YogaEducation INSTITUTE

Kids Yoga Teacher Certification Program

Section 2
Physiology of Breathing

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Breathing in Yoga

Introduction

Breath is life. We can live for days without food or water, but deprive us of breath and we die in minutes. In view of this, it is surprising how little attention we pay to the importance of breathing correctly.

Why is breathing important in yoga? The body depends on breathing for the intake of oxygen and the exhalation of waste matter in the form of carbon dioxide. But is breath only chemical? Not so, say the great yogis. They equate breath with both life and energy. In fact, in India, the word “prana” is used for all three. Breath acts as a strong stimulus to the natural energy flow. Proper breathing can help immensely make you more energetic.

Breathing patterns also reflect our emotional states. When we are emotionally upset, the breath becomes erratic, jerky and rapid. But this connection also works in the other direction, whereas the breath can affect our emotional state, and we can use this influence to our benefit. In yoga, deliberate, deep, harmonious breathing is used to help overcome harmful emotional states.

Experts say that few people in Western, industrialized societies know how to breathe correctly. We are taught to suck in our guts and puff out our chests, which causes the muscles to tense and respiration rate to increase. Tensing the belly during breathing also prevents the diaphragm from moving freely. As a result, many of us become shallow "chest breathers," who primarily use the middle and upper portions of the lungs, using as little as 20% of our lung capacity. Babies breathe from the belly, but with age, many people shift from this healthy abdominal breathing to shallow chest breathing. We also often breathe through the mouth rather than the nose, especially during a stressful situation. Breathing through the mouth permits inhaling and exhaling large volumes of air quickly, which can lead to hyperventilation, diminished energy, and a weakening of health and well-being.

There are many reasons for poor breathing habits, including:

- Poor posture. Diaphragmatic breathing is nearly impossible when a person habitually stoops forward
- Mental tension and the ensuing stomach tension. When the stomach is always kept tense, diaphragmatic breathing is impossible.
- Clothing. Wearing tight belts or constraining clothing makes it difficult to breathe properly.

You can see the process of natural breathing most clearly in the breathing of a baby, whose belly will rise and fall with each breath. Babies seem to breathe with their whole bodies, as if every part expands and contracts with the movement of breath. Kids begin to change their breathing habits as young as four years old. However, through yoga, they can learn to maintain healthy breathing habits for a lifetime.

In general, encourage kids to breathe through their noses throughout the practice, and to breathe fully, keeping their mouths gently closed. Breathing through the nose helps filter the air they breathe, slow down their breath rate and keep their bodies warm. It also helps to kids to focus and not to talk too much and helps activate the relaxation response. As a general rule, instruct kids to inhale as they open up or extend their spines and exhale as they close their arms in front, fold forward or flex their spines forward.

Encourage your students to observe their own diaphragmatic breathing by lying on their back and noticing the natural rise and fall of the belly with the breath.

Diaphragmatic Breathing

To breathe properly, one should begin with the diaphragm – that membrane that separates the lungs from the visceral cavity. When we breathe naturally, the diaphragm moves down as we inhale. The downward movement of the diaphragm pushes the abdomen out slightly. If your abdomen does not expand as you inhale, you are not breathing diaphragmatically. There are breathing exercises in yoga in which we do not use diaphragmatic breathing, but when someone is breathing naturally during normal activity, diaphragmatic breathing is preferred.

Slow, smooth, abdominal breathing (otherwise known as diaphragmatic breathing) is a powerful anti-stress technique. Studies have shown that simply learning how to breathe correctly can have remarkable effects throughout your body. When you bring air down into the lower portion of the lungs, where the oxygen exchange is most efficient, heart rate slows, blood pressure decreases, muscles relax, anxiety eases and the mind calms. A natural stress release is created as you breathe diaphragmatically. Your heartbeat will naturally slow down as your diaphragm stimulates the vagus nerve. Your overall circulation will also improve.

<u>Benefits of Diaphragmatic Breathing</u>

- Energy efficient
- Enhances gas exchange in your lungs
- Calming/relaxing, activates the relaxation response
- Strengthens your diaphragm
- Increases lung capacity
- Enhances flexibility of ribs and spine
- Provides a gentle internal massage to abdominal organs, enhancing function of stomach, intestines and lymph system
- Slow, regular breathing (done at least 10 minutes a day) can lower blood pressure

How to Breathe Diaphragmatically

Keep your abdomen relaxed, so your diaphragm can move freely and do your best to:

- Breathe in and out through your nose, keeping your mouth gently closed
- Inhale air into the bottom part of your lungs
- Allow your breath to gently expand your belly, but don't push your belly out
- Take slow, smooth and even breaths
- Keep your breath fluid between inhalations and exhalations (no pauses between the two)

Place your hands on your belly. As you breathe in, notice how your fingertips will slightly separate. Your fingertips will go back together when you breathe back out.

Be mindful of your shoulders. If you feel any tightness or tension, allow them to relax and soften as you exhale.

Try focusing your attention on the sensation of breathing itself. Know when you are breathing in and when you are breathing out, following the trail of your breath with your mind. When you mind begins to drift to other thoughts or concerns, gently bring your attention back to your breath. If your mind continues to wander, try counting slowly to 5 or 6 as you inhale and counting slowly as you exhale. This allows your mind to take a break from its usual activities of analyzing, reasoning and judging. And will allow it to come back more refreshed for those activities when the time is right.

Breathing Practices in Kids Yoga

Proper breathing techniques are an integral part of any yoga program. Proper breathing is essential to the practice of yoga as it improves focus and brings increased oxygen to the system. While doing a yoga practice, it is a general principle to breathe when the body comes up or the chest opens (such as when the arms move back) and to breathe out when the body goes down or the chest collapses/upper back rounds. Students then are encouraged to breathe fully through the nose while they hold a posture. In general, students should always inhale through their nose during yoga practice, if possible. Breathing through the nose is helpful during yoga practice. Some of the benefits of nose breathing include the following: (maybe add "1" here)

- It slows down the breath rate (no gulping air through the mouth)
- It filters out impurities and dust before the air enters the lungs
- It humidifies the air you breathe
- It warms/cools the air to body temperature
- It activates the relaxation response

Yoga Breathing Exercises are an important way to warm up the body and to help students bring their focus to their yoga practice, as well as bring them into a more peaceful state and thereby experience the full benefits of their yoga practice. The breathing practices of hatha yoga incorporate a simple form of meditation within each practice.

Breathing exercises:

1) Relax muscles, allowing them to stretch more easily.
2) Help heal the body by increasing circulation and flexibility.
3) Increase the supply of oxygen, nourishing the brain and body, which helps yoga students practice yoga poses and exercises with greater ease and focus.
4) Send a neurological message of relaxation to the brain and body.
5) Improve concentration and help students stay present in the moment.
6) Help students learn how to relax and control their emotions in daily life.

Benefits of Breathing Exercises

Practicing breathing exercises can:

1) Relieve of stress and stress related disorders
2) Improve autonomic functions
3) Relieve of the symptoms of asthma
4) Improve concentration and focus
5) Improve the oxidative status of an individual
6) Relax muscles and allow them to stretch more easily
7) Increase body temperature and circulation
8) Increase the supply of oxygen to the brain and body, improving efficiency
9) Send a neurological message of relaxation to the brain and body by triggering parasympathetic nervous system activity
10) Relieve mild depression and anxiety, while increasing calmness.
11) Improve lung function and capacity

Anatomy and Physiology of Breathing

The primary purposes of the respiratory system are to:

1) Provide a means of gas exchange between the external environment and the body. The respiratory system provides a person with the means of replacing oxygen and removing carbon dioxide from the blood.
2) Help maintain the acid-base balance (ph) of the blood.

The respiratory and cardiovascular systems are interdependent and function as a unit. The respiratory system brings oxygen into the lungs and carries carbon dioxide away. The cardiovascular system distributes oxygen to the cells and tissues and carries carbon dioxide back to the lungs to be expelled during exhalation.

Because of its contact with the external environment, the respiratory system has a strong defense system that cleanses, warms and moisturizes the air before it reaches the lung tissue.

The organs of respiration include the following:

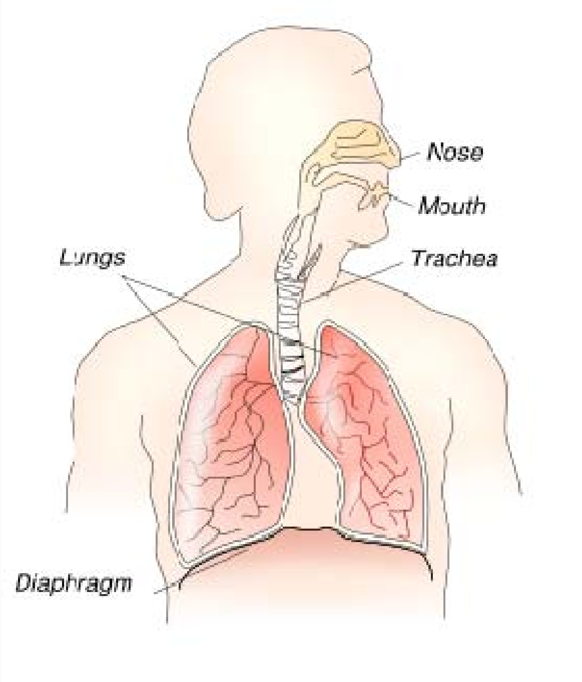
1) Nose
2) Pharynx (back of the throat – connects nose with respiratory system)
3) Larynx (voice box at the top of the trachea)
4) Trachea (connects throat with lungs – made out of cartilage)
5) Bronchial Tree (made up of bronchi, secondary bronchi, bronchioles and terminal bronchioles)
6) Alveoli (150-300 million alveoli with make up 540 square feet of surface of respiratory tissue)
7) Lungs

The muscles of respiration include the following:

1) Diaphragm (thin dome-shaped muscle that attaches to lower ribs and lumbar vertebrae, separating the chest cavity from the abdominal cavity – separates respiratory system from the digestive system). The diaphragm consists of the central tendon, the costal portion and the crural portion. It is the most important muscle of inspiration and is the only skeletal muscle considered essential for life. When the diaphragm contracts, it forces the abdominal contents downward and forward, while the ribs are lifted outward. The outcome is to reduce the intrapleural pressure, which in turn causes the lungs to expand. This expansion of lungs results in a reduction in intrapulmonary pressure below atmospheric, which allows airflow into the lungs.
2) Abdominal muscles (these muscles expand and contract to assist the diaphragm muscle in its work). Abdominal muscles, including the rectus abdominus and the internal oblique contract during exhalation. When these muscles contract, the diaphragm is pushed upward and the ribs are pulled downward. This results in an increase in intrapulmonary pressure and expiration (exhalation) occurs.

3) Intercostal muscles (muscles between the ribs that provide vertical and lateral expansion of the chest cavity).
4) Sternocleidomastoids (extend from top of sternum and collar bones to the base of the skull behind the ears – lift the ribcage)
5) Erector spinae (long muscles of the back along the spine – they support the spine and allow for openness in the front of the body)

Any muscles that are involved in respiration that are weak or tight will affect a person's ability to breathe in an optimal way. For example, weak erector spinae muscles lead to poor, rounded or slumped posture, which constricts breathing.



The Respiratory System

Among four-legged animals, the respiratory system generally includes tubes, such as the bronchi, used to carry air to the lungs, where gas exchange takes place. A diaphragm pulls air in and pushes it out. Respiratory systems of various types are found in a wide variety of organisms. Even trees have respiratory systems.

In humans and other mammals, the respiratory system consists of the airways, the lungs, and the respiratory muscles that mediate the movement of air into and out of the body. Within the alveolar system of the lungs, molecules of oxygen and carbon dioxide are passively exchanged, by diffusion, between the gaseous environment and the blood. Thus, the respiratory system facilitates oxygenation of the blood with a concomitant removal of carbon dioxide and other gaseous metabolic wastes from the circulation. The system also helps to maintain the acid-base balance of the body through the efficient removal of carbon dioxide from the blood.

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In humans and other animals, the respiratory system can be conveniently subdivided into an upper respiratory tract (or conducting zone) and lower respiratory tract (respiratory zone), trachea and lungs.

Air moves through the body in the following order:

- Nostrils
- Nasal cavity
- Pharynx (naso-, oro-, laryngo-)
- Larynx (voice box)
- Trachea (wind pipe)
- Thoracic cavity (chest)
- Bronchi (right and left)
- Alveoli (site of gas exchange)

Upper respiratory tract/conducting zone

The conducting zone starts with the nostrils of the nose, which open into the nasopharynx (nasal cavity). The primary functions of the nasal passages are to: 1) filter, 2) warm, 3) moisten, and 4) provide resonance in speech. The nasopharnyx opens into the oropharynx (behind the oral cavity). The oropharynx leads to the laryngopharynx, and empties into the larynx (voicebox), which contains the vocal cords, passing through the glottis, connecting to the trachea (wind pipe).

Lower respiratory tract/respiratory zone

The trachea leads down to the thoracic cavity (chest) where it divides into the right and left "main stem" bronchi. The subdivisions of the bronchus are: primary, secondary, and tertiary divisions (first, second and third levels). In all, they divide 16 more times into even smaller bronchioles.

The bronchioles lead to the respiratory zone of the lungs which consists of respiratory bronchioles, alveolar ducts and the alveoli, the multi-lobulated sacs in which most of the gas exchange occurs.

Breath Control

Ventilation occurs under the control of the autonomic nervous system from the part of the brain stem, the medulla oblongata and the pons. This area of the brain forms the respiration regulatory center, a series of interconnected neurons within the lower and middle brain stem which coordinate respiratory movements. The sections are the pneumotaxic center, the apneustic center, and the dorsal and ventral respiratory groups.

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Inhalation

Inhalation is initiated by the diaphragm and supported by the external intercostal muscles. Normal resting respirations are 10 to 18 breaths per minute. Its time period is 2 seconds. During vigorous inhalation (at rates exceeding 35 breaths per minute), or in approaching respiratory failure, accessory muscles of respiration are recruited for support. These consist of sternocleidomastoid, platysma, and the strap muscles of the neck.

Inhalation is driven primarily by the diaphragm. When the diaphragm contracts, the ribcage expands and the contents of the abdomen are moved downward. This results in a larger thoracic volume, which in turn causes a decrease in intrathoracic pressure. As the pressure in the chest falls, air moves into the conducting zone. Here, the air is filtered, warmed, and humidified as it flows to the lungs.

During forced inhalation, as when taking a deep breath, the external intercostal muscles and accessory muscles further expand the thoracic cavity.

Exhalation

Exhalation is generally a passive process, however active or forced exhalation is achieved by the abdominal and the internal intercostal muscles.
The lungs have a natural elasticity; as they recoil from the stretch of inhalation, air flows back out until the pressures in the chest and the atmosphere reach equilibrium.

During forced exhalation, as when blowing out a candle, expiratory muscles including the abdominal muscles and internal intercostal muscles, generate abdominal and thoracic pressure, which forces air out of the lungs.

Circulation

The right side of the heart pumps blood from the right ventricle through the pulmonary semilunar valve into the pulmonary trunk. The trunk branches into right and left pulmonary arteries to the pulmonary blood vessels. The vessels generally accompany the airways and also undergo numerous branchings. Once the gas exchange process is complete in the pulmonary capillaries, blood is returned to the left side of the heart through four pulmonary veins, two from each side. The pulmonary circulation has a very low resistance, due to the short distance within the lungs, compared to the systemic circulation, and for this reason, all the pressures within the pulmonary blood vessels are normally low as compared to the pressure of the systemic circulation loop.

Virtually all the body's blood travels through the lungs every minute. The lungs add and remove many chemical messengers from the blood as it flows through pulmonary capillary bed. The fine capillaries also trap blood clots that have formed in systemic veins.

Gas Exchange

The major function of the respiratory system is gas exchange. As gas exchange occurs, the acid-base balance of the body is maintained as part of homeostasis. If proper ventilation is not maintained two opposing conditions could occur: 1) respiratory acidosis, a life threatening condition, and 2) respiratory alkalosis.

Upon inhalation, gas exchange occurs at the alveoli, the tiny sacs which are the basic functional component of the lungs. The alveolar walls are extremely thin (approx. 0.2 micrometres), and are permeable to gases. The alveoli are lined with pulmonary capillaries, the walls of which are also thin enough to permit gas exchange. All gases diffuse from the alveolar air to the blood in the pulmonary capillaries, as carbon dioxide diffuses in the opposite direction, from capillary blood to alveolar air. At this point, the pulmonary blood is oxygen-rich, and the lungs are holding carbon dioxide. Exhalation follows, thereby ridding the body of the carbon dioxide and completing the cycle of respiration.

In an average resting adult, the lungs take up about 250ml of oxygen every minute while excreting about 200ml of carbon dioxide. During an average breath, an adult will exchange from 500 ml to 700 ml of air. This average breath capacity is called the tidal volume.

Respiratory Volumes:
During normal breathing about 500 ml of air are taken in with each inhalation (inspiration) and the same amount flows out with each exhalation (expiration). This is called “tidal volume.” About 350 ml of air actually arrive at the alveoli. The remaining air (150 ml) fills the open spaces of the lungs and passage ways of the respiratory systems.

By breathing in as deeply as possible, we can inhale up to an average of 3,100 ml of air beyond the usual 500 ml. This is called the “inspiratory reserve volume.” The maximum amount of air an individual can take in is called the “inspiratory capacity” and is calculated by: inspiratory capacity = tidal volume + inspiratory reserve volume

By inhaling normally and exhaling forcefully, we expel approximately 1,200 ml of air beyond the tidal volume. This extra 1,200 ml is called the “expiratory reserve volume.”
After a forcible expiration, some air still remains in the lungs (in the alveoli). This air amounts to about 1200 ml and is called the “residual volume.” The air remaining in the lungs after death is called the “minimal volume.”

Total lung capacity = tidal volume + inspiratory reserve volume + residual volume + minimal volume

Cardiovascular System

The cardiovascular system is composed of the blood, the blood vessels and the heart. The cardiovascular system has the following functions:

1) Circulates oxygen and nutrients to the cells
2) Carries carbon dioxide and metabolic wastes from the cells
3) Protects against disease
4) Helps regulate body temperature
5) Prevents serious blood loss after injury through the formation of clots

The organs of circulation include:

1) Heart (pumps the blood throughout the system)
2) Arteries (move blood away from the heart – pulmonary arteries carry old blood CO2 away to lungs) Arteries are thicker than veins and their muscular walls help propel blood.
3) Arterioles (branches off arteries)
4) Capillaries (where the exchange of oxygen and carbon dioxide takes place)
5) Venules (branches that come together to make veins)
6) Veins (blood vessels that bring blood to the heart – pulmonary vein carries fresh blood to the heart) Unlike arteries, veins have valves that prevent blood from flowing backward.

Cardiac muscle is myogenic (able to contract and relax on its own). It is a specialized muscle found nowhere else but in the heart because it has its own conducting system. This is in contrast with skeletal muscle, which requires either conscious or reflex nervous stimuli. The heart's rhythmic contractions occur spontaneously, although the waves or nerves can be changed by nervous frequency influences such as exercise or the perception of danger.

The rhythmic sequence of contractions is coordinated by the sinoatrial and atrioventricular nodes. The sinoatrial node, often known as the cardiac pacemaker, is located in the upper wall of the right atrium and is responsible for the wave of electrical stimulation that initiates atria contraction. Once the wave reaches the atrioventricular node, situated in the lower right atrium, it is conducted through the bundle of His and causes contraction of the ventricles. The time taken for the wave to reach this node from the sinoatrial nerve creates a delay between the contractions of the two chambers and ensures that each contraction is coordinated simultaneously throughout all of the heart. In the event of severe pathology, the Purkinje fibers can also act as a pacemaker; this is usually not the case because their rate of spontaneous firing is considerably lower than that of the other pacemakers and hence is over-ridden.

The bundle of His is a collection of heart muscle cells specialized for electrical conduction that transmits the electrical impulses from the AV node (located between the atria and the ventricles) to the point of the apex of the fascicular branches. The fascicular branches then lead to the Purkinje fibers which innervate the ventricles, causing the cardiac muscle of the ventricles to contract at a paced interval. These specialized muscle fibers in the heart were named after the Swiss cardiologist Wilhelm His, Jr., who discovered them in 1893.

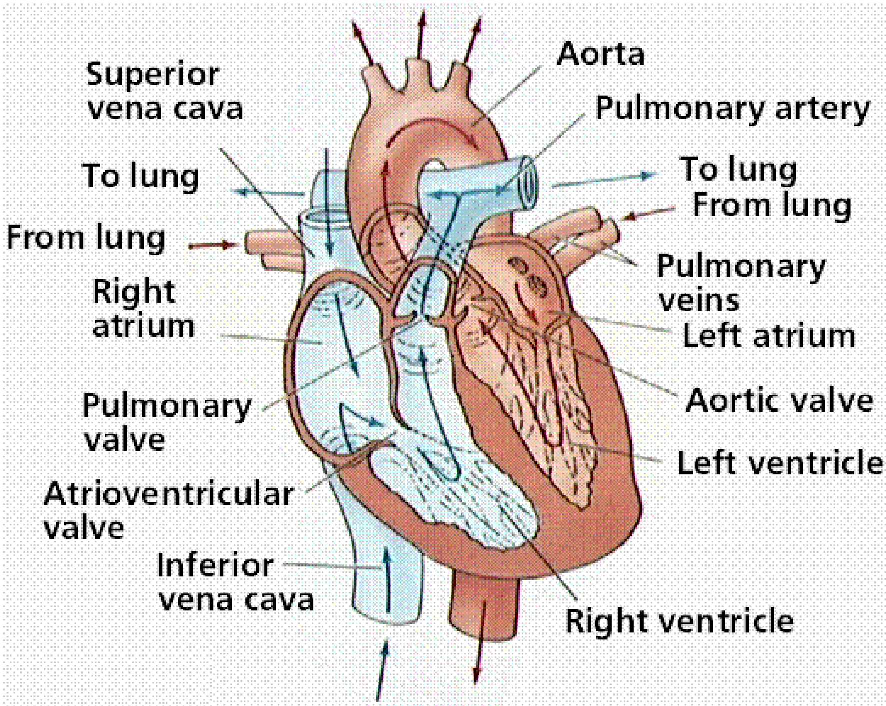
Cardiac muscle is very specialized, as it is the only type of muscle that has an internal rhythm; i.e., it is myogenic which means that it can naturally contract and relax without receiving electrical impulses from nerves. When a cell of cardiac muscle is placed next to another, they will beat in unison.

The fibers of the Bundle of His allow electrical conduction to occur more easily and quickly than typical cardiac muscle. They are an important part of the electrical conduction system of the heart as they transmit the impulse from the AV node (the ventricular pacemaker) to the rest of the heart. The bundle of His branches into the three bundle branches: the right and left anterior and left posterior bundle branches that run along the interventricular septum. The bundles give rise to thin filaments known as Purkinje fibers. These fibers distribute the impulse to the ventricular muscle. Together, the bundle branches and purkinje network comprise the ventricular conduction system. It takes about 0.03-0.04s for the impulse to travel from the bundle of His to the ventricular muscle.

Poorly oxygenated blood collects in two major veins: the perior vena cava and the inferior vena cava. The superior and inferior vena cava empty into the right atrium. The coronary sinus which brings blood back from the heart itself also empties into the right atrium. The right atrium is the larger of the two atria although it receives the same amount of blood. The blood is then pumped through the tricuspid valve, or right atrioventricular valve, into the right ventricle. From the right ventricle, blood is pumped through the pulmonary semi-lunar valve into the pulmonary artery. This blood leaves the heart by the pulmonary arteries and travels through the lungs (where it is oxygenated) and into the pulmonary veins. The oxygenated blood then enters the left atrium. From the left atrium, the blood then travels through the bicuspid valve, also called mitral or left atrioventricular valve, into the left ventricle. The left ventricle is thicker and more muscular than the right ventricle because it pumps blood at a higher pressure. Also, the right ventricle cannot be too powerful or it would cause pulmonary hypertension in the lungs. From the left ventricle, blood is pumped through the aortic semi-lunar valve into the aorta.

Once the blood goes through systemic circulation, peripheral tissues will extract oxygen from the blood, which will again be collected inside the vena cava and the process will continue. Peripheral tissues do not fully deoxygenate the blood, thus venous blood does have oxygen, only in a lower concentration in comparison to arterial blood. The release of oxygen from erythrocytes is regulated. The diffusion of oxygen from red blood cells increases with an increase of carbon dioxide in tissues, increase in temperature, or a decrease in pH. Such characteristics are exhibited by tissues undergoing high metabolism, as they require increased levels of oxygen.

Anatomy of the Heart



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