Mechanics and Control of Breathing

See pp. 445-446 of your textbook
Mechanics of breathing

Air does not flow into and out of the body on its own. It involves the movement of a number of muscles, and coordination of breathing movements by the brain.

Air pressure in the chest cavity and the volume of the chest cavity affects air movement.
Muscles used in breathing

There are 2 sets of muscles involved in breathing:

**Diaphragm** – a dome-shaped muscle that separates the chest (thoracic) cavity from the abdomen.

**Intercostals** – muscles found between the ribs and along the inner surface of the rib cage
Muscles used in breathing

- Ribs and sternum elevate
- Diaphragm contracts

- Scalene muscles
- Pectoralis minor muscle
- Transversus thoracis muscle
- Serratus anterior muscle
- Diaphragm

(c) Inhalation
- Sternocecidomastoid muscle
- Pectoralis minor muscle
- Serratus anterior muscle
- Diaphragm

(d) Exhalation
- Transversus thoracis muscle
- Rectus abdominis and other abdominal muscles (not shown)
Inhalation

Inhalation is the process of drawing air into the body.

In order to get air to move into the lungs, there must be a difference between the air pressure outside the body and inside the lungs.
Inhalation

Air will move from an area of high pressure to an area of low pressure.

To draw air in, the air pressure inside the chest must be less than the air pressure outside the body.
Inhalation

To accomplish this, the size of the chest cavity must increase.

The diaphragm and intercostals will contract; the diaphragm will move down and the intercostals move up and out.
Inhalation

- Rib cage expands as rib muscles contract
- Air inhaled
- Lung
- Diaphragm

INHALATION
Diaphragm contracts (moves down)
Inhalation

**Increasing the volume** of the chest cavity **decreases the air pressure** inside the chest cavity.

The volume of air already in the chest cavity has not changed, but there is **more space** for the particles to move, therefore, the pressure they exert is less.
Inhalation

The **lungs** are suspended in the chest cavity and are sensitive to the changes in air pressure. When the pressure drops in the chest, the lungs expand, and the air pressure in the lungs is less than the air pressure outside. **Air moves into the lungs from the outside.**
Exhalation

Since air moves from high pressure to low, to move air out of the lungs, the air pressure inside the chest cavity must increase above the outside air pressure.

This is accomplished by reducing the size of the chest cavity. Again, this is due to the action of the muscles.
Exhalation

The diaphragm and intercostal muscles relax. The diaphragm moves back up to its resting dome-shape. The intercostal muscles drop the ribs back down and in.

This reduces the volume of the chest cavity.
Exhalation

INHALATION
Diaphragm contracts (moves down)

EXHALATION
Diaphragm relaxes (moves up)
Exhalation

Reducing the volume of the chest cavity gives the air particles in the chest less room to move. They will exert more pressure.

The lung volume decreases, causing air pressure in the lungs to increase, and air moves out from the lungs to the lower pressure outside.
Control of breathing

You are able to voluntarily control your rate of breathing. If you think about it, your breathing rate can be slowed or sped up. However, when you are distracted by some other activity, breathing becomes involuntary.
Control of breathing

It is controlled automatically by a region of your brain known as the **medulla oblongata**. This area of the brain regularly sends messages to the muscles controlling breathing to maintain regular inhalations and exhalations.
Increasing breathing rates

When your activity levels increase, your body’s need for oxygen increases, as does the need to eliminate carbon dioxide. To accommodate these needs, you begin to breathe at an increased rate.
Increasing breathing rates

To increase your breathing rate, your body has sensors that read the levels of certain chemicals in your body. These include:
Breathing sensors

a) **Chemoreceptors** that read the level of **carbon dioxide** and **carbonic acid** in the blood. When these levels are high, the medulla oblongata sends out nerve impulses to initiate faster movement of the muscles of the rib cage and diaphragm. **This is the main regulator of breathing rate.**
b) **Chemoreceptors** that read **oxygen** levels in the blood. This is **NOT THE MAIN RECEPTOR THAT REGULATES BREATHING**. Receptors in some of the main blood vessels (aorta and carotid artery) read when oxygen levels in the blood drop. These receptors send messages to the medulla oblongata and cause an increase in breathing rate.
Breathing sensors

c) **Stretch receptors** in the lungs and alveoli are stimulated when the lungs are expanded. This causes the receptors to send messages to the medulla oblongata. The medulla will then send a signal to the respiratory muscles to stop the inhalation.