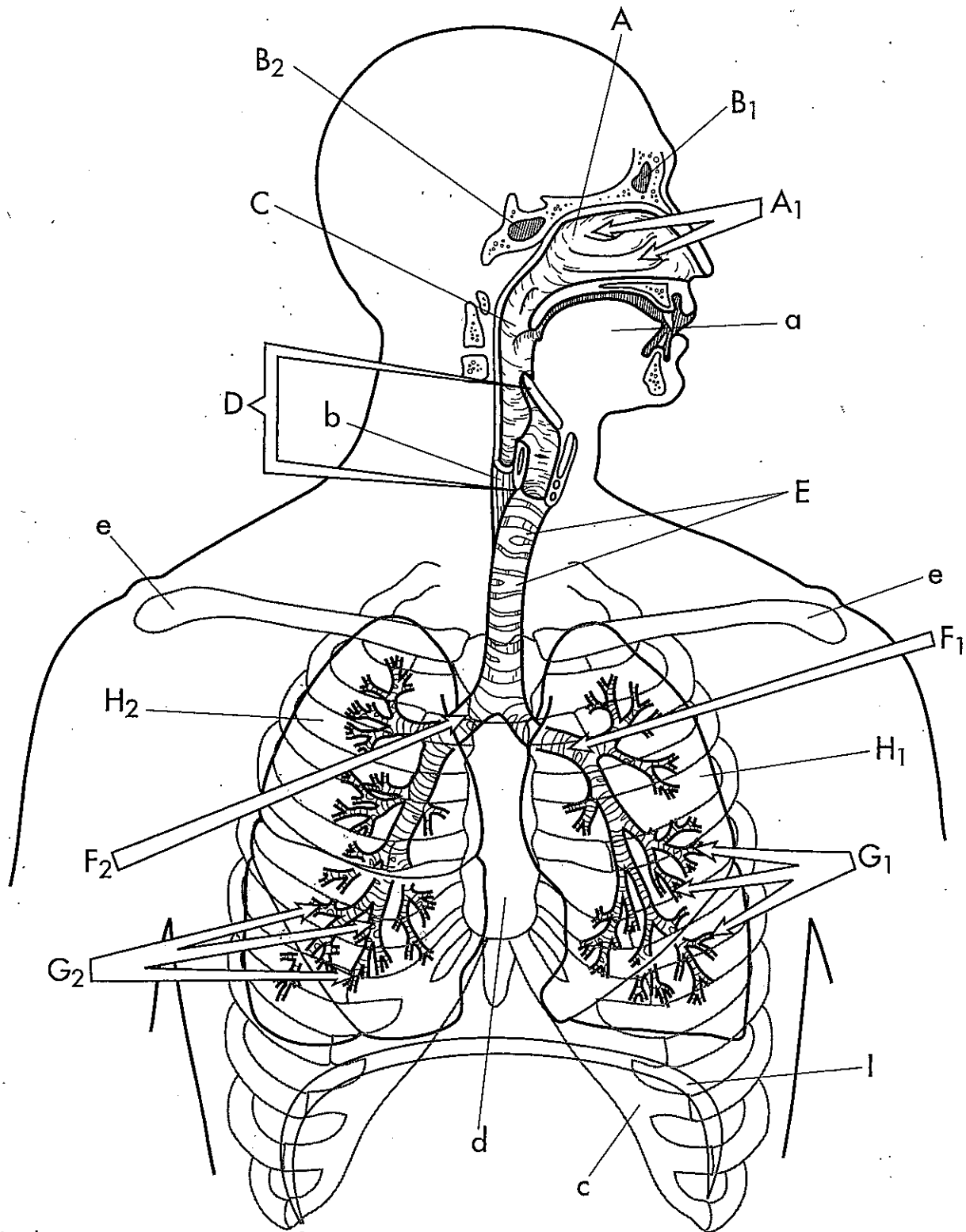
Each bronchus continues as the bronchial tree. The left bronchial tree and the right bronchial tree are designated with arrows that may be colored boldly, but the tubes themselves should be colored with a light color continuous with that used for the bronchi. The **left bronchial tree (G₁)** and the **right bronchial tree (G₂)** are seen in the plate.

The main organ of gas exchange in the body is the lung. This paired organ should be outlined with a very light color in the plate. We also show some of the bones surrounding the lungs. It would be best to outline them in bold color without coloring them in to avoid obscuring the lungs. As you read about these structures below, color their titles, then finish coloring the plate.

The right and left bronchial trees lead to the smaller alveolar ducts, then to the air sacs of the lungs. The **left lung (H₁)** and the **right lung (H₂)** occupy most of the space of the thoracic cavity. The lungs are soft, spongy organs in the shape of a cone. They are separated by the heart and mediastinum, and their gross anatomy is reviewed in an upcoming plate.

The expansion of the lungs depends heavily on the activity of intercostal muscles and the large, dome-shaped **diaphragm (I)**. When this muscle contracts, air enters the lungs. Enclosing the lungs are the bones of the thoracic cage. These include the **ribs (c)**, the **sternum (d)**, and the **clavicles (e)**. We suggest you simply outline the margins of these bones to show their proximity to the lungs.

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Nasal passage	A	○	Left mainstem bronchus	F ₁	○	Diaphragm	I	○
Nasal conchae	A ₁	○	Right mainstem bronchus	F ₂	○	Tongue	a	○
Frontal sinus	B ₁	○	Left bronchial tree	G ₁	○	Esophagus	b	○
Sphenoid sinus	B ₂	○	Right bronchial tree	G ₂	○	Ribs	c	○
Pharynx	C	○	Left lung	H ₁	○	Sternum	d	○
Larynx	D	○	Right lung	H ₂	○	Clavicles	e	○
Trachea	E	○						

the TRACHEA and BRONCHIAL TREE

The trachea is a flexible cylindrical tube about one inch in diameter and approximately four inches in length. It extends downward in front of the esophagus and into the thoracic cavity, where it splits to right and left mainstem bronchi and respective bronchial trees. Often called the windpipe, it is the passageway for air to the lungs.

Begin the plate by coloring the main title The Trachea and Bronchial Tree. As you look over the diagram, note that we are presenting the passageway from the pharynx to the lobules of the lung showing the details of the tubes involved. We also present a cross section of the trachea so you may see the tissue layers of this organ. Bold colors such as purples, oranges, greens, and reds may be used for this plate because the structures are large and separated from each other. We begin with a brief review of the larynx.

At its superior border, the trachea is continuous with the **larynx (A)**. Also known as the voicebox, the larynx was considered in detail in the previous plate. Some notable features are the large, shield-like **thyroid cartilage (A₁)**, which is more prominent in males than in females. Connected to the thyroid cartilage is the smaller **cricoid cartilage (A₂)**, which connects to the trachea. The **cricothyroid ligament (A₃)** connects these two large cartilages to one another, and the **thyrohyoid ligament (A₄)** connects the thyroid cartilage to the **hyoid bone (A₅)**.

Inferior to the larynx is the **trachea (B)**. Viewed from the anterior aspect, the trachea contains 16 to 20 incomplete rings of **hyaline or tracheal cartilage (B₁)**. These cartilages may be colored in dark colors. The cartilages have the shape of a C, where the open portion faces the esophagus. The cartilage rings provide a semirigid support to the wall of the trachea, preventing it from collapsing inward.

The tracheal cartilages are connected to one another by elastic **annular ligaments (B₂)**. A lighter color is recommended for these ligaments. The annular ligament may also be seen in the cross section of the tracheal wall. Note that it also surrounds the cartilage.

Before moving on to the bronchial tree, we shall examine a cross section of the trachea. Here we see some of the structures mentioned previously as well as other structures important to the integrity of this organ. Dark colors may be used for most structures, since they are fairly clear.

In cross section, one can see the **tracheal cartilage (B₁)** and the **annular ligament (B₂)** mentioned previously. The inner layer of the trachea is the **mucosa (J)**. A dark color may be used to indicate the bracket. Within the mucosa, the innermost layer is the **ciliated epithelium (K)**. Cilia along the borders of the cells trap particles in the air. The surface is moistened by mucus secreted by **mucous cells (N)**. The mucus traps airborne particles, which are then carried back to the pharynx.

The second layer of the mucosa is the **lamina propria (L)**. The lamina propria contains elastic and reticular fibers and provides support to the other tissues. Finally, the trachea contains a band of **smooth muscle (M)**. This smooth muscle connects the ends of the tracheal cartilages and provides a flexible surface against which the esophagus can expand.

We now return to the main passageway and study the divisions of the trachea into smaller tubes entering the lung tissue. Bold colors are recommended as before, and you should note the changing nature of the tissues involved in the passageways. As you encounter the structures, color the titles before locating and coloring them in the diagram.

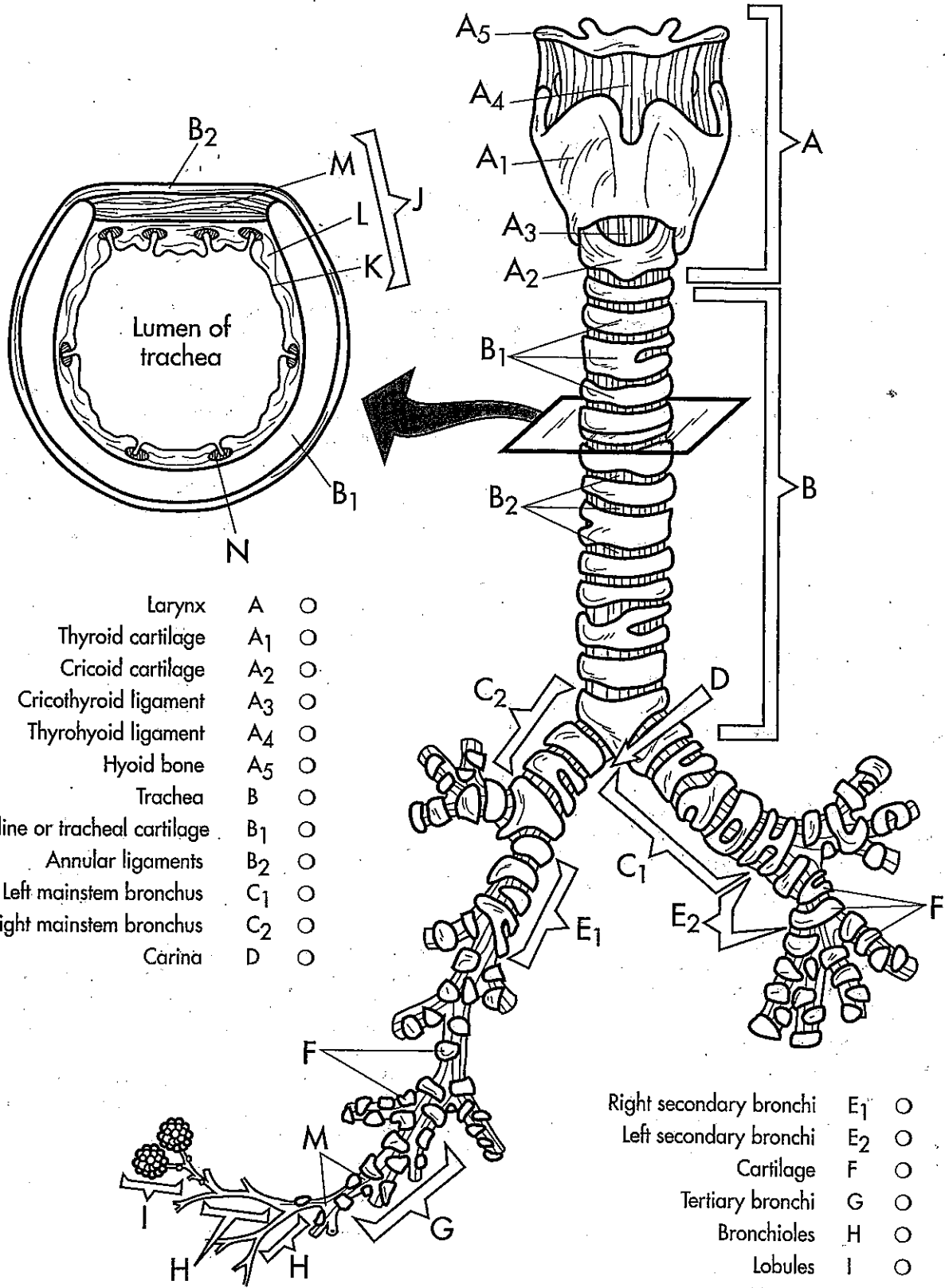
The bronchial tree consists of the branched airways extending from the trachea to the air sacs of the lungs. It begins with the **left and right mainstem bronchi (C₁ and C₂)**. The openings to these tubes are separated by a ridge of cartilage called the **carina (D)**. Beyond the carina, each bronchus, accompanied by large blood vessels, enters a lung.

Note that the structural organization of the primary bronchus is similar to that of the trachea. There are C-shaped rings of cartilage that support the tissue. Also note that the **right mainstem bronchus (C₂)** has a slightly larger diameter than the left, and it descends at a steeper angle into the lung.

A short distance from its origin, each primary bronchus subdivides and forms **left and right secondary bronchi (E₁ and E₂)**. The secondary bronchi proceed to the five lobes of the lung. There are two secondary bronchi on the left side of the bronchial tree and three secondary bronchi on the right side. At this point, the cartilage rings become plates of **cartilage (F)**. The same color as that used for the rings may be used. As the secondary bronchi branch into **tertiary bronchi (G)**, the number and size of cartilage plates decreases. The structure of the bronchial tree at this point is composed largely of **smooth muscle (M)** and attending tissue.

Further along, the tertiary bronchi become **bronchioles (H)**. These small branches enter the basic units of the lung, called **lobules (I)**. The lobule contains the terminal bronchioles as well as the alveolar air sacs and capillaries. They are discussed in greater detail in upcoming plates and you are referred there for the details.

THE TRACHEA AND BRONCHIAL TREE



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|-------------------------------|----------------|---|
| Larynx | A | ○ |
| Thyroid cartilage | A ₁ | ○ |
| Cricoid cartilage | A ₂ | ○ |
| Cricothyroid ligament | A ₃ | ○ |
| Thyrohyoid ligament | A ₄ | ○ |
| Hyoid bone | A ₅ | ○ |
| Trachea | B | ○ |
| Hyaline or tracheal cartilage | B ₁ | ○ |
| Annular ligaments | B ₂ | ○ |
| Left mainstem bronchus | C ₁ | ○ |
| Right mainstem bronchus | C ₂ | ○ |
| Carina | D | ○ |

- | | | |
|-------------------------|----------------|---|
| Right secondary bronchi | E ₁ | ○ |
| Left secondary bronchi | E ₂ | ○ |
| Cartilage | F | ○ |
| Tertiary bronchi | G | ○ |
| Bronchioles | H | ○ |
| Lobules | I | ○ |
| Mucosa | J | ○ |
| Ciliated epithelium | K | ○ |
| Lamina propria | L | ○ |
| Smooth muscle | M | ○ |
| Mucous cells | N | ○ |