

Just Breathe: Breathing for health

By Tamara Mitchell



Elite athletes, singers, and musicians who play wind or brass instruments know that breathing style and rhythms have a huge impact on performance. The way you breathe can affect you physically and mentally because there are close ties between breathing and the part of the nervous system that controls the involuntary mechanisms of the body. Breathing affects the oxygen/carbon dioxide balance in the body that affects the health and performance of body tissues. There is evidence that people who learn to control their breathing can relieve harmful stresses in life. Practice of controlled breathing exercises during work along with biofeedback to train relaxation of neck and shoulder muscle and scheduling breaks, decreases muscle tension which then results in reduced discomfort and disorders including arm, wrist, and hand pain.^{1,2}

In a typical day, people often become very focused on a task and hold their breath or forget to breathe properly.³ Also, there is some evidence that there is an interaction between the limb motor cortex and the respiratory motor cortex that modulates breathing, so when tasks involve vision and motor coordination irregular breathing patterns often result.⁴ Shallow chest breathing is also common. When the demands of the body require little oxygen, such as when we are resting, sleeping, or working at the computer, breathing naturally becomes slower.³ However, shallow chest breathing and forgetting to breathe is not healthy. Even children can experience disorders that affect their breathing patterns by holding their breath, sometimes until they pass out.⁵

There are options available to help you remember to breathe:

- *www.breathminder.com* is a small battery-operated timer for \$20 that has a silent reminder and comes with instructions on 4-7-8 breathing⁶
- Meditation Oasis⁷ offers several helpful apps for Apple devices and android, but the *Breathe and Relax* app specifically reminds you to breathe several times a day with breathing audios and exercises.
 - Apple *Breathe and Relax* app:
<http://www.meditationoasis.com/smartphone-apps/iphone-ipod-touch-ipad-apps/>
 - Android *Breathe and Relax* app:
<http://www.meditationoasis.com/smartphone-apps/android-apps/>

Breathing Basics. With each breath, we bring oxygen into the lungs. When we exhale, we release carbon dioxide (CO₂), water, and other gases from the lungs. The balance of CO₂ and oxygen in the blood is very important to general health. By altering your breathing, you can change this balance and cause other physical and mental symptoms.

Breathing engages various parts of the body to expand the lungs. The primary muscle of breathing is the diaphragm.⁸ As the diaphragm flattens downward when you inhale (also known as inspiration), the chest cavity expands and air is drawn into the lungs.⁸

The intercostal muscles, which are in crisscrossed sets of muscles between each rib, contract during inspiration, expanding the ribcage and increasing chest volume.⁸ Muscles of the shoulders may be used to inhale, but this does not increase chest volume very much. If someone primarily uses the shoulder muscles to breathe, breath is often faster and more shallow.⁹

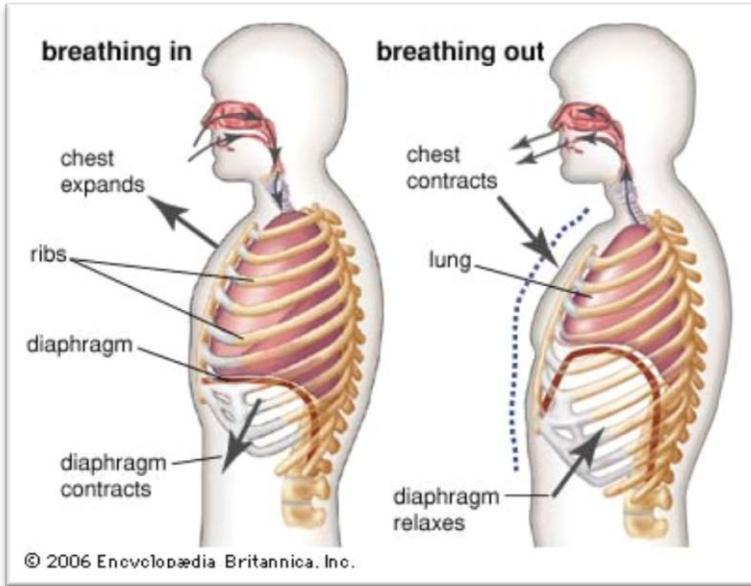


Illustration courtesy of Reference 8

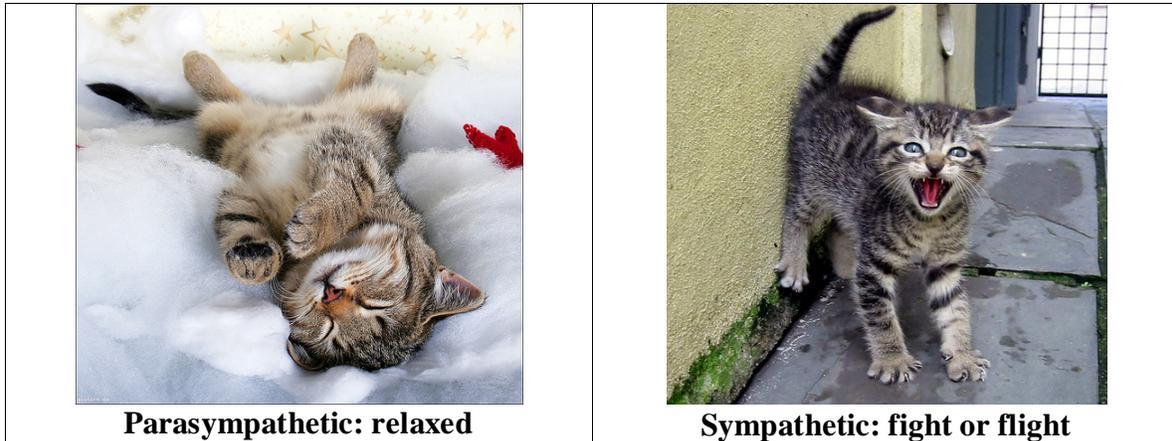
During exhalation, the diaphragm assumes its natural curve. The intercostal muscles relax, decreasing the volume of the chest and causing the air to escape the lungs through the trachea and nose.⁸

Autonomic Nervous System Basics

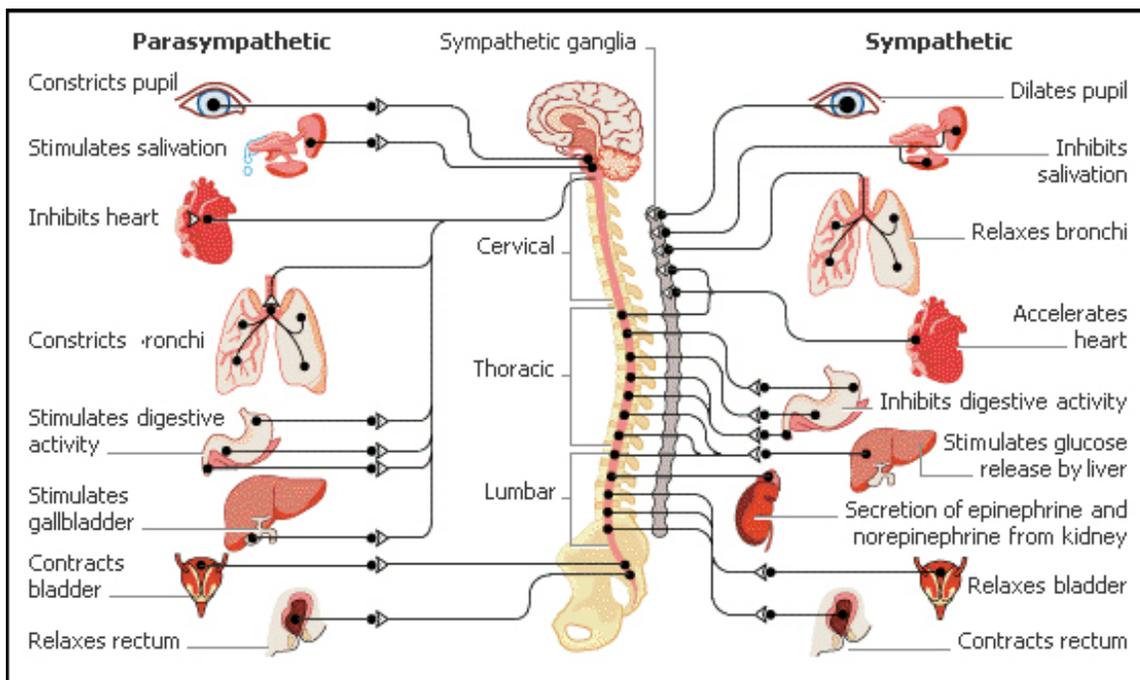
Breathing, as well as functions of the heart, stomach, intestines, and pupils of the eyes are controlled by the **autonomic nervous system (ANS)** and these functions are largely involuntary.⁹ We do not have to remember to digest or make our heart beat. These systems are wired to operate without conscious control.¹⁰ Many of these automatic systems can, however, be controlled at a conscious level and how we breathe can actually have very major impacts on how our body functions. We will discuss this mechanism in much more detail, but for now, we will mention that external situations, internal discomforts, emotional states (such as stress or depression) cause an interplay of the two parts of the ANS, but we are not a victim of our nervous system! We can exert control through our own focus and breathing patterns, which modify the hormonal chemistry of the body and alter the release of neurotransmitters.

The ANS is actually divided into three parts: the sympathetic, parasympathetic, and enteric nervous systems that control many parts of your body. When you are calm, the *parasympathetic nervous system* is in primary control and breathing is slow and relaxed.⁹ When a real or perceived emergency arises, the *sympathetic nervous system* kicks in to prepare you to respond. Breathing becomes faster and heart rate increases to supply your body with the oxygen it will presumably need to escape danger.⁹ The *enteric nervous system* is called the “second brain” and typically, discussion of it is either omitted

completely or it is glossed over by simply mentioning that the ENS regulates the activity of the stomach.^{10,11,12} In fact, the ENS not only controls digestion, but it plays an important role in physical and mental well-being, acting independently and in conjunction with the brain in our head to sense environmental threats and to respond to them.¹³

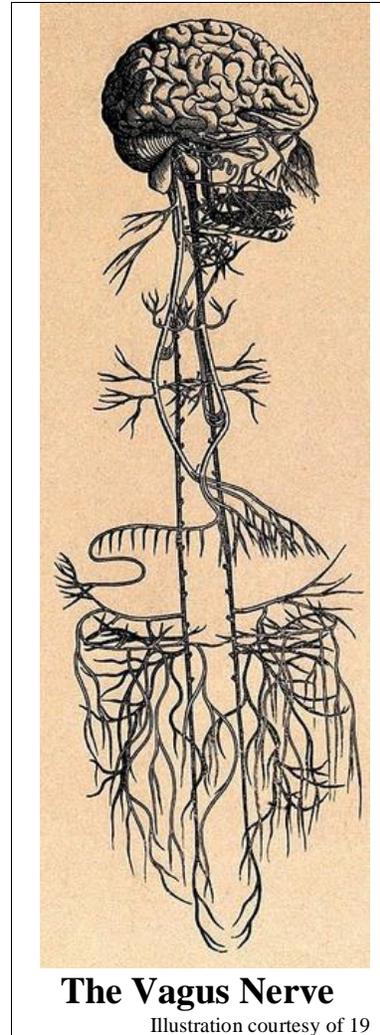


Most of the sympathetic nerves merge in clumps called the ganglia located at each of the vertebrae and down to the coccyx (tailbone). After this point of merging in the ganglia the output is a multiple branching of the nerve transmissions and this allows for both quick and direct transmission of resulting actions with some branches, as well as for more finely tuned and diffused responses for other branches.^{10,14,15,16} The sympathetic nervous system releases hormones and neurotransmitters that over-ride the routine activities of the parasympathetic nervous system.¹⁷



The vagus nerve is the main nerve of the parasympathetic nervous system and it has a long way to travel from the brain down to the lower end of the digestive tract.¹⁸ It wanders around, rather than following the spine and connects to all of the organs shown above as well as to the glands that produce anti-stress enzymes and hormones.¹⁹ In actuality, the vagus nerve is two nerves that route signals coming from the brain and going to the brain.¹⁹ The vagus nerve handles the functions of digestion, heartbeat regulation, thinking, feelings, and memory, and regulation of all the other organs of the body, sending status signals back to the brain. The vagus nerve utilizes the neurotransmitter acetylcholine to communicate. This hormone acts as a brake on inflammation in the body and it regulates the immune system.^{18,19} So stimulation of the vagus nerve makes us feel relaxed, but it also reduces inflammation (and associated obesity) which results from stress.^{18,19} Stimulation of the vagus nerve has been used to help individuals with epilepsy and depression, and it is being studied for conditions such as multiple sclerosis, migraine, and Alzheimers disease.^{20,21}

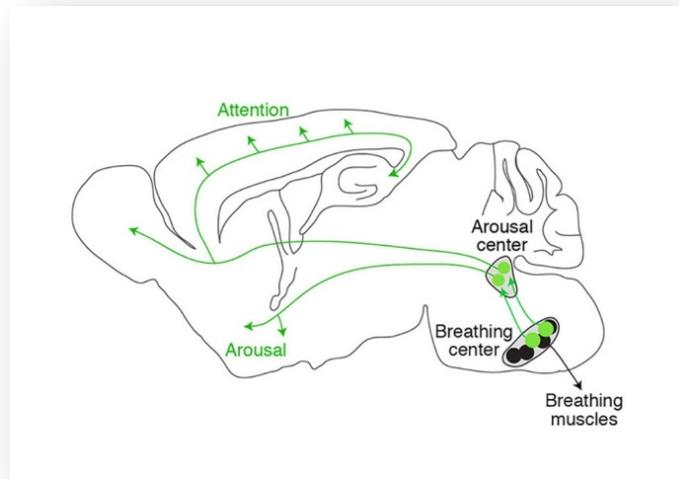
In other words, vagus nerve functioning is vitally important to being a happy, relaxed, and healthy individual without chronic inflammation and a stabile immune system!!



The Enteric Nervous System is a complex network of neurons that are embedded in the gut, esophagus, intestines, and anus measuring 9 meters long and containing about 100 million neurons.²² The Enteric Nervous System communicates with the brain primarily through the vagus nerve, but even when the vagus nerve is severed, the ENS continues to coordinate digestion.¹³ 90% of the signals passing along the vagus nerve come from the ENS. It appears that the function of the ENS is essential to survival, since the content of our food and its toxicity can threaten existence. The release of various hormones in the gut as a response to food components such as fat, or in response to stress, affects our emotional state. The ENS is responsible for the release of serotonin and natural painkillers within the gut.^{13,23} Exposing the stomachs of newborn rats to a mild chemical irritant resulted in more depressed and anxious rats, even after the physical damage from the chemical was healed.¹³ There are actually some indications that Parkinson's disease and Alzheimer's may originate in the gut and get transmitted to the brain via the vagus nerve. The effect of viruses and the way that the bacteria within our gut communicate information to the ENS is really not understood at all.²² Research on the ENS is seriously lacking, but there are indications that what we eat and our gut reactions may have very real impacts on our emotional and mental state.¹³ It's important to note, however, that feelings of uneasiness about a situation, typically labeled a gut reaction, actually originate

in the brain and the queasiness or fluttering sensation in the stomach result from brain activity, not activity of the ENS.¹³

In the brain, the rhythm of breathing is monitored by a set of neurons located at the base of the brain stem in the Medulla in a limited region called the pre-Bötzinger Complex (preBötC).⁵¹ Until recently, it was thought that these neurons actually controlled the rate of breathing and this region was called the respiratory pacemaker.⁵¹ There are a lot of types of breaths besides passive breathing including sighing, excited, yawning, gasping, sleeping, laughing, talking, and sobbing.⁵¹ Recent research has found that there are actually 60 different subtypes of neurons in this region and by destroying individual neurons in mice, they were able to observe the effect on breathing.⁵¹ While destruction of one type of neuron definitely discontinued sighing, turning off a couple of other neurons resulted in overall calm behaviors without affecting any one particular type of breathing.⁵¹ It appears that these two neurons monitor breathing and relay messages to another structure in the brain stem (locus coeruleus) that sends signals to the rest of the brain that it needs to wake up, be alert, and possibly get anxious or distressed if the signal is urgent enough.⁵¹ These researchers feel that by controlling breathing, it may be possible to modify this whole monitoring and relay system in the brain to reduce stress, depression, and many other emotions.



Although research is still ongoing to identify the exact mechanisms behind how the brain reacts to various types of breathing, it has been known for centuries that there is a very definite connection.

What does all of this mean? By modifying our breathing, we change the stimulation of the ANS including the parasympathetic, sympathetic, and enteric systems. Over time, this may cause long-term changes in the ANS functioning.²⁴ Breathing is truly a bridge between the mind and the body.¹ Practicing breathing techniques can have a powerful effect on blood pressure, a racing heart, or a frantic mind. Breathing affects the Autonomic Nervous System.¹ If you breathe as if you are calm, you will become calm, but if you breathe as if you are stressed or scared, you will become aroused. For most people, thinking about something relaxing or taking a couple



of long slow breaths is a fairly easy way to bring the parasympathetic nervous system back into play and gain some control in stressful situations.¹⁰ It is possible through more intensive training such as yoga, to gain control over the heart rate, blood pressure, and even body temperature.^{9,10} It also appears that by using controlled breathwork, positive emotions, yoga and other such anti-stress techniques, inflammation and all of the health problems associated with chronic inflammation, may be altered by stimulating the vagus nerve.^{18,19} Stimulation of the vagus nerve affects the hypothalamus which is the grand central station for keeping the body's functions in balance, or in a steady state.¹² In the medical world, stimulation of the vagus nerve is accomplished by surgically implanting a device under the skin on the chest and a wire is connected under the skin to the vagus nerve.²¹ When the device is activated, it sends electrical signals to the brain via the vagus nerve.²¹ There are many things that can go wrong all the way from complications during and after surgery due to the invasive nature of the procedure to physical side effects of the stimulation itself including throat pain, cough, headache, chest pain, difficulty breathing, abdominal pain, and nausea.²¹ While this may be the only solution for people with epileptic seizures, for the average person, a much more logical method of stimulating the vagus nerve is through controlled breathwork.¹⁹

Body chemistry.

Hypoventilation. Hypoventilation refers to not breathing enough to meet the needs of the body. Breathing is too shallow or too slow. There is inadequate oxygenation of the blood and a rise in CO₂ levels with reduced lung function.²⁵ Hypoventilation occurs when people hold their breath, have sleep apnea, are obese, or take certain drugs.²⁶ *The dangers of not breathing enough are much less dangerous than the dangers of breathing too fast or too deeply.*

Hypoventilation can cause acidosis due to loss of bicarbonate¹⁶ which **actually allows oxygen to be released more easily to the body tissues that need it most.**²⁸ Hypoventilation has been shown to be of potential therapeutic use in certain instances because it increases blood flow to the brain, lungs, and upper chest area by decreasing vascular resistance.²⁷ Intermittent hypoventilation has been used to successfully treat conditions such as asthma, chronic fatigue, sleep apnea, allergy, hypertension, congestive heart failure, and obstructive pulmonary disease.²⁹

Hyperventilation. Some people breathe too much all the time, often using the upper chest rather than the whole chest and diaphragm. Breathing fast and deeply is a response in the fight-or-flight episode where a person is agitated, and lots of oxygen is necessary for survival if you are needing to fight or run from an enemy.³⁰ Of course, in the modern world, these are rarely required behaviors, but your body is wired to prepare anyway.

If you are not running for your life, hyperventilation has potentially very harmful effects on the body. Hyperventilation causes an imbalance of oxygen to carbon dioxide in the blood, specifically too little CO₂. As **CO₂ levels in the blood decrease**, pH becomes more alkaline and **oxygen is bound more tightly to hemoglobin in the blood, so it is not released to the tissues as readily.**³¹ Hyperventilation induces sympathetic stimulation and results in a large number of changes in circulation, gastrointestinal effects, and

emotional responses sometimes including panic attacks and epileptic seizures.¹¹ Although oxygen is very important to your body, a surplus of oxygen from rapid breathing causes potentially dangerous responses.³² Hyperventilation is a powerful physiological stimulus that can: 1) induce seizures in epileptic patients and heart muscle electrical activity in patients without heart disease, 2) increase blood pressure, and 3) produce spasm in patients with angina.³⁰ In other words, ***hyperventilation induces tremendous sympathetic stimulation and results in a large number of changes in circulation, gastrointestinal effects, and emotional responses.***³⁰

Panic and hyperventilation become a vicious cycle because panic leads to rapid breathing, while rapid breathing can make you feel panicked.^{30,33}

Preparing to breathe

The following guidelines are given for the optimal practice of controlled breathing. In reality, you can use controlled breathing in any situation where you feel the need to calm down. If you make a regular practice of doing some breathing exercises, you will find it very natural to switch to controlled breathing throughout a stressful day.

We really don't want to make it sound like a formal practice that requires a special outfit and a commitment of time. That is certainly an option, but what is most important is that you start paying attention to your breathing, its effect on your body and mental state, and that you learn how to use your breath to modify these things in your daily life.

Use your whole chest cavity. Breathing techniques often emphasize use of the diaphragm, but it is actually healthy and natural to use the entire chest cavity.^{34,35} In traditional Yogic breathing, the breath starts with the diaphragm, and continues up through the ribcage area and into the shoulders.³¹ If you are breathing shallowly into your upper chest, you are not using your full lung capacity down into your abdomen.

Sit with neutral posture. Posture is important when you breathe.³⁶ Breathing is not as efficient or effective if you are in an awkward position.³⁶ Your body should be aligned symmetrically, not listing to one side. You should not slouch, but you should not sit bolt upright, either. Your head should be balanced directly over your shoulders and you should look straight ahead. You don't actually have to sit in the Lotus Pose shown to the right, but it illustrates balanced, neutral posture. Controlled breathing can be done anywhere, standing or seated so you can use it to calm yourself in any situation!



No restrictive clothing. Tight undergarments, clothing, belts, and even an over-muscled upper body can restrict the ability to expand the chest cavity.³⁶

Clear nose and sinuses. It is important to have clear nasal passages and sinuses in order to breathe effortlessly.³⁷ Although it seems strange to most Westerners, the use of a neti pot or nasal irrigation can be very helpful, especially for people with allergies and asthma.^{37,38} It can also reduce sinus infections and the need for medication.^{37,38} In this method, a mild saline solution (1/4 teaspoon of plain non-iodized table salt to 1 cup lukewarm water) is poured into one nostril so it runs out the other.³⁸

The ins and outs of breathing

Many breathing techniques have been a part of meditation, spiritual practices, and cultures for hundreds or thousands of years. People made the observation long ago that changing breathing patterns had a big effect on one's mental state. New techniques may or may not be credible, since selling breathing workshops and videos has become a money-making enterprise rather than a spiritual practice. There is much misinformation about breathing, but there are also new practices that are beneficial. The information in this article can help you weed out practices that are extreme or harmful by understanding the physiology of breathing. If you don't feel well after participating in a breathing practice, there is a good chance it is not doing something beneficial.

There are two types of breathing techniques:

1) *Deep Breathing* and 2) *Rhythmic/controlled breathing*, such as breathing awareness and counting, Pranayama and Sudarshan Kriya, Qigong, Eucapnic Buteyko breathwork.

Deep Breathing. Simply breathing deeply using the diaphragm is encouraged in an alarming number of websites, books, and articles. Breathing deeply often or too fast can result in hyperventilation, which, as we have discussed, has serious negative effects.³ An occasional deep breath is not going to wreak havoc on your body or your Autonomic Nervous System. In fact, taking a couple of *long, slow deep breaths* has a calming effect, which we tend to do naturally by sighing or yawning.³⁹

Controlled Breathing.

Breathing while counting/Breath awareness

Doing counting exercises or simply doing some breath awareness practices is extremely simple, and these techniques can be done anywhere and at any time. These are probably the most practical ways to utilize breathwork to alter your level of stress or anxiety in everyday life. The other methods described later are also excellent, but they do generally require a bit more focus and devotion to a time and place set aside for practice.

Breathing through your nose is considered important because it limits the amount of air you can intake, so you are less likely to take in too much oxygen.⁴⁰ Also, the hairs that line the nostrils help clean the air, and the nose helps to warm the air before it enters the lungs.⁴⁰

Breath awareness and counting techniques.

Awareness of breath involves sitting quietly with your eyes closed and being aware of your breathing in and out, without forcing yourself to get too much or too little oxygen.⁴⁰ Pay attention to your exhale. Many people tend to use effort to inhale, but not to exhale.

⁴⁰ At the end of a normal breath, try squeezing as much air out of your lungs as possible.
⁴⁰ You will use the intercostal muscles to do this, squeezing the ribcage inwards.⁴⁰

Breath counting is a breath awareness technique that can be practiced anywhere.⁴¹ This practice doesn't change or influence your breathing pattern at all, but simply brings awareness to your breathing. Sit comfortably with your eyes closed, empty your mind and count each exhale. First exhale, count "one"; second exhale, count "two", etc. until you reach five. Then start with one again. Do not let your mind wander to anything except your breathing; if you do, you will find yourself counting past five! Try this for 10 minutes.⁴¹

Another of the easiest and best breathing exercises to master is 4-7-8 breathing.^{3,42,43} It is controlled, slow, and unlikely to result in a dangerous rise in blood oxygen levels. It is a natural tranquilizer that can be used whenever you feel anxious, stressed, unable to sleep, or are not breathing as you focus on a task or reading too closely. This type of breathing is demonstrated in this video: https://youtu.be/YRPh_GaiL8s

Follow these instructions:^{42,43}

- Start by exhaling completely through your mouth.
- Close your mouth and inhale quietly through your nose to the count of 4.
- Hold your breath for a count of 7.
- Exhale completely through your mouth, making a whoosh sound to the count of 8.
- Repeat the cycle four times. Always inhale quietly through your nose and exhaling with a whoosh through your mouth.

In general, exhalation should be twice as long as inhalation. Another method is quite similar...2-1-4-1 (inhale, hold, exhale, hold) with variations of 4-1-6-1 and 6-1-8-1 if the 2-1-4-1 feels too short. Whatever length you choose should not be a challenge and your breathing should be even and smooth, and you should be able to do this for 5 minutes without dizziness or anxiety.⁴⁴

Pranayama and Sudarshan Kriya

Pranayama techniques have been practiced for centuries in India.⁴⁵ The origins of pranayama stem from the ideas that our life span is dependent on how many times we breathe. In order to live longer, we must reduce the number of breaths we take.⁴⁵

One of the basic presumptions of yoga is that the breath (prana) and the mind (chitta) are not separate, but actually different expressions of a single entity.⁴⁵ Everything that leads to contentment, happiness and enjoyment is a result of a peaceful mind and our reaction to the world around us.⁴⁵ Although it is very difficult to control the mind directly, it can be controlled indirectly by controlling the breath. When the breath is silenced, so is the mind.⁴⁵

*Bellows Breathing (The Stimulating Breath)*⁴²

Bellows breathing is one Pranayama technique that can be used to stimulate energy when needed. We mention it because it is an effective alternative to using caffeine and it differs from most of the other Pranayama techniques which are used to calm the body and mind. It is not a good idea if you have not had a recent physical exam to rule out the possibility of any of the health problems that can be triggered by hyperventilation. This exercise is done to intentionally stimulate the sympathetic nervous system any time you feel the need for a cup of coffee. Do not overuse this exercise, do not do it for more than 15 seconds, and make sure you are sitting in a supported position in case you get dizzy from hyperventilating.



The technique is similar to panting like a dog. A demonstration and explanation of this type of breathing is given in this video: *Tips to Begin Vigorous Pranayama: Kapalabhati and Bhastrika*
https://youtu.be/eKV_s_pYNc0

Sudarshan Kriya (SK) has been described as a crash course in Pranayama.⁴⁶ It makes Pranayama accessible to the average person. SK is a yogic breathing technique of well defined sequence of rhythmic breathing with paced breathing at varying rates and depths interspersed with definite pauses.³⁰ The specific rhythms of breath used in SK have been used to eliminate stress, support the various organs and systems within the body, transform overpowering emotions, and restore peace of mind.⁴⁷ Research has found that people who practice SK have:⁴⁷

- Reduced cortisol levels which are an indication of lowered stress.
- Increased levels of prolactin, a well-being hormone.
- Increased levels of antioxidants.
- Improvements in immune system functioning.
- Reduced heart rate.
- Reduced blood pressure as well as cholesterol and triglyceride profiles.
- Improved respiratory function.
- Relief from anxiety, depression, PTSD, and stress.
- Reduction in impulsive and addictive behaviors.
- Improved emotional regulation, optimism, and feelings of well-being and quality of life.
- Increased mental focus and heightened awareness.
- Three times more time spent in deep restful stages of sleep.

There are three ways that breathing can be modified according to Pranayama practices:⁴⁵

- By inhaling and exhaling rapidly and shallowly
- By inhaling and exhaling slowly taking long or deep breaths
- By stopping the act of breathing totally

Qigong

Qigong is one part of the practice of Tai Chi. Breathing is just one part of the practice of Qigong, but it is an essential part. In Qigong, body postures, movements, sounds, and images are used in addition to breathwork.⁴⁸ Qi and breath are very closely related, so that doing breathing exercises is the most effective way to get the qi or energy in your body flowing.⁴⁹ While breathing in and breathing out can be seen as a rhythm of giving and receiving, opposites, with practice they blend so that it becomes a continuous flow through the body.⁴⁹

Buteyko and Eucapnic Breathing

Dr. K.P. Buteyko, a Russian physician, developed the theory that chronic hyperventilation and the resulting depletion of carbon dioxide led to the development of defensive reactions in the body.²⁹ By assessing the length of time a person can hold their breath, the Buteyko method assesses the degree of depletion of CO2.²⁹ The conclusion is that most people habitually hyperventilate and have chronically low CO2 and alkaline blood levels. Systematic breath holding and underbreathing to the point of experiencing a lack of air allows a rapid accumulation of CO2 levels.²⁹ It is felt that this normalizes systems in the body that have adapted to chronically low levels of CO2 due to overbreathing or hyperventilation.²⁹

The term Eucapnic breathing is used to refer to the breathing techniques that attempt to normalize CO2. They utilize the concepts of the Buteyko method but take a broader, more eclectic approach.⁵⁰ Eucapnic breathing emphasizes hypoventilation techniques to encourage adaptive changes in the body, but also stress the importance of nutrition, exercise, and stress reduction in overall health of the body.⁵⁰

Conclusions

Many controlled breathing techniques are available, from focused awareness to formal practices. We encourage everyone to become more aware of their breathing to overcome bad habits such as breath holding, chest breathing, and frequent sighing. The balance of oxygen to carbon dioxide and the balance of regulatory hormones in the body are critical to physical and mental well-being.

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This article and all of our articles are intended for your information and education. We are not experts in the diagnosis and treatment of specific medical or mental problems. When dealing with a severe problem, please consult your healthcare or mental health professional and research the alternatives available for your particular diagnosis prior to embarking on a treatment plan. You are ultimately responsible for your health and treatment!

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