* **Hypoxia types**
  1. Hypoxic Hypoxia
  2. Hypemic Hypoxia
  3. Stagnant Hypoxia
  4. Histotoxic Hypoxia

**##############################################################################**

* **What hypoxia is**

Hypoxia is a state in which oxygen is not available in sufficient amounts at tissue level to maintain adequate homeostasis; this can result from inadequate oxygen delivery to the tissues either due to low blood supply or low oxygen content in blood (hypoxemia).

Hypoxia can vary in intensity from mild to severe and can present in acute, chronic, or acute and chronic forms. The response to hypoxia is variable; while some tissues can tolerate some forms of hypoxia/ischemia for a longer duration, other tissues are severely damaged by low oxygen levels.

**##############################################################################Hypoxic Hypoxia ##############################################################################**

* **What Hypoxic Hypoxia is**

In hypoxic hypoxia, there is a lack of oxygen in the arterial blood. The oxygen tension is lowered in both the lungs and the arterial blood, and the hemoglobin is not saturated with oxygen to its normal extent. This type of hypoxia affects the body as a whole and is one of the most serious forms of hypoxia. Hypoxic hypoxia is often produced by low tensions of oxygen in the inspired air as is seen in high altitudes, breathing of inert gases, and the inhalation of anesthetic agents. Abnormal lung conditions may also produce hypoxic hypoxia. Emphysema, asthma, pneumonia, or pneumothorax encourage the formation of this type of hypoxia. Mechanical obstruction of the airway by foreign objects, laryngospasm, or bronchospasm inhibits the flow of oxygen from the atmosphere into the lungs, creating a state of oxygen want. Shallow respiratory movements from any cause, with either a decrease in rate or amplitude, may cause hypoxic hypoxia. A chronic state of hypoxic hypoxia may result from a patent foramen ovale and other embryo logical malformations of the heart and blood vessels.

* **Causes**
* **Oxygen content in venous blood**
* **Oxygen content in arterial blood**
* **cyanosis**

**############################################################################## Hypemic Hypoxia ##############################################################################**

* **Definition**
* **Causes**
* **Oxygen content in venous blood**
* **Oxygen content in arterial blood**
* **Cyanosis**

**##############################################################################Stagnant Hypoxia ##############################################################################**

* **Definition**

Stagnant hypoxia is due to a decrease in the rate of flow of the circulating blood. Local regions of the body are usually involved, but it may affect the entire body. The blood is saturated normally with oxygen, and the oxygen load, as well as the tension under which it is held, also may be normal. Hypoxia is produced because the amount of oxygen reaching the tissues is inadequate. Sluggishness in the rate of the circulating blood allows the blood to stagnate and give up a greater percentage of its oxygen. This slow circulation also permits the accumulation of a greater quantity of carbon dioxide in the tissues. Stagnant hypoxia is produced by failure of the circulation, impairment of venous return, and shock.

* **Causes**

This form of hypoxia is caused by inadequate blood flow, which results in less oxygen available to the tissues. Causes include: -

* **Edema**: Edema, a swelling of the tissues (like from heart failure), can limit the ability of oxygen present in the blood to adequately reach the tissues.
* **Ischemic** **hypoxia**: Obstruction to the flow of blood carrying oxygen, like from a clot in a coronary artery (a [heart attack](https://www.verywellhealth.com/heart-attack-symptoms-1746023)), can prevent the tissues from receiving oxygen.
* **Oxygen content in venous blood**
* **Oxygen content in arterial blood**
* **cyanosis**

**##############################################################################Histotoxic Hypoxia**

**##############################################################################**

* **Definition**

As the term suggests, the tissue cells are poisoned and are unable to accept oxygen from the capillaries. In this type of hypoxia the cells are not able to utilize the oxygen, although the amount of oxygen in the blood may be normal and under normal tension. Histotoxic hypoxia is produced by cyanides. Theoretically, it may be produced by any agent which depre ses cellular respiration.

* **Causes**

With histiotoxic hypoxia, an adequate amount of oxygen is inhaled through the lungs and delivered to the tissues, but the tissues are unable to use the oxygen that is present. Cyanide poisoning is a possible cause.

* **Oxygen content in venous blood**
* **Oxygen content in arterial blood**
* **Cyanosis**

**##############################################################################Anemic hypoxia**

**##############################################################################**

* **Definition**

The arterial blood contains oxygen at its normal tension in anemic hypoxia, but there is a shortage of functioning hemoglobin. Anemic hypoxia, on the whole, is less serious than hypoxic hypoxia. However, it does affect the whole body. Ancmic hypoxia may be caused by acute or chronic hemorrhage, primary or secondary anemia, alterations in the hemoglobin of the blood (caused by nitrates, chlorates, or coal tar derivatives), and carbon monoxide poisoning.

* **Causes**

In the setting of anemia, low hemoglobin levels result in a reduced ability of the blood to carry oxygen that is breathed in, and hence, a diminished supply of oxygen available to the tissues. Causes include:

* Anemia of any cause: This can include iron deficiency anemia, pernicious anemia, and [chemotherapy-induced anemia](https://www.verywellhealth.com/chemotherapy-induced-anemia-symptoms-and-treatment-2249320).
* Hemorrhage: Hemorrhage can be obvious, such as from injuries sustained in an accident, or hidden due to internal bleeding.
* Methemoglobinemia: Methemoglobinemia, also known as affinity hypoxia, is an abnormal hemoglobin that doesn't bind oxygen very well.
* Carbon monoxide poisoning: With [Carbon monoxide poisoning](https://www.verywellhealth.com/carbon-monoxide-poisoning-3885555), hemoglobin is unable to bind oxygen.
* **Oxygen content in venous blood**
* **Oxygen content in arterial blood**
* **Cyanosis**

**###################################################**

1. **Metabolic hypoxia:**

* **Definition**
* **Causes**
* **Oxygen content in venous blood**
* **Oxygen content in arterial blood**
* **Cyanosis**

**###################################################**

1. **FULMINATING** **HYPOXIA**

**Definition:**

Fulminating hypoxia is a newly recognized form of hypoxia. It is a very rapidly induced type of hypoxia caused by the inhalation of undiluted inert gases such as nitrogen, methane, or helium. In anesthesia, fulminating hypoxia may be produced by administering nitrous oxide anesthesia without the simultaneous use of oxygen.

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**Hypoxia**[[1]](https://en.wikipedia.org/wiki/Hypoxia_(medical)#cite_note-1) is a condition in which the body or a region of the body is deprived of adequate [oxygen](https://en.wikipedia.org/wiki/Oxygen) supply at the [tissue](https://en.wikipedia.org/wiki/Tissue_(biology)) level. Hypoxia may be classified as either *generalized*, affecting the whole body, or *local*, affecting a region of the body[[2]](https://en.wikipedia.org/wiki/Hypoxia_(medical)#cite_note-2). Although hypoxia is often a [pathological](https://en.wikipedia.org/wiki/Pathological) condition, variations in arterial oxygen concentrations can be part of the normal physiology, for example, during [hypoventilation training](https://en.wikipedia.org/wiki/Hypoventilation_training) or strenuous physical exercise.

Hypoxia differs from [hypoxemia](https://en.wikipedia.org/wiki/Hypoxemia) and anoxemia in that hypoxia refers to a state in which oxygen supply is insufficient, whereas hypoxemia and anoxemia refer specifically to states that have low or zero arterial oxygen supply.[[3]](https://en.wikipedia.org/wiki/Hypoxia_(medical)#cite_note-3) Hypoxia in which there is complete deprivation of oxygen supply is referred to as **anoxia**.

Generalized hypoxia occurs in healthy people when they ascend to [high altitude](https://en.wikipedia.org/wiki/High_altitude), where it causes [altitude sickness](https://en.wikipedia.org/wiki/Altitude_sickness) leading to potentially fatal complications: [high altitude pulmonary edema](https://en.wikipedia.org/wiki/High_altitude_pulmonary_edema) ([HAPE](https://en.wikipedia.org/wiki/HAPE)) and [high altitude cerebral edema](https://en.wikipedia.org/wiki/High_altitude_cerebral_edema) ([HACE](https://en.wikipedia.org/wiki/HACE)).[[4]](https://en.wikipedia.org/wiki/Hypoxia_(medical)#cite_note-MedicalProblems-4) Hypoxia also occurs in healthy individuals when breathing mixtures of gases with a low oxygen content, e.g. while diving underwater especially when using closed-circuit [rebreather](https://en.wikipedia.org/wiki/Rebreather) systems that control the amount of oxygen in the supplied air. Mild, non-damaging intermittent hypoxia is used intentionally during [altitude training](https://en.wikipedia.org/wiki/Altitude_training) to develop an athletic performance adaptation at both the systemic and cellular level.[[5]](https://en.wikipedia.org/wiki/Hypoxia_(medical)#cite_note-5)

In acute or **silent hypoxia**, a person’s oxygen level in blood cells and tissue can drop without any initial warning, even though the individual’s chest x-ray shows diffuse pneumonia with an oxygen level below normal. Doctors report cases of silent hypoxia with [COVID-19](https://en.wikipedia.org/wiki/Coronavirus_disease_2019) patients who did not experience shortness of breath or coughing until their oxygen levels had plummeted to such a degree that the patients risked acute respiratory distress (ARDS) and organ failure.[[6]](https://en.wikipedia.org/wiki/Hypoxia_(medical)#cite_note-nythypoxia-6) In a New York Times opinion piece (4/20/20), emergency room doctor [Richard Levitan](https://en.wikipedia.org/wiki/Richard_Levitan) reports "a vast majority of Covid pneumonia patients I met had remarkably low oxygen saturations at triage — seemingly incompatible with life — but they were using their cellphones as we put them on monitors."[[6]](https://en.wikipedia.org/wiki/Hypoxia_(medical)#cite_note-nythypoxia-6)

Hypoxia is a common complication of [preterm birth](https://en.wikipedia.org/wiki/Preterm_birth) in newborn infants. Because the lungs develop late in pregnancy, premature infants frequently possess underdeveloped lungs. To improve lung function, doctors frequently place infants at risk of hypoxia inside incubators (also known as humidicribs) that provide warmth, humidity, and oxygen. More serious cases are treated with [continuous positive airway pressure](https://en.wikipedia.org/wiki/Continuous_positive_airway_pressure).[[7]](https://en.wikipedia.org/wiki/Hypoxia_(medical)#cite_note-7)

The 2019 Nobel Prize in Physiology or Medicine was awarded to William G. Kaelin Jr., Sir Peter J. Ratcliffe, and Gregg L. Semenza in recognition of their discovery of cellular mechanisms to sense and adapt to different oxygen concentrations, establishing a basis for how oxygen levels affect physiological function.[[8]](https://en.wikipedia.org/wiki/Hypoxia_(medical)#cite_note-8)[[9]](https://en.wikipedia.org/wiki/Hypoxia_(medical)#cite_note-9)



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## **Generalized hypoxia[**[**edit**](https://en.wikipedia.org/w/index.php?title=Hypoxia_(medical)&action=edit&section=1)**]**

The symptoms of generalized hypoxia depend on its severity and acceleration of onset.

In the case of [altitude sickness](https://en.wikipedia.org/wiki/Altitude_sickness), where hypoxia develops gradually, the symptoms include [fatigue](https://en.wikipedia.org/wiki/Fatigue_(medical)), [numbness](https://en.wikipedia.org/wiki/Hypoesthesia) / tingling of [extremities](https://en.wikipedia.org/wiki/Limb_(anatomy)), [nausea](https://en.wikipedia.org/wiki/Nausea), and [cerebral anoxia](https://en.wikipedia.org/wiki/Cerebral_hypoxia).[[10]](https://en.wikipedia.org/wiki/Hypoxia_(medical)#cite_note-Oxford_University_Press-10) These symptoms are often difficult to identify, but early detection of symptoms can be critical.[[11]](https://en.wikipedia.org/wiki/Hypoxia_(medical)#cite_note-pia-11)[[*additional citation(s) needed*](https://en.wikipedia.org/wiki/Wikipedia:Citation_needed)]

In severe hypoxia, or hypoxia of very rapid onset, [ataxia](https://en.wikipedia.org/wiki/Ataxia), confusion / disorientation / [hallucinations](https://en.wikipedia.org/wiki/Hallucination) / behavioral change, severe [headaches](https://en.wikipedia.org/wiki/Headache) / reduced level of consciousness, [papilloedema](https://en.wikipedia.org/wiki/Papilloedema), [breathlessness](https://en.wikipedia.org/wiki/Tachypnea),[[10]](https://en.wikipedia.org/wiki/Hypoxia_(medical)#cite_note-Oxford_University_Press-10) [pallor](https://en.wikipedia.org/wiki/Pallor),[[12]](https://en.wikipedia.org/wiki/Hypoxia_(medical)#cite_note-12) [tachycardia](https://en.wikipedia.org/wiki/Tachycardia), and [pulmonary hypertension](https://en.wikipedia.org/wiki/Pulmonary_hypertension) eventually leading to the late signs [cyanosis](https://en.wikipedia.org/wiki/Cyanosis), [slow heart rate](https://en.wikipedia.org/wiki/Bradycardia) / [cor pulmonale](https://en.wikipedia.org/wiki/Cor_pulmonale" \o "Cor pulmonale), and [low blood pressure](https://en.wikipedia.org/wiki/Hypotension) followed by [heart failure](https://en.wikipedia.org/wiki/Heart_failure) eventually leading to [shock](https://en.wikipedia.org/wiki/Shock_(circulatory)) and [death](https://en.wikipedia.org/wiki/Death).[[13]](https://en.wikipedia.org/wiki/Hypoxia_(medical)#cite_note-13)[[14]](https://en.wikipedia.org/wiki/Hypoxia_(medical)#cite_note-14)

Because [hemoglobin](https://en.wikipedia.org/wiki/Hemoglobin) is a darker red when it is not bound to oxygen ([deoxyhemoglobin](https://en.wikipedia.org/wiki/Deoxyhemoglobin)), as opposed to the rich red color that it has when bound to oxygen ([oxyhemoglobin](https://en.wikipedia.org/wiki/Oxyhemoglobin)), when seen through the skin it has an increased tendency to reflect blue light back to the eye.[[15]](https://en.wikipedia.org/wiki/Hypoxia_(medical)#cite_note-15) In cases where the oxygen is displaced by another molecule, such as carbon monoxide, the skin may appear 'cherry red' instead of cyanotic.[[16]](https://en.wikipedia.org/wiki/Hypoxia_(medical)#cite_note-16) Hypoxia can cause [premature birth](https://en.wikipedia.org/wiki/Preterm_birth), and injure the liver, among other deleterious effects.

## **Local hypoxia[**[**edit**](https://en.wikipedia.org/w/index.php?title=Hypoxia_(medical)&action=edit&section=2)**]**

If tissue is not being perfused properly, it may feel cold and appear pale; if severe, hypoxia can result in [cyanosis](https://en.wikipedia.org/wiki/Cyanosis), a blue discoloration of the skin. If hypoxia is very severe, a tissue may eventually become gangrenous. Extreme pain may also be felt at or around the site.[[*citation needed*](https://en.wikipedia.org/wiki/Wikipedia:Citation_needed)]

Tissue hypoxia from low oxygen delivery may be due to low haemoglobin concentration (anaemic hypoxia), low cardiac output (stagnant hypoxia) or low haemoglobin saturation (hypoxic hypoxia).[[17]](https://en.wikipedia.org/wiki/Hypoxia_(medical)#cite_note-17) The consequence of oxygen deprivation in tissues is a switch to anaerobic metabolism at the cellular level. As such, reduced systemic blood flow may result in increased serum lactate.[[18]](https://en.wikipedia.org/wiki/Hypoxia_(medical)#cite_note-:1-18) Serum lactate levels have been correlated with illness severity and mortality in critically ill adults and in ventilated neonates with respiratory distress.[[18]](https://en.wikipedia.org/wiki/Hypoxia_(medical)#cite_note-:1-18)

## **Cause[**[**edit**](https://en.wikipedia.org/w/index.php?title=Hypoxia_(medical)&action=edit&section=3)**]**

Oxygen passively diffuses in the lung [alveoli](https://en.wikipedia.org/wiki/Pulmonary_alveolus) according to a pressure gradient. Oxygen diffuses from the breathed air, mixed with water vapour, to [arterial](https://en.wikipedia.org/wiki/Artery) blood, where its partial pressure is around 100 mmHg (13.3 kPa).[[19]](https://en.wikipedia.org/wiki/Hypoxia_(medical)#cite_note-02_calc-19) In the blood, oxygen is bound to hemoglobin, a protein in [red blood cells](https://en.wikipedia.org/wiki/Red_blood_cell). The binding capacity of hemoglobin is influenced by the [partial pressure](https://en.wiktionary.org/wiki/partial_pressure) of oxygen in the environment, as described in the [oxygen–hemoglobin dissociation curve](https://en.wikipedia.org/wiki/Oxygen%E2%80%93hemoglobin_dissociation_curve). A smaller amount of oxygen is transported in solution in the blood.

In peripheral tissues, oxygen again diffuses down a pressure gradient into cells and their [mitochondria](https://en.wikipedia.org/wiki/Mitochondria), where it is [used to produce energy](https://en.wikipedia.org/wiki/Cellular_respiration) in conjunction with the breakdown of [glucose](https://en.wikipedia.org/wiki/Glucose), [fats](https://en.wikipedia.org/wiki/Fat), and some [amino acids](https://en.wikipedia.org/wiki/Amino_acid).[[20]](https://en.wikipedia.org/wiki/Hypoxia_(medical)#cite_note-20)

Hypoxia can result from a failure at any stage in the delivery of oxygen to cells. This can include decreased partial pressures of oxygen, problems with diffusion of oxygen in the lungs, insufficient available hemoglobin, problems with blood flow to the end tissue, and problems with breathing rhythm.

Experimentally, oxygen diffusion becomes rate limiting (and lethal) when arterial oxygen partial pressure falls to 60 mmHg (5.3 kPa) or below.[[*citation needed*](https://en.wikipedia.org/wiki/Wikipedia:Citation_needed)]

Almost all the oxygen in the blood is bound to hemoglobin, so interfering with this carrier molecule limits oxygen delivery to the periphery. Hemoglobin increases the oxygen-carrying capacity of blood by about 40-fold,[[21]](https://en.wikipedia.org/wiki/Hypoxia_(medical)#cite_note-MARTIN1999-21) with the ability of hemoglobin to carry oxygen influenced by the partial pressure of oxygen in the environment, a relationship described in the [oxygen–hemoglobin dissociation curve](https://en.wikipedia.org/wiki/Oxygen%E2%80%93hemoglobin_dissociation_curve). When the ability of hemoglobin to carry oxygen is interfered with, a hypoxic state can result.[[22]](https://en.wikipedia.org/wiki/Hypoxia_(medical)#cite_note-DAVIDSONS2010-22):997–999

### Ischemia[[edit](https://en.wikipedia.org/w/index.php?title=Hypoxia_(medical)&action=edit&section=4)]

*Main article:*[*Ischemia*](https://en.wikipedia.org/wiki/Ischemia)

[Ischemia](https://en.wikipedia.org/wiki/Ischemia), meaning insufficient blood flow to a tissue, can also result in hypoxia. This is called 'ischemic hypoxia'. This can include an [embolic event](https://en.wikipedia.org/wiki/Embolus), a [heart attack](https://en.wikipedia.org/wiki/Myocardial_infarction) that decreases overall blood flow, or trauma to a tissue that results in damage. An example of insufficient blood flow causing local hypoxia is [gangrene](https://en.wikipedia.org/wiki/Gangrene) that occurs in [diabetes](https://en.wikipedia.org/wiki/Diabetes).[[23]](https://en.wikipedia.org/wiki/Hypoxia_(medical)#cite_note-Levin_O'Neal-23)

Diseases such as [peripheral vascular disease](https://en.wikipedia.org/wiki/Peripheral_vascular_disease) can also result in local hypoxia. For this reason, symptoms are worse when a limb is used. Pain may also be felt as a result of increased hydrogen ions leading to a decrease in blood pH (acidity) created as a result of [anaerobic metabolism](https://en.wikipedia.org/wiki/Anaerobic_metabolism).[[*citation needed*](https://en.wikipedia.org/wiki/Wikipedia:Citation_needed)]

### Hypoxemic hypoxia[[edit](https://en.wikipedia.org/w/index.php?title=Hypoxia_(medical)&action=edit&section=5)]

*Main article:*[*Hypoxemia*](https://en.wikipedia.org/wiki/Hypoxemia)

This refers specifically to hypoxic states where the arterial content of oxygen is insufficient.[[24]](https://en.wikipedia.org/wiki/Hypoxia_(medical)#cite_note-24) This can be caused by alterations in [respiratory drive](https://en.wikipedia.org/wiki/Respiratory_drive), such as in [respiratory alkalosis](https://en.wikipedia.org/wiki/Respiratory_alkalosis), physiological or pathological shunting of blood, diseases interfering in lung function resulting in a [ventilation-perfusion mismatch](https://en.wikipedia.org/wiki/Ventilation-perfusion_mismatch), such as a [pulmonary embolus](https://en.wikipedia.org/wiki/Pulmonary_embolus), or alterations in the [partial pressure](https://en.wikipedia.org/wiki/Partial_pressure) of oxygen in the environment or lung alveoli, such as may occur at altitude or when diving.

#### Carbon monoxide poisoning**[**[**edit**](https://en.wikipedia.org/w/index.php?title=Hypoxia_(medical)&action=edit&section=6)**]**

*Main article:*[*Carbon monoxide poisoning*](https://en.wikipedia.org/wiki/Carbon_monoxide_poisoning)

[Carbon monoxide](https://en.wikipedia.org/wiki/Carbon_monoxide) competes with oxygen for binding sites on hemoglobin molecules. As carbon monoxide binds with hemoglobin hundreds of times tighter than oxygen, it can prevent the carriage of oxygen.[[25]](https://en.wikipedia.org/wiki/Hypoxia_(medical)#cite_note-25) [Carbon monoxide](https://en.wikipedia.org/wiki/Carbon_monoxide) poisoning can occur acutely, as with smoke intoxication, or over a period of time, as with cigarette smoking. Due to physiological processes, carbon monoxide is maintained at a resting level of 4–6 ppm. This is increased in urban areas (7–13 ppm) and in smokers (20–40 ppm).[[26]](https://en.wikipedia.org/wiki/Hypoxia_(medical)#cite_note-CO_ppm-26) A carbon monoxide level of 40 ppm is equivalent to a reduction in hemoglobin levels of 10 g/L.[[26]](https://en.wikipedia.org/wiki/Hypoxia_(medical)#cite_note-CO_ppm-26){{notetag|The formula {\displaystyle Hb\_{CO}(\%)={\frac {CO-2.34}{5.09}}} can be used to calculate the amount of carbon monoxide-bound hemoglobin. For example, at carbon monoxide level of 5 ppm, {\displaystyle ={\frac {5-2.34}{5.09}}=.5\%}, or a loss of half a percent of their blood's hemoglobin.[[26]](https://en.wikipedia.org/wiki/Hypoxia_(medical)#cite_note-CO_ppm-26)

CO has a second toxic effect, namely removing the allosteric shift of the oxygen dissociation curve and shifting the foot of the curve to the left. In so doing, the hemoglobin is less likely to release its oxygens at the peripheral tissues.[[21]](https://en.wikipedia.org/wiki/Hypoxia_(medical)#cite_note-MARTIN1999-21) Certain [abnormal hemoglobin variants](https://en.wikipedia.org/wiki/Hemoglobinopathies) also have higher than normal affinity for oxygen, and so are also poor at delivering oxygen to the periphery.

#### Altitude**[**[**edit**](https://en.wikipedia.org/w/index.php?title=Hypoxia_(medical)&action=edit&section=7)**]**

*Main article:*[*Altitude sickness*](https://en.wikipedia.org/wiki/Altitude_sickness)

Atmospheric pressure reduces with altitude and with it, the amount of oxygen.[[27]](https://en.wikipedia.org/wiki/Hypoxia_(medical)#cite_note-netzer-27) The reduction in the partial pressure of inspired oxygen at higher altitudes lowers the oxygen saturation of the blood, ultimately leading to hypoxia.[[27]](https://en.wikipedia.org/wiki/Hypoxia_(medical)#cite_note-netzer-27) The clinical features of altitude sickness include: sleep problems, dizziness, headache and oedema.[[27]](https://en.wikipedia.org/wiki/Hypoxia_(medical)#cite_note-netzer-27)

#### Hypoxic breathing gases**[**[**edit**](https://en.wikipedia.org/w/index.php?title=Hypoxia_(medical)&action=edit&section=8)**]**

*Main articles:*[*Inert gas asphyxiation*](https://en.wikipedia.org/wiki/Inert_gas_asphyxiation)*and*[*Asphyxiant gases*](https://en.wikipedia.org/wiki/Asphyxiant_gases)

The [breathing gas](https://en.wikipedia.org/wiki/Breathing_gas) in [underwater diving](https://en.wikipedia.org/wiki/Underwater_diving) may contain an insufficient partial pressure of oxygen, particularly in malfunction of rebreathers. Such situations may lead to unconsciousness without symptoms since carbon dioxide levels are normal and the human body senses pure hypoxia poorly. Hypoxic breathing gases can be defined as mixtures with a lower oxygen fraction than air, though gases containing sufficient oxygen to reliably maintain consciousness at normal sea level atmospheric pressure may be described as normoxic even when slightly hypoxic. Hypoxic mixtures in this context are those which will not reliably maintain consciousness at sea level pressure. Gases with as little as 2% oxygen by volume in a helium diluent are used for deep diving operations. The ambient pressure at 190 [msw](https://en.wikipedia.org/wiki/Msw" \o "Msw) is sufficient to provide a partial pressure of about 0.4 bar, which is suitable for [saturation diving](https://en.wikipedia.org/wiki/Saturation_diving). As the divers are [decompressed](https://en.wikipedia.org/wiki/Decompression_(diving)), the breathing gas must be oxygenated to maintain a breathable atmosphere.[[28]](https://en.wikipedia.org/wiki/Hypoxia_(medical)#cite_note-usn_ch15-28)

Inert gas asphyxiation may be deliberate with use of a [suicide bag](https://en.wikipedia.org/wiki/Suicide_bag). Accidental death has occurred in cases where concentrations of nitrogen in controlled atmospheres, or methane in mines, has not been detected or appreciated.[[29]](https://en.wikipedia.org/wiki/Hypoxia_(medical)#cite_note-29)

#### Other**[**[**edit**](https://en.wikipedia.org/w/index.php?title=Hypoxia_(medical)&action=edit&section=9)**]**

Hemoglobin's function can also be lost by chemically oxidizing its iron atom to its ferric form. This form of inactive hemoglobin is called [methemoglobin](https://en.wikipedia.org/wiki/Methemoglobin) and can be made by ingesting sodium nitrite[[30]](https://en.wikipedia.org/wiki/Hypoxia_(medical)#cite_note-30)[[*unreliable medical source?*](https://en.wikipedia.org/wiki/Wikipedia:Identifying_reliable_sources_(medicine))] as well as certain drugs and other chemicals.[[31]](https://en.wikipedia.org/wiki/Hypoxia_(medical)#cite_note-BC_DPIC-31)

### Anemia[[edit](https://en.wikipedia.org/w/index.php?title=Hypoxia_(medical)&action=edit&section=10)]

*Main article:*[*Anemia*](https://en.wikipedia.org/wiki/Anemia)

Hemoglobin plays a substantial role in carrying oxygen throughout the body,[[21]](https://en.wikipedia.org/wiki/Hypoxia_(medical)#cite_note-MARTIN1999-21) and when it is deficient, [anemia](https://en.wikipedia.org/wiki/Anemia) can result, causing 'anaemic hypoxia' if tissue [perfusion](https://en.wikipedia.org/wiki/Perfusion) is decreased. [Iron deficiency](https://en.wikipedia.org/wiki/Iron_deficiency) is the most common cause of anemia. As iron is used in the synthesis of hemoglobin, less hemoglobin will be synthesised when there is less iron, due to insufficient intake, or poor absorption.[[22]](https://en.wikipedia.org/wiki/Hypoxia_(medical)#cite_note-DAVIDSONS2010-22):997–999

Anemia is typically a chronic process that is compensated over time by increased levels of [red blood cells](https://en.wikipedia.org/wiki/Red_blood_cell) via upregulated [erythropoetin](https://en.wikipedia.org/wiki/Erythropoetin" \o "Erythropoetin). A chronic hypoxic state can result from a poorly compensated anaemia.[[22]](https://en.wikipedia.org/wiki/Hypoxia_(medical)#cite_note-DAVIDSONS2010-22):997–999

### Histotoxic hypoxia[[edit](https://en.wikipedia.org/w/index.php?title=Hypoxia_(medical)&action=edit&section=11)]

#### Cyanide poisoning**[**[**edit**](https://en.wikipedia.org/w/index.php?title=Hypoxia_(medical)&action=edit&section=12)**]**

Histotoxic hypoxia results when the quantity of oxygen reaching the cells is normal, but the cells are unable to use the oxygen effectively as a result of disabled oxidative phosphorylation enzymes. This may occur in [cyanide poisoning](https://en.wikipedia.org/wiki/Cyanide_poisoning).[[32]](https://en.wikipedia.org/wiki/Hypoxia_(medical)#cite_note-32)

## **Physiological compensation[**[**edit**](https://en.wikipedia.org/w/index.php?title=Hypoxia_(medical)&action=edit&section=13)**]**

### Acute[[edit](https://en.wikipedia.org/w/index.php?title=Hypoxia_(medical)&action=edit&section=14)]

If oxygen delivery to cells is insufficient for the demand (hypoxia), electrons will be shifted to [pyruvic acid](https://en.wikipedia.org/wiki/Pyruvic_acid) in the process of [lactic acid fermentation](https://en.wikipedia.org/wiki/Lactic_acid_fermentation). This temporary measure (anaerobic metabolism) allows small amounts of energy to be released. Lactic acid build up (in tissues and blood) is a sign of inadequate mitochondrial oxygenation, which may be due to hypoxemia, poor blood flow (e.g., shock) or a combination of both.[[33]](https://en.wikipedia.org/wiki/Hypoxia_(medical)#cite_note-33) If severe or prolonged it could lead to cell death. [[34]](https://en.wikipedia.org/wiki/Hypoxia_(medical)#cite_note-34)

In humans, hypoxia is detected by the peripheral chemoreceptors in the [carotid body](https://en.wikipedia.org/wiki/Carotid_body) and [aortic body](https://en.wikipedia.org/wiki/Aortic_body), with the carotid body chemoreceptors being the major mediators of reflex responses to hypoxia.[[35]](https://en.wikipedia.org/wiki/Hypoxia_(medical)#cite_note-35) This response does not control ventilation rate at normal pO  
2, but below normal the activity of neurons innervating these receptors increases dramatically, so much so to override the signals from central chemoreceptors in the [hypothalamus](https://en.wikipedia.org/wiki/Hypothalamus), increasing pO  
2 despite a falling pCO  
2

In most tissues of the body, the response to hypoxia is [vasodilation](https://en.wikipedia.org/wiki/Vasodilation). By widening the blood vessels, the tissue allows greater perfusion.

By contrast, in the [lungs](https://en.wikipedia.org/wiki/Lung), the response to hypoxia is [vasoconstriction](https://en.wikipedia.org/wiki/Vasoconstriction). This is known as [hypoxic pulmonary vasoconstriction](https://en.wikipedia.org/wiki/Hypoxic_pulmonary_vasoconstriction), or "HPV".[[36]](https://en.wikipedia.org/wiki/Hypoxia_(medical)#cite_note-36)

### Chronic[[edit](https://en.wikipedia.org/w/index.php?title=Hypoxia_(medical)&action=edit&section=15)]

When the pulmonary capillary pressure remains elevated chronically (for at least 2 weeks), the lungs become even more resistant to pulmonary edema because the lymph vessels expand greatly, increasing their capability of carrying fluid away from the interstitial spaces perhaps as much as 10-fold. Therefore, in patients with chronic [mitral stenosis](https://en.wikipedia.org/wiki/Mitral_stenosis), pulmonary capillary pressures of 40 to 45 mm Hg have been measured without the development of lethal pulmonary edema.[Guytun and Hall physiology]

Hypoxia exists when there is a reduced amount of oxygen in the tissues of the body. Hypoxemia refers to a reduction in PO2 below the normal range, regardless of whether gas exchange is impaired in the lung, CaO2 is adequate, or tissue hypoxia exists. There are several potential physiologic mechanisms for hypoxemia, but in patients with [COPD](https://en.wikipedia.org/wiki/COPD) the predominant one is V/Q mismatching, with or without alveolar hypoventilation, as indicated by PaCO2. Hypoxemia caused by V/Q mismatching as seen in COPD is relatively easy to correct, so that only comparatively small amounts of supplemental oxygen (less than 3 L/min for the majority of patients) are required for [LTOT](https://en.wikipedia.org/wiki/LTOT). Although hypoxemia normally stimulates ventilation and produces dyspnea, these phenomena and the other symptoms and signs of hypoxia are sufficiently variable in patients with COPD as to be of limited value in patient assessment. Chronic alveolar hypoxia is the main factor leading to development of cor pulmonale—right ventricular hypertrophy with or without overt right ventricular failure—in patients with COPD. Pulmonary hypertension adversely affects survival in COPD, to an extent that parallels the degree to which resting mean pulmonary artery pressure is elevated. Although the severity of airflow obstruction as measured by [FEV1](https://en.wikipedia.org/wiki/FEV1) is the best correlate with overall prognosis in patients with COPD, chronic hypoxemia increases mortality and morbidity for any severity of disease. Large-scale studies of LTOT in patients with COPD have demonstrated a [dose–response relationship](https://en.wikipedia.org/wiki/Dose%E2%80%93response_relationship) between daily hours of oxygen use and survival. There is reason to believe that continuous, 24-hours-per-day oxygen use in appropriately selected patients would produce a survival benefit even greater than that shown in the NOTT and MRC studies.[[37]](https://en.wikipedia.org/wiki/Hypoxia_(medical)#cite_note-37)

## **Treatment[**[**edit**](https://en.wikipedia.org/w/index.php?title=Hypoxia_(medical)&action=edit&section=16)**]**

To counter the effects of high-altitude diseases, the body must return arterial pO  
2 toward normal. [Acclimatization](https://en.wikipedia.org/wiki/Acclimatization), the means by which the body adapts to higher altitudes, only partially restores pO  
2 to standard levels. [Hyperventilation](https://en.wikipedia.org/wiki/Hyperventilation), the body's most common response to high-altitude conditions, increases alveolar pO  
2 by raising the depth and rate of breathing. However, while pO  
2 does improve with hyperventilation, it does not return to normal. Studies of miners and astronomers working at 3000 meters and above show improved alveolar pO  
2 with full acclimatization, yet the pO  
2 level remains equal to or even below the threshold for continuous oxygen therapy for patients with [chronic obstructive pulmonary disease](https://en.wikipedia.org/wiki/Chronic_obstructive_pulmonary_disease) (COPD).[[38]](https://en.wikipedia.org/wiki/Hypoxia_(medical)#cite_note-West_2004_789%E2%80%93800-38) In addition, there are complications involved with acclimatization. [Polycythemia](https://en.wikipedia.org/wiki/Polycythemia), in which the body increases the number of red blood cells in circulation, thickens the blood, raising the danger that the heart can't pump it.

In high-altitude conditions, only oxygen enrichment can counteract the effects of hypoxia. By increasing the concentration of oxygen in the air, the effects of lower barometric pressure are countered and the level of arterial pO  
2 is restored toward normal capacity. A small amount of supplemental oxygen reduces the equivalent altitude in climate-controlled rooms. At 4000 m, raising the oxygen concentration level by 5 percent via an oxygen concentrator and an existing ventilation system provides an altitude equivalent of 3000 m, which is much more tolerable for the increasing number of low-landers who work in high altitude.[[39]](https://en.wikipedia.org/wiki/Hypoxia_(medical)#cite_note-39) In a study of astronomers working in Chile at 5050 m, oxygen concentrators increased the level of oxygen concentration by almost 30 percent (that is, from 21 percent to 27 percent). This resulted in increased worker productivity, less fatigue, and improved sleep.[[38]](https://en.wikipedia.org/wiki/Hypoxia_(medical)#cite_note-West_2004_789%E2%80%93800-38)

[Oxygen concentrators](https://en.wikipedia.org/wiki/Oxygen_concentrator) are uniquely suited for this purpose. They require little maintenance and electricity, provide a constant source of oxygen, and eliminate the expensive, and often dangerous, task of transporting oxygen cylinders to remote areas. Offices and housing already have climate-controlled rooms, in which temperature and humidity are kept at a constant level. Oxygen can be added to this system easily and relatively cheaply.[[*citation needed*](https://en.wikipedia.org/wiki/Wikipedia:Citation_needed)]

A prescription renewal for home oxygen following hospitalization requires an assessment of the patient for ongoing hypoxemia.[[40]](https://en.wikipedia.org/wiki/Hypoxia_(medical)#cite_note-ACCPandATSfive-40)