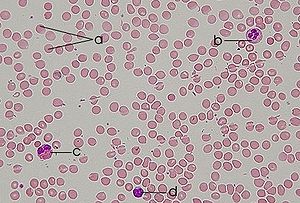
**Blood**

From Wikipedia, the free encyclopedia

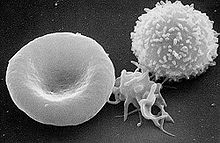
Jump to: [navigation](http://en.wikipedia.org/wiki/Blood#mw-head), [search](http://en.wikipedia.org/wiki/Blood#p-search)

*For other uses, see* [*Blood (disambiguation)*](http://en.wikipedia.org/wiki/Blood_(disambiguation))*.*

[](http://en.wikipedia.org/wiki/File:Blood_smear.jpg)

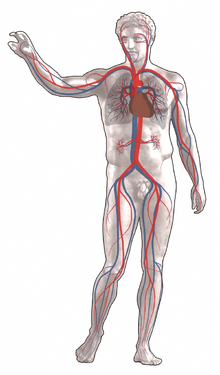
[http://bits.wikimedia.org/skins-1.5/common/images/magnify-clip.png](http://en.wikipedia.org/wiki/File:Blood_smear.jpg)

Human [blood smear](http://en.wikipedia.org/wiki/Blood_smear):  
a – [erythrocytes](http://en.wikipedia.org/wiki/Erythrocytes); b – [neutrophil](http://en.wikipedia.org/wiki/Neutrophil);  
c – [eosinophil](http://en.wikipedia.org/wiki/Eosinophil); d – [lymphocyte](http://en.wikipedia.org/wiki/Lymphocyte).

[](http://en.wikipedia.org/wiki/File:Red_White_Blood_cells.jpg)

[http://bits.wikimedia.org/skins-1.5/common/images/magnify-clip.png](http://en.wikipedia.org/wiki/File:Red_White_Blood_cells.jpg)

A [scanning electron microscope](http://en.wikipedia.org/wiki/Scanning_electron_microscope) (SEM) image of a normal [red blood cell](http://en.wikipedia.org/wiki/Red_blood_cell), a [platelet](http://en.wikipedia.org/wiki/Platelet), and a [white blood cell](http://en.wikipedia.org/wiki/White_blood_cell).

[](http://en.wikipedia.org/wiki/File:Blutkreislauf.png)

[http://bits.wikimedia.org/skins-1.5/common/images/magnify-clip.png](http://en.wikipedia.org/wiki/File:Blutkreislauf.png)

Blood circulation:  
Red = oxygenated  
Blue = deoxygenated

[](http://en.wikipedia.org/wiki/File:Humanbood600x.jpg)

[http://bits.wikimedia.org/skins-1.5/common/images/magnify-clip.png](http://en.wikipedia.org/wiki/File:Humanbood600x.jpg)

Human blood magnified 600 times

[](http://en.wikipedia.org/wiki/File:320frogblood600x2.jpg)

[http://bits.wikimedia.org/skins-1.5/common/images/magnify-clip.png](http://en.wikipedia.org/wiki/File:320frogblood600x2.jpg)

Frog blood magnified 600 times

[](http://en.wikipedia.org/wiki/File:320fishblood600x2.jpg)

[http://bits.wikimedia.org/skins-1.5/common/images/magnify-clip.png](http://en.wikipedia.org/wiki/File:320fishblood600x2.jpg)

Fish blood magnified 600 times

**Blood** is a specialized [bodily fluid](http://en.wikipedia.org/wiki/Body_fluid) that delivers necessary substances to the body's [cells](http://en.wikipedia.org/wiki/Cell_(biology)) – such as nutrients and [oxygen](http://en.wikipedia.org/wiki/Oxygen) – and transports [waste](http://en.wikipedia.org/wiki/Waste) products away from those same cells.

In [vertebrates](http://en.wikipedia.org/wiki/Vertebrate), it is composed of [blood cells](http://en.wikipedia.org/wiki/Blood_cells) suspended in a [liquid](http://en.wikipedia.org/wiki/Liquid) called [blood plasma](http://en.wikipedia.org/wiki/Blood_plasma). Plasma, which constitutes 55% of blood fluid, is mostly water (90% by volume),[[1]](http://en.wikipedia.org/wiki/Blood#cite_note-0) and contains dissolved proteins, [glucose](http://en.wikipedia.org/wiki/Glucose), mineral ions, [hormones](http://en.wikipedia.org/wiki/Hormone), [carbon dioxide](http://en.wikipedia.org/wiki/Carbon_dioxide) (plasma being the main medium for excretory product transportation), [platelets](http://en.wikipedia.org/wiki/Platelets) and blood cells themselves. The blood cells present in blood are mainly [red blood cells](http://en.wikipedia.org/wiki/Red_blood_cell) (also called RBCs or erythrocytes) and [white blood cells](http://en.wikipedia.org/wiki/White_blood_cell), including leukocytes and [platelets](http://en.wikipedia.org/wiki/Platelet). The most abundant cells in vertebrate blood are [red blood cells](http://en.wikipedia.org/wiki/Red_blood_cells). These contain [hemoglobin](http://en.wikipedia.org/wiki/Hemoglobin), an [iron](http://en.wikipedia.org/wiki/Iron)-containing protein, which facilitates transportation of [oxygen](http://en.wikipedia.org/wiki/Oxygen) by reversibly binding to this [respiratory](http://en.wikipedia.org/wiki/Breath) gas and greatly increasing its solubility in blood. In contrast, carbon dioxide is almost entirely transported extracellularly dissolved in plasma as [bicarbonate](http://en.wikipedia.org/wiki/Bicarbonate) ion.

Vertebrate blood is bright red when its hemoglobin is oxygenated. Some animals, such as [crustaceans](http://en.wikipedia.org/wiki/Crustacean) and [mollusks](http://en.wikipedia.org/wiki/Mollusk), use [hemocyanin](http://en.wikipedia.org/wiki/Hemocyanin) to carry oxygen, instead of hemoglobin. [Insects](http://en.wikipedia.org/wiki/Insect) and some molluscs use a fluid called [hemolymph](http://en.wikipedia.org/wiki/Hemolymph) instead of blood, the difference being that hemolymph is not contained in a closed [circulatory system](http://en.wikipedia.org/wiki/Circulatory_system). In most insects, this "blood" does not contain oxygen-carrying molecules such as hemoglobin because their bodies are small enough for their [tracheal system](http://en.wikipedia.org/wiki/Invertebrate_trachea) to suffice for supplying oxygen.

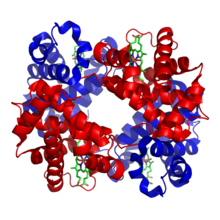
[Jawed vertebrates](http://en.wikipedia.org/wiki/Gnathostomata) have an [adaptive immune system](http://en.wikipedia.org/wiki/Adaptive_immune_system), based largely on [white blood cells](http://en.wikipedia.org/wiki/White_blood_cell). White blood cells help to resist infections and parasites. [Platelets](http://en.wikipedia.org/wiki/Platelet) are important in the [clotting](http://en.wikipedia.org/wiki/Coagulation) of blood.[[2]](http://en.wikipedia.org/wiki/Blood#cite_note-1) [Arthropods](http://en.wikipedia.org/wiki/Arthropod), using hemolymph, have [hemocytes](http://en.wikipedia.org/wiki/Hemocyte) as part of their [immune system](http://en.wikipedia.org/wiki/Immune_system).

Blood is circulated around the body through [blood vessels](http://en.wikipedia.org/wiki/Blood_vessel) by the pumping action of the [heart](http://en.wikipedia.org/wiki/Heart). In animals with [lungs](http://en.wikipedia.org/wiki/Lung), [arterial](http://en.wikipedia.org/wiki/Artery) blood carries oxygen from inhaled air to the tissues of the body, and [venous](http://en.wikipedia.org/wiki/Vein) blood carries carbon dioxide, a waste product of [metabolism](http://en.wikipedia.org/wiki/Metabolism) produced by [cells](http://en.wikipedia.org/wiki/Cell_(biology)), from the tissues to the [lungs](http://en.wikipedia.org/wiki/Lung) to be exhaled.

Medical terms related to blood often begin with ***hemo-*** or ***hemato-*** ([also spelled](http://en.wikipedia.org/wiki/American_and_British_English_spelling_differences#Simplification_of_ae_and_oe) ***haemo-*** and ***haemato-***) from the [Ancient Greek](http://en.wikipedia.org/wiki/Ancient_Greek) word αἷμα (*haima*) for "blood". In terms of [anatomy](http://en.wikipedia.org/wiki/Anatomy) and [histology](http://en.wikipedia.org/wiki/Histology), blood is considered a specialized form of [connective tissue](http://en.wikipedia.org/wiki/Connective_tissue), given its origin in the bones and the presence of potential molecular fibers in the form of [fibrinogen](http://en.wikipedia.org/wiki/Fibrinogen).

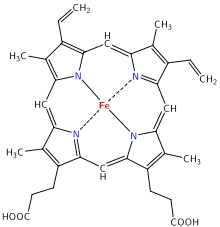
|  |
| --- |
| **Contents**  [[hide](http://en.wikipedia.org/wiki/Blood)]   * [1 Functions](http://en.wikipedia.org/wiki/Blood#Functions) * [2 Constituents of human blood](http://en.wikipedia.org/wiki/Blood#Constituents_of_human_blood)   + [2.1 Cells](http://en.wikipedia.org/wiki/Blood#Cells)   + [2.2 Plasma](http://en.wikipedia.org/wiki/Blood#Plasma)   + [2.3 Narrow range of pH values](http://en.wikipedia.org/wiki/Blood#Narrow_range_of_pH_values)   + [2.4 Blood in non-human vertebrates](http://en.wikipedia.org/wiki/Blood#Blood_in_non-human_vertebrates) * [3 Physiology](http://en.wikipedia.org/wiki/Blood#Physiology)   + [3.1 Cardiovascular system](http://en.wikipedia.org/wiki/Blood#Cardiovascular_system)   + [3.2 Production and degradation of blood cells](http://en.wikipedia.org/wiki/Blood#Production_and_degradation_of_blood_cells)   + [3.3 Oxygen transport](http://en.wikipedia.org/wiki/Blood#Oxygen_transport)   + [3.4 Carbon dioxide transport](http://en.wikipedia.org/wiki/Blood#Carbon_dioxide_transport)   + [3.5 Transport of hydrogen ions](http://en.wikipedia.org/wiki/Blood#Transport_of_hydrogen_ions)   + [3.6 Lymphatic system](http://en.wikipedia.org/wiki/Blood#Lymphatic_system)   + [3.7 Thermoregulation](http://en.wikipedia.org/wiki/Blood#Thermoregulation)   + [3.8 Hydraulic functions](http://en.wikipedia.org/wiki/Blood#Hydraulic_functions)   + [3.9 Invertebrates](http://en.wikipedia.org/wiki/Blood#Invertebrates) * [4 Color](http://en.wikipedia.org/wiki/Blood#Color)   + [4.1 Hemoglobin](http://en.wikipedia.org/wiki/Blood#Hemoglobin)   + [4.2 Hemocyanin](http://en.wikipedia.org/wiki/Blood#Hemocyanin) * [5 Pathology](http://en.wikipedia.org/wiki/Blood#Pathology)   + [5.1 General medical disorders](http://en.wikipedia.org/wiki/Blood#General_medical_disorders)   + [5.2 Hematological disorders](http://en.wikipedia.org/wiki/Blood#Hematological_disorders)   + [5.3 Carbon monoxide poisoning](http://en.wikipedia.org/wiki/Blood#Carbon_monoxide_poisoning) * [6 Medical treatments](http://en.wikipedia.org/wiki/Blood#Medical_treatments)   + [6.1 Blood products](http://en.wikipedia.org/wiki/Blood#Blood_products)   + [6.2 Intravenous administration](http://en.wikipedia.org/wiki/Blood#Intravenous_administration)   + [6.3 Bloodletting](http://en.wikipedia.org/wiki/Blood#Bloodletting) * [7 History](http://en.wikipedia.org/wiki/Blood#History)   + [7.1 Classical Greek medicine](http://en.wikipedia.org/wiki/Blood#Classical_Greek_medicine)   + [7.2 Hippocratic medicine](http://en.wikipedia.org/wiki/Blood#Hippocratic_medicine) * [8 Cultural and religious beliefs](http://en.wikipedia.org/wiki/Blood#Cultural_and_religious_beliefs)   + [8.1 Indigenous Australians](http://en.wikipedia.org/wiki/Blood#Indigenous_Australians)   + [8.2 Indo-European paganism](http://en.wikipedia.org/wiki/Blood#Indo-European_paganism)   + [8.3 Judaism](http://en.wikipedia.org/wiki/Blood#Judaism)   + [8.4 Christianity](http://en.wikipedia.org/wiki/Blood#Christianity)   + [8.5 Islam](http://en.wikipedia.org/wiki/Blood#Islam)   + [8.6 Jehovah's Witnesses](http://en.wikipedia.org/wiki/Blood#Jehovah.27s_Witnesses)   + [8.7 Chinese and Japanese culture](http://en.wikipedia.org/wiki/Blood#Chinese_and_Japanese_culture)   + [8.8 Blood libel](http://en.wikipedia.org/wiki/Blood#Blood_libel)   + [8.9 Vampire legends](http://en.wikipedia.org/wiki/Blood#Vampire_legends) * [9 Applications](http://en.wikipedia.org/wiki/Blood#Applications)   + [9.1 In the applied sciences](http://en.wikipedia.org/wiki/Blood#In_the_applied_sciences)   + [9.2 In art](http://en.wikipedia.org/wiki/Blood#In_art)   + [9.3 In genealogy & family history](http://en.wikipedia.org/wiki/Blood#In_genealogy_.26_family_history) * [10 See also](http://en.wikipedia.org/wiki/Blood#See_also) * [11 References](http://en.wikipedia.org/wiki/Blood#References) * [12 External links](http://en.wikipedia.org/wiki/Blood#External_links) |

**[**[**edit**](http://en.wikipedia.org/w/index.php?title=Blood&action=edit&section=1)**] Functions**

[](http://en.wikipedia.org/wiki/File:1GZX_Haemoglobin.png)

[http://bits.wikimedia.org/skins-1.5/common/images/magnify-clip.png](http://en.wikipedia.org/wiki/File:1GZX_Haemoglobin.png)

Hemoglobin  
green = heme groups  
red & blue = protein subunits

[](http://en.wikipedia.org/wiki/File:Heme.svg)

[http://bits.wikimedia.org/skins-1.5/common/images/magnify-clip.png](http://en.wikipedia.org/wiki/File:Heme.svg)

Heme

Blood performs many important functions within the body including:

* Supply of [oxygen](http://en.wikipedia.org/wiki/Oxygen) to tissues (bound to [hemoglobin](http://en.wikipedia.org/wiki/Hemoglobin), which is carried in red cells)
* Supply of nutrients such as [glucose](http://en.wikipedia.org/wiki/Glucose), [amino acids](http://en.wikipedia.org/wiki/Amino_acids), and [fatty acids](http://en.wikipedia.org/wiki/Fatty_acids) (dissolved in the blood or bound to [plasma proteins](http://en.wikipedia.org/wiki/Blood_proteins) (e.g., [blood lipids](http://en.wikipedia.org/wiki/Blood_lipid))
* Removal of waste such as [carbon dioxide](http://en.wikipedia.org/wiki/Carbon_dioxide), [urea](http://en.wikipedia.org/wiki/Urea), and [lactic acid](http://en.wikipedia.org/wiki/Lactic_acid)
* Immunological functions, including circulation of [white blood cells](http://en.wikipedia.org/wiki/White_blood_cells), and detection of foreign material by [antibodies](http://en.wikipedia.org/wiki/Antibodies)
* [Coagulation](http://en.wikipedia.org/wiki/Coagulation), which is one part of the body's self-repair mechanism (the act of blood clotting when one gets cut to stop the bleeding.)
* Messenger functions, including the transport of [hormones](http://en.wikipedia.org/wiki/Hormones) and the signaling of [tissue](http://en.wikipedia.org/wiki/Tissue_(biology)) damage
* Regulation of body [pH](http://en.wikipedia.org/wiki/PH)
* Regulation of core [body temperature](http://en.wikipedia.org/wiki/Body_temperature)
* [Hydraulic](http://en.wikipedia.org/wiki/Hydraulics) functions

**[**[**edit**](http://en.wikipedia.org/w/index.php?title=Blood&action=edit&section=2)**] Constituents of human blood**

*See also:* [*Reference ranges for common blood tests*](http://en.wikipedia.org/wiki/Reference_ranges_for_common_blood_tests)

[](http://en.wikipedia.org/wiki/File:Blut-EDTA.jpg)

[http://bits.wikimedia.org/skins-1.5/common/images/magnify-clip.png](http://en.wikipedia.org/wiki/File:Blut-EDTA.jpg)

Two tubes of [EDTA](http://en.wikipedia.org/wiki/EDTA)-anticoagulated blood.  
Left tube: after standing, the RBCs have settled at the bottom of the tube.  
Right tube: contains freshly drawn blood.

Blood accounts for 8% of the human body weight,[[3]](http://en.wikipedia.org/wiki/Blood#cite_note-alberts_table-2) with an average density of approximately 1060 kg/m3, very close to pure water's density of 1000 kg/m3.[[4]](http://en.wikipedia.org/wiki/Blood#cite_note-3) The average adult has a [blood volume](http://en.wikipedia.org/wiki/Blood_volume) of roughly 5 [liters](http://en.wikipedia.org/wiki/Liter) (1.3 gal), composed of plasma and several kinds of cells (occasionally called *corpuscles*); these formed elements of the blood are erythrocytes ([red blood cells](http://en.wikipedia.org/wiki/Red_blood_cell)), leukocytes ([white blood cells](http://en.wikipedia.org/wiki/White_blood_cell)), and thrombocytes ([platelets](http://en.wikipedia.org/wiki/Platelet)). By volume, the red blood cells constitute about 45% of whole blood, the plasma about 54.3%, and white cells about 0.7%.

Whole blood (plasma and cells) exhibits [non-Newtonian fluid](http://en.wikipedia.org/wiki/Non-Newtonian_fluid) dynamics; its flow properties are adapted to flow effectively through tiny capillary blood vessels with less resistance than plasma by itself. In addition, if all human hemoglobin were free in the plasma rather than being contained in RBCs, the circulatory fluid would be too viscous for the cardiovascular system to function effectively.

**[**[**edit**](http://en.wikipedia.org/w/index.php?title=Blood&action=edit&section=3)**] Cells**

*Further information:* [*Complete blood count*](http://en.wikipedia.org/wiki/Complete_blood_count)

One microliter of blood contains:

* **4.7 to 6.1 million (male), 4.2 to 5.4 million (female)** [**erythrocytes**](http://en.wikipedia.org/wiki/Erythrocyte)**:**[[5]](http://en.wikipedia.org/wiki/Blood#cite_note-4) In most mammals, mature red blood cells lack a [nucleus](http://en.wikipedia.org/wiki/Cell_nucleus) and [organelles](http://en.wikipedia.org/wiki/Organelle). They contain the blood's [hemoglobin](http://en.wikipedia.org/wiki/Hemoglobin) and distribute oxygen. The red blood cells (together with [endothelial](http://en.wikipedia.org/wiki/Endothelial) vessel cells and other cells) are also marked by [glycoproteins](http://en.wikipedia.org/wiki/Glycoprotein) that define the different [blood types](http://en.wikipedia.org/wiki/Human_blood_group_systems). The proportion of blood occupied by red blood cells is referred to as the [hematocrit](http://en.wikipedia.org/wiki/Hematocrit), and is normally about 45%. The combined surface area of all red blood cells of the human body would be roughly 2,000 times as great as the body's exterior surface.[[6]](http://en.wikipedia.org/wiki/Blood#cite_note-5)
* **4,000–11,000** [**leukocytes**](http://en.wikipedia.org/wiki/Leukocyte)**:**[[7]](http://en.wikipedia.org/wiki/Blood#cite_note-Ganong_WF-6) White blood cells are part of the [immune system](http://en.wikipedia.org/wiki/Immune_system); they destroy and remove old or aberrant cells and cellular debris, as well as attack infectious agents ([pathogens](http://en.wikipedia.org/wiki/Pathogens)) and foreign substances. The cancer of leukocytes is called [leukemia](http://en.wikipedia.org/wiki/Leukemia).
* **200,000–500,000 thrombocytes:**[[7]](http://en.wikipedia.org/wiki/Blood#cite_note-Ganong_WF-6) [thrombocytes](http://en.wikipedia.org/wiki/Thrombocyte), also called [platelets](http://en.wikipedia.org/wiki/Platelet), are responsible for blood clotting ([coagulation](http://en.wikipedia.org/wiki/Coagulation)). They change [fibrinogen](http://en.wikipedia.org/wiki/Fibrinogen) into [fibrin](http://en.wikipedia.org/wiki/Fibrin). This fibrin creates a mesh onto which red blood cells collect and clot, which then stops more blood from leaving the body and also helps to prevent bacteria from entering the body.

|  |  |
| --- | --- |
| Constitution of normal blood | |
| **Parameter** | **Value** |
| [Hematocrit](http://en.wikipedia.org/wiki/Hematocrit) | 45 ± 7 (38–52%) for males 42 ± 5 (37–47%) for females |
| [pH](http://en.wikipedia.org/wiki/PH) | 7.35–7.45 |
| [base excess](http://en.wikipedia.org/wiki/Base_excess) | −3 to +3 |
| P[O2](http://en.wikipedia.org/wiki/Oxygen) | 10–13 kPa (80–100 mm Hg) |
| P[CO2](http://en.wikipedia.org/wiki/Carbon_dioxide) | 4.8–5.8 kPa (35–45 mm Hg) |
| [HCO3−](http://en.wikipedia.org/wiki/Carbonic_acid) | 21–27 mM |
| Oxygen saturation | Oxygenated: 98–99% Deoxygenated: 75% |

**[**[**edit**](http://en.wikipedia.org/w/index.php?title=Blood&action=edit&section=4)**] Plasma**

About 55% of whole blood is [blood plasma](http://en.wikipedia.org/wiki/Blood_plasma), a fluid that is the blood's liquid medium, which by itself is straw-yellow in color. The blood plasma volume totals of 2.7–3.0 liters (2.8–3.2 quarts) in an average human. It is essentially an [aqueous](http://en.wikipedia.org/wiki/Water) solution containing 92% water, 8% blood plasma [proteins](http://en.wikipedia.org/wiki/Protein), and trace amounts of other materials. Plasma circulates dissolved nutrients, such as [glucose](http://en.wikipedia.org/wiki/Glucose), [amino acids](http://en.wikipedia.org/wiki/Amino_acids), and [fatty acids](http://en.wikipedia.org/wiki/Fatty_acids) (dissolved in the blood or bound to plasma proteins), and removes waste products, such as [carbon dioxide](http://en.wikipedia.org/wiki/Carbon_dioxide), [urea](http://en.wikipedia.org/wiki/Urea), and [lactic acid](http://en.wikipedia.org/wiki/Lactic_acid).

Other important [components](http://en.wikipedia.org/wiki/List_of_human_blood_components) include:

* [Serum albumin](http://en.wikipedia.org/wiki/Serum_albumin)
* Blood-clotting factors (to facilitate [coagulation](http://en.wikipedia.org/wiki/Coagulation))
* [Immunoglobulins](http://en.wikipedia.org/wiki/Immunoglobulins) (antibodies)
* [lipoprotein](http://en.wikipedia.org/wiki/Lipoprotein) particles
* Various other [proteins](http://en.wikipedia.org/wiki/Protein)
* Various [electrolytes](http://en.wikipedia.org/wiki/Electrolyte) (mainly [sodium](http://en.wikipedia.org/wiki/Sodium) and [chloride](http://en.wikipedia.org/wiki/Chloride))

The term **serum** refers to plasma from which the clotting proteins have been removed. Most of the proteins remaining are albumin and [immunoglobulins](http://en.wikipedia.org/wiki/Antibody).

**[**[**edit**](http://en.wikipedia.org/w/index.php?title=Blood&action=edit&section=5)**] Narrow range of pH values**

*See also:* [*Acid-base homeostasis*](http://en.wikipedia.org/wiki/Acid-base_homeostasis)

Blood [pH](http://en.wikipedia.org/wiki/PH) is regulated to stay within the narrow range of 7.35 to 7.45, making it slightly alkaline.[[8]](http://en.wikipedia.org/wiki/Blood#cite_note-Waugh-7)[[9]](http://en.wikipedia.org/wiki/Blood#cite_note-ReferenceA-8) Blood that has a pH below 7.35 is too [acidic](http://en.wikipedia.org/wiki/Acidic), whereas blood pH above 7.45 is too [alkaline](http://en.wikipedia.org/wiki/Alkaline). Blood pH, [partial pressure](http://en.wikipedia.org/wiki/Partial_pressure) of oxygen (pO2), partial pressure of carbon dioxide (pCO2), and [HCO3](http://en.wikipedia.org/wiki/Bicarbonate) are carefully regulated by a number of [homeostatic mechanisms](http://en.wikipedia.org/wiki/Homeostasis), which exert their influence principally through the [respiratory system](http://en.wikipedia.org/wiki/Respiratory_system) and the [urinary system](http://en.wikipedia.org/wiki/Urinary_system) in order to control the [acid-base balance](http://en.wikipedia.org/wiki/Acid-base_homeostasis) and respiration. An [arterial blood gas](http://en.wikipedia.org/wiki/Arterial_blood_gas) will measure these. Plasma also circulates [hormones](http://en.wikipedia.org/wiki/Hormone) transmitting their messages to various tissues. The list of normal [reference ranges](http://en.wikipedia.org/wiki/Reference_ranges_for_blood_tests) for various blood electrolytes is extensive.

Bones are especially affected by blood pH as they tend to be used as a mineral source for pH buffering. Consuming a high ratio of animal protein to vegetable protein is implicated in bone loss in women.[[10]](http://en.wikipedia.org/wiki/Blood#cite_note-9)

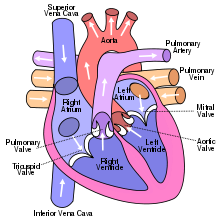
**[**[**edit**](http://en.wikipedia.org/w/index.php?title=Blood&action=edit&section=6)**] Blood in non-human vertebrates**

Human blood is typical of that of mammals, although the precise details concerning cell numbers, size, [protein structure](http://en.wikipedia.org/wiki/Protein_structure), and so on, vary somewhat between species. In non-mammalian vertebrates, however, there are some key differences:[[11]](http://en.wikipedia.org/wiki/Blood#cite_note-VB-10)

* Red blood cells of non-mammalian vertebrates are flattened and ovoid in form, and retain their cell nuclei
* There is considerable variation in the types and proportions of white blood cells; for example, acidophils are generally more common than in humans
* Platelets are unique to mammals; in other vertebrates, small, nucleated, spindle cells are responsible for blood clotting instead

**[**[**edit**](http://en.wikipedia.org/w/index.php?title=Blood&action=edit&section=7)**] Physiology**

**[**[**edit**](http://en.wikipedia.org/w/index.php?title=Blood&action=edit&section=8)**] Cardiovascular system**

[](http://en.wikipedia.org/wiki/File:Diagram_of_the_human_heart_(cropped).svg)

[http://bits.wikimedia.org/skins-1.5/common/images/magnify-clip.png](http://en.wikipedia.org/wiki/File:Diagram_of_the_human_heart_(cropped).svg)

The circulation of blood through the human heart

*Main article:* [*Circulatory system*](http://en.wikipedia.org/wiki/Circulatory_system)

Blood is circulated around the body through [blood vessels](http://en.wikipedia.org/wiki/Blood_vessel) by the pumping action of the [heart](http://en.wikipedia.org/wiki/Heart). In humans, blood is pumped from the strong [left ventricle](http://en.wikipedia.org/wiki/Left_ventricle) of the heart through [arteries](http://en.wikipedia.org/wiki/Artery) to peripheral [tissues](http://en.wikipedia.org/wiki/Tissue_(biology)) and returns to the right [atrium](http://en.wikipedia.org/wiki/Atrium_(heart)) of the heart through [veins](http://en.wikipedia.org/wiki/Vein). It then enters the right [ventricle](http://en.wikipedia.org/wiki/Ventricle_(heart)) and is pumped through the [pulmonary artery](http://en.wikipedia.org/wiki/Pulmonary_artery) to the [lungs](http://en.wikipedia.org/wiki/Lung) and returns to the left atrium through the [pulmonary veins](http://en.wikipedia.org/wiki/Pulmonary_vein). Blood then enters the left ventricle to be circulated again. Arterial blood carries oxygen from inhaled air to all of the cells of the body, and [venous blood](http://en.wikipedia.org/wiki/Venous_blood) carries carbon dioxide, a waste product of [metabolism](http://en.wikipedia.org/wiki/Metabolism) by [cells](http://en.wikipedia.org/wiki/Cell_(biology)), to the lungs to be exhaled. However, one exception includes pulmonary arteries, which contain the most deoxygenated blood in the body, while the pulmonary veins contain oxygenated blood.

Additional return flow may be generated by the movement of [skeletal muscles](http://en.wikipedia.org/wiki/Skeletal_muscle), which can compress veins and push blood through the valves in veins toward the [right atrium](http://en.wikipedia.org/wiki/Right_atrium).

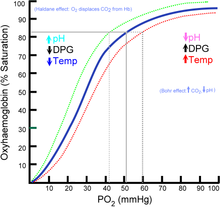
The blood circulation was famously described by [William Harvey](http://en.wikipedia.org/wiki/William_Harvey) in 1628.[[12]](http://en.wikipedia.org/wiki/Blood#cite_note-11)

**[**[**edit**](http://en.wikipedia.org/w/index.php?title=Blood&action=edit&section=9)**] Production and degradation of blood cells**

In vertebrates, the various cells of blood are made in the [bone marrow](http://en.wikipedia.org/wiki/Bone_marrow) in a process called [hematopoiesis](http://en.wikipedia.org/wiki/Hematopoiesis), which includes [erythropoiesis](http://en.wikipedia.org/wiki/Erythropoiesis), the production of red blood cells; and myelopoiesis, the production of white blood cells and platelets. During childhood, almost every human bone produces red blood cells; as adults, red blood cell production is limited to the larger bones: the bodies of the vertebrae, the breastbone (sternum), the ribcage, the pelvic bones, and the bones of the upper arms and legs. In addition, during childhood, the [thymus](http://en.wikipedia.org/wiki/Thymus) gland, found in the [mediastinum](http://en.wikipedia.org/wiki/Mediastinum), is an important source of [lymphocytes](http://en.wikipedia.org/wiki/Lymphocytes).[[13]](http://en.wikipedia.org/wiki/Blood#cite_note-12) The proteinaceous component of blood (including clotting proteins) is produced predominantly by the [liver](http://en.wikipedia.org/wiki/Liver), while hormones are produced by the [endocrine glands](http://en.wikipedia.org/wiki/Endocrine_gland) and the watery fraction is regulated by the [hypothalamus](http://en.wikipedia.org/wiki/Hypothalamus) and maintained by the [kidney](http://en.wikipedia.org/wiki/Kidney).

Healthy [erythrocytes](http://en.wikipedia.org/wiki/Erythrocytes) have a plasma life of about 120 days before they are degraded by the [spleen](http://en.wikipedia.org/wiki/Spleen), and the [Kupffer cells](http://en.wikipedia.org/wiki/Kupffer_cell) in the liver. The liver also clears some proteins, lipids, and [amino acids](http://en.wikipedia.org/wiki/Amino_acid). The kidney actively secretes waste products into the [urine](http://en.wikipedia.org/wiki/Urine).

**[**[**edit**](http://en.wikipedia.org/w/index.php?title=Blood&action=edit&section=10)**] Oxygen transport**

[](http://en.wikipedia.org/wiki/File:Oxyhaemoglobin_dissociation_curve.png)

[http://bits.wikimedia.org/skins-1.5/common/images/magnify-clip.png](http://en.wikipedia.org/wiki/File:Oxyhaemoglobin_dissociation_curve.png)

Basic hemoglobin saturation curve. It is moved to the right in higher acidity (more dissolved carbon dioxide) and to the left in lower acidity (less dissolved carbon dioxide)

About 98.5% of the [oxygen](http://en.wikipedia.org/wiki/Oxygen) in a sample of arterial blood in a healthy human breathing air at sea-level pressure is chemically combined with the Hgb. About 1.5% is physically dissolved in the other blood liquids and not connected to Hgb. The [hemoglobin](http://en.wikipedia.org/wiki/Hemoglobin) molecule is the primary transporter of oxygen in [mammals](http://en.wikipedia.org/wiki/Mammals) and many other species (for exceptions, see below). Hemoglobin has an oxygen binding capacity of between 1.36 and 1.37 ml O2 per gram Hemoglobin,[[14]](http://en.wikipedia.org/wiki/Blood#cite_note-13) which increases the total [blood oxygen capacity](http://en.wikipedia.org/wiki/Blood_oxygen_capacity) seventyfold,[[15]](http://en.wikipedia.org/wiki/Blood#cite_note-brsphys-14) compared to if oxygen solely was carried by its solubility of 0.03 mL O2 per liter blood per mmHg [partial pressure](http://en.wikipedia.org/wiki/Partial_pressure) of oxygen (approximately 100 mmHg in arteries).[[15]](http://en.wikipedia.org/wiki/Blood#cite_note-brsphys-14)

With the exception of [pulmonary](http://en.wikipedia.org/wiki/Pulmonary_artery) and [umbilical arteries](http://en.wikipedia.org/wiki/Umbilical_artery) and their corresponding veins, [arteries](http://en.wikipedia.org/wiki/Artery) carry oxygenated blood away from the [heart](http://en.wikipedia.org/wiki/Heart) and deliver it to the body via [arterioles](http://en.wikipedia.org/wiki/Arteriole) and [capillaries](http://en.wikipedia.org/wiki/Capillary), where the oxygen is consumed; afterwards, [venules](http://en.wikipedia.org/wiki/Venule), and [veins](http://en.wikipedia.org/wiki/Vein) carry deoxygenated blood back to the heart.

Under normal conditions in humans at rest; hemoglobin in blood leaving the lungs is about 98–99% saturated with oxygen. In a healthy adult at rest, *deoxygenated* blood returning to the lungs is still approximately 75% saturated.[[16]](http://en.wikipedia.org/wiki/Blood#cite_note-15)[[17]](http://en.wikipedia.org/wiki/Blood#cite_note-16) Increased oxygen consumption during sustained exercise reduces the oxygen saturation of venous blood, which can reach less than 15% in a trained athlete; although breathing rate and blood flow increase to compensate, oxygen saturation in arterial blood can drop to 95% or less under these conditions.[[18]](http://en.wikipedia.org/wiki/Blood#cite_note-17) Oxygen saturation this low is considered dangerous in an individual at rest (for instance, during surgery under anesthesia. Sustained hypoxia (oxygenation of less than 90%), is dangerous to health, and severe hypoxia (saturations of less than 30%) may be rapidly fatal.[[19]](http://en.wikipedia.org/wiki/Blood#cite_note-18)

A [fetus](http://en.wikipedia.org/wiki/Fetus), receiving oxygen via the [placenta](http://en.wikipedia.org/wiki/Placenta), is exposed to much lower oxygen pressures (about 21% of the level found in an adult's lungs), and, so, fetuses produce another form of hemoglobin with a much higher affinity for oxygen ([hemoglobin F](http://en.wikipedia.org/wiki/Fetal_hemoglobin)) in order to function under these conditions.[[20]](http://en.wikipedia.org/wiki/Blood#cite_note-19)

**[**[**edit**](http://en.wikipedia.org/w/index.php?title=Blood&action=edit&section=11)**] Carbon dioxide transport**

When blood flows through capillaries, carbon dioxide diffuses from the tissues into the blood. Some carbon dioxide is dissolved in the blood. A part of CO2 reacts with hemoglobin and other proteins to form [carbamino](http://en.wikipedia.org/wiki/Carbamino) compounds. The remaining carbon dioxide is converted to [bicarbonate](http://en.wikipedia.org/wiki/Bicarbonate) and [hydrogen ions](http://en.wikipedia.org/wiki/Hydrogen_ion) through the action of RBC [carbonic anhydrase](http://en.wikipedia.org/wiki/Carbonic_anhydrase). Most carbon dioxide is transported through the blood in the form of bicarbonate ions.

[Carbon dioxide](http://en.wikipedia.org/wiki/Carbon_dioxide) (CO2), the main [cellular waste product](http://en.wikipedia.org/wiki/Cellular_waste_product) is carried in blood mainly dissolved in [plasma](http://en.wikipedia.org/wiki/Blood_plasma), in equilibrium with [bicarbonate](http://en.wikipedia.org/wiki/Bicarbonate) (HCO3-) and [carbonic acid](http://en.wikipedia.org/wiki/Carbonic_acid) (H2CO3). 86–90% of CO2 in the body is converted into [carbonic acid](http://en.wikipedia.org/wiki/Carbonic_acid), which can quickly turn into bicarbonate, the chemical equilibrium being important in the pH [buffering](http://en.wikipedia.org/wiki/Buffering_agent) of plasma.[[21]](http://en.wikipedia.org/wiki/Blood#cite_note-veq-20) Blood [pH](http://en.wikipedia.org/wiki/PH) is kept in a narrow range (pH between 7.35 and 7.45).[[9]](http://en.wikipedia.org/wiki/Blood#cite_note-ReferenceA-8)

**[**[**edit**](http://en.wikipedia.org/w/index.php?title=Blood&action=edit&section=12)**] Transport of hydrogen ions**

Some oxyhemoglobin loses oxygen and becomes deoxyhemoglobin. Deoxyhemoglobin binds most of the hydrogen ions as it has a much greater affinity for more hydrogen than does oxyhemoglobin.

**[**[**edit**](http://en.wikipedia.org/w/index.php?title=Blood&action=edit&section=13)**] Lymphatic system**

*Main article:* [*Lymphatic system*](http://en.wikipedia.org/wiki/Lymphatic_system)

In mammals, blood is in equilibrium with [lymph](http://en.wikipedia.org/wiki/Lymph), which is continuously formed in tissues from blood by capillary ultrafiltration. Lymph is collected by a system of small lymphatic vessels and directed to the [thoracic duct](http://en.wikipedia.org/wiki/Thoracic_duct), which drains into the left [subclavian vein](http://en.wikipedia.org/wiki/Subclavian_vein) where lymph rejoins the systemic blood circulation.

**[**[**edit**](http://en.wikipedia.org/w/index.php?title=Blood&action=edit&section=14)**] Thermoregulation**

Blood circulation transports [heat](http://en.wikipedia.org/wiki/Heat) throughout the body, and adjustments to this flow are an important part of [thermoregulation](http://en.wikipedia.org/wiki/Thermoregulation). Increasing blood flow to the surface (e.g., during warm weather or strenuous exercise) causes warmer skin, resulting in faster heat loss. In contrast, when the external temperature is low, blood flow to the extremities and surface of the skin is reduced and to prevent heat loss and is circulated to the important organs of the body, preferentially.

**[**[**edit**](http://en.wikipedia.org/w/index.php?title=Blood&action=edit&section=15)**] Hydraulic functions**

The restriction of blood flow can also be used in specialized tissues to cause engorgement, resulting in an [erection](http://en.wikipedia.org/wiki/Erection) of that tissue; examples are the [erectile tissue](http://en.wikipedia.org/wiki/Erectile_tissue) in the [penis](http://en.wikipedia.org/wiki/Penis) and [clitoris](http://en.wikipedia.org/wiki/Clitoris).

Another example of a hydraulic function is the [jumping spider](http://en.wikipedia.org/wiki/Jumping_spider), in which blood forced into the legs under pressure causes them to straighten for a powerful jump, without the need for bulky muscular legs.[[22]](http://en.wikipedia.org/wiki/Blood#cite_note-21)

**[**[**edit**](http://en.wikipedia.org/w/index.php?title=Blood&action=edit&section=16)**] Invertebrates**

In [insects](http://en.wikipedia.org/wiki/Insect), the blood (more properly called [hemolymph](http://en.wikipedia.org/wiki/Hemolymph)) is not involved in the transport of oxygen. (Openings called [tracheae](http://en.wikipedia.org/wiki/Invertebrate_trachea) allow oxygen from the air to diffuse directly to the tissues). Insect blood moves nutrients to the tissues and removes waste products in an open system.

Other invertebrates use respiratory proteins to increase the oxygen-carrying capacity. Hemoglobin is the most common respiratory protein found in nature. [Hemocyanin](http://en.wikipedia.org/wiki/Hemocyanin) ([blue](http://en.wikipedia.org/wiki/Blue)) contains [copper](http://en.wikipedia.org/wiki/Copper) and is found in [crustaceans](http://en.wikipedia.org/wiki/Crustacean) and [mollusks](http://en.wikipedia.org/wiki/Mollusk). It is thought that [tunicates](http://en.wikipedia.org/wiki/Tunicate) (sea squirts) might use [vanabins](http://en.wikipedia.org/wiki/Vanabins) ([proteins](http://en.wikipedia.org/wiki/Protein) containing [vanadium](http://en.wikipedia.org/wiki/Vanadium)) for [respiratory pigment](http://en.wikipedia.org/wiki/Respiratory_pigment) (bright-green, blue, or orange).

In many invertebrates, these oxygen-carrying proteins are freely soluble in the blood; in vertebrates they are contained in specialized [red blood cells](http://en.wikipedia.org/wiki/Red_blood_cell), allowing for a higher concentration of respiratory pigments without increasing [viscosity](http://en.wikipedia.org/wiki/Viscosity) or damaging blood filtering organs like the [kidneys](http://en.wikipedia.org/wiki/Kidneys).

[Giant tube worms](http://en.wikipedia.org/wiki/Giant_tube_worms) have unusual hemoglobins that allow them to live in extraordinary environments. These hemoglobins also carry sulfides normally fatal in other animals.

**[**[**edit**](http://en.wikipedia.org/w/index.php?title=Blood&action=edit&section=17)**] Color**

**[**[**edit**](http://en.wikipedia.org/w/index.php?title=Blood&action=edit&section=18)**] Hemoglobin**

[](http://en.wikipedia.org/wiki/File:Bleeding_finger.jpg)

[http://bits.wikimedia.org/skins-1.5/common/images/magnify-clip.png](http://en.wikipedia.org/wiki/File:Bleeding_finger.jpg)

Capillary blood from a bleeding finger

[](http://en.wikipedia.org/wiki/File:Bloodbags.jpg)

[http://bits.wikimedia.org/skins-1.5/common/images/magnify-clip.png](http://en.wikipedia.org/wiki/File:Bloodbags.jpg)

Venous blood collected during blood donation

Hemoglobin is the principal determinant of the color of blood in vertebrates. Each molecule has four heme groups, and their interaction with various molecules alters the exact color. In [vertebrates](http://en.wikipedia.org/wiki/Vertebrate) and other hemoglobin-using creatures, arterial blood and capillary blood are bright red, as oxygen imparts a strong red color to the heme group. Deoxygenated blood is a darker shade of red; this is present in veins, and can be seen during [blood donation](http://en.wikipedia.org/wiki/Blood_donation) and when venous blood samples are taken. Blood in [carbon monoxide poisoning](http://en.wikipedia.org/wiki/Carbon_monoxide_poisoning) is bright red, because [carbon monoxide](http://en.wikipedia.org/wiki/Carbon_monoxide) causes the formation of [carboxyhemoglobin](http://en.wikipedia.org/wiki/Carboxyhemoglobin). In [cyanide](http://en.wikipedia.org/wiki/Cyanide) poisoning, the body cannot utilize oxygen, so the venous blood remains oxygenated, increasing the redness. While hemoglobin-containing blood is never blue, there are several conditions and diseases wherein the color of the heme groups make the skin appear blue. If the heme is oxidized, [methaemoglobin](http://en.wikipedia.org/wiki/Methaemoglobin), which is more brownish and cannot transport oxygen, is formed. In the rare condition [sulfhemoglobinemia](http://en.wikipedia.org/wiki/Sulfhemoglobinemia), arterial hemoglobin is partially oxygenated, and appears dark red with a bluish hue ([cyanosis](http://en.wikipedia.org/wiki/Cyanosis)).

Veins in the skin appear blue for a variety of reasons only weakly dependent on the color of the blood. Light scattering in the skin, and the visual processing of color play roles as well.[[23]](http://en.wikipedia.org/wiki/Blood#cite_note-22)

[Skinks](http://en.wikipedia.org/wiki/Skink) in the genus [*Prasinohaema*](http://en.wikipedia.org/wiki/Prasinohaema) have green blood due to a buildup of the waste product [biliverdin](http://en.wikipedia.org/wiki/Biliverdin).[[24]](http://en.wikipedia.org/wiki/Blood#cite_note-23)

**[**[**edit**](http://en.wikipedia.org/w/index.php?title=Blood&action=edit&section=19)**] Hemocyanin**

The blood of most [mollusks](http://en.wikipedia.org/wiki/Mollusks) – including [cephalopods](http://en.wikipedia.org/wiki/Cephalopods) and [gastropods](http://en.wikipedia.org/wiki/Gastropods) – as well as some [arthropods](http://en.wikipedia.org/wiki/Arthropods), such as [horseshoe crabs](http://en.wikipedia.org/wiki/Horseshoe_crab), is blue, as it contains the copper-containing protein hemocyanin at concentrations of about 50 grams per liter.[[25]](http://en.wikipedia.org/wiki/Blood#cite_note-AHC_2004_p276-7-24) Hemocyanin is colorless when deoxygenated and dark blue when oxygenated. The blood in the circulation of these creatures, which generally live in cold environments with low oxygen tensions, is grey-white to pale yellow,[[25]](http://en.wikipedia.org/wiki/Blood#cite_note-AHC_2004_p276-7-24) and it turns dark blue when exposed to the oxygen in the air, as seen when they bleed.[[25]](http://en.wikipedia.org/wiki/Blood#cite_note-AHC_2004_p276-7-24) This is due to change in color of [hemocyanin](http://en.wikipedia.org/wiki/Hemocyanin) when it is oxidized.[[25]](http://en.wikipedia.org/wiki/Blood#cite_note-AHC_2004_p276-7-24) Hemocyanin carries oxygen in [extracellular fluid](http://en.wikipedia.org/wiki/Extracellular_fluid), which is in contrast to the intracellular oxygen transport in mammals by hemoglobin in RBCs.[[25]](http://en.wikipedia.org/wiki/Blood#cite_note-AHC_2004_p276-7-24)

**[**[**edit**](http://en.wikipedia.org/w/index.php?title=Blood&action=edit&section=20)**] Pathology**

**[**[**edit**](http://en.wikipedia.org/w/index.php?title=Blood&action=edit&section=21)**] General medical disorders**

* Disorders of volume
  + [Injury](http://en.wikipedia.org/wiki/Injury) can cause blood loss through [bleeding](http://en.wikipedia.org/wiki/Bleeding).[[26]](http://en.wikipedia.org/wiki/Blood#cite_note-25) A healthy adult can lose almost 20% of blood volume (1 L) before the first symptom, restlessness, begins, and 40% of volume (2 L) before [shock](http://en.wikipedia.org/wiki/Shock_(circulatory)) sets in. [Thrombocytes](http://en.wikipedia.org/wiki/Thrombocyte) are important for blood [coagulation](http://en.wikipedia.org/wiki/Coagulation) and the formation of blood clots, which can stop bleeding. Trauma to the internal organs or bones can cause [internal bleeding](http://en.wikipedia.org/wiki/Internal_bleeding), which can sometimes be severe.
  + [Dehydration](http://en.wikipedia.org/wiki/Dehydration) can reduce the blood volume by reducing the water content of the blood. This would rarely result in [shock](http://en.wikipedia.org/wiki/Shock_(circulatory)) (apart from the very severe cases) but may result in [orthostatic hypotension](http://en.wikipedia.org/wiki/Orthostatic_hypotension) and [fainting](http://en.wikipedia.org/wiki/Fainting).
* Disorders of circulation
  + Shock is the ineffective [perfusion](http://en.wikipedia.org/wiki/Perfusion) of tissues, and can be caused by a variety of conditions including blood loss, [infection](http://en.wikipedia.org/wiki/Infection), poor [cardiac output](http://en.wikipedia.org/wiki/Cardiac_output).
  + [Atherosclerosis](http://en.wikipedia.org/wiki/Atherosclerosis) reduces the flow of blood through arteries, because atheroma lines arteries and narrows them. Atheroma tends to increase with age, and its progression can be compounded by many causes including smoking, [high blood pressure](http://en.wikipedia.org/wiki/Hypertension), excess circulating lipids ([hyperlipidemia](http://en.wikipedia.org/wiki/Hyperlipidemia)), and [diabetes mellitus](http://en.wikipedia.org/wiki/Diabetes_mellitus).
  + Coagulation can form a [thrombosis](http://en.wikipedia.org/wiki/Thrombosis), which can obstruct vessels.
  + Problems with blood composition, the pumping action of the heart, or narrowing of blood vessels can have many consequences including hypoxia (lack of oxygen) of the tissues supplied. The term *ischemia* refers to tissue that is inadequately perfused with blood, and *infarction* refers to tissue death ([necrosis](http://en.wikipedia.org/wiki/Necrosis)), which can occur when the blood supply has been blocked (or is very inadequate).

**[**[**edit**](http://en.wikipedia.org/w/index.php?title=Blood&action=edit&section=22)**] Hematological disorders**

*See also:* [*Hematology*](http://en.wikipedia.org/wiki/Hematology)

* Anemia
  + Insufficient red cell mass ([anemia](http://en.wikipedia.org/wiki/Anemia)) can be the result of bleeding, blood disorders like [thalassemia](http://en.wikipedia.org/wiki/Thalassemia), or [nutritional deficiencies](http://en.wikipedia.org/wiki/Illnesses_related_to_poor_nutrition); and may require [blood transfusion](http://en.wikipedia.org/wiki/Blood_transfusion). Several countries have [blood banks](http://en.wikipedia.org/wiki/Blood_bank) to fill the demand for transfusable blood. A person receiving a blood transfusion must have a [blood type](http://en.wikipedia.org/wiki/Blood_type) compatible with that of the donor.
  + [Sickle-cell anemia](http://en.wikipedia.org/wiki/Sickle-cell_anemia)
* Disorders of cell proliferation
  + [Leukemia](http://en.wikipedia.org/wiki/Leukemia) is a group of [cancers](http://en.wikipedia.org/wiki/Cancer_(medicine)) of the blood-forming tissues.
  + Non-cancerous overproduction of red cells ([polycythemia vera](http://en.wikipedia.org/wiki/Polycythemia_vera)) or platelets ([essential thrombocytosis](http://en.wikipedia.org/wiki/Essential_thrombocytosis)) may be [premalignant](http://en.wikipedia.org/wiki/Premalignant_condition).
  + [Myelodysplastic syndromes](http://en.wikipedia.org/wiki/Myelodysplastic_syndrome) involve ineffective production of one or more cell lines.
* Disorders of coagulation
  + [Hemophilia](http://en.wikipedia.org/wiki/Hemophilia) is a [genetic illness](http://en.wikipedia.org/wiki/Genetic_disorder) that causes dysfunction in one of the blood's [clotting mechanisms](http://en.wikipedia.org/wiki/Coagulation). This can allow otherwise inconsequential wounds to be life-threatening, but more commonly results in [hemarthrosis](http://en.wikipedia.org/wiki/Hemarthrosis), or bleeding into joint spaces, which can be crippling.
  + Ineffective or insufficient platelets can also result in [coagulopathy](http://en.wikipedia.org/wiki/Coagulopathy) (bleeding disorders).
  + Hypercoagulable state ([thrombophilia](http://en.wikipedia.org/wiki/Thrombophilia)) results from defects in regulation of platelet or clotting factor function, and can cause thrombosis.
* Infectious disorders of blood
  + Blood is an important vector of infection. [HIV](http://en.wikipedia.org/wiki/HIV), the [virus](http://en.wikipedia.org/wiki/Virus), which causes [AIDS](http://en.wikipedia.org/wiki/AIDS), is transmitted through contact with blood, semen or other body secretions of an infected person. [Hepatitis B](http://en.wikipedia.org/wiki/Hepatitis_B) and [C](http://en.wikipedia.org/wiki/Hepatitis_C) are transmitted primarily through blood contact. Owing to [blood-borne infections](http://en.wikipedia.org/wiki/Blood-borne_infection), bloodstained objects are treated as a [biohazard](http://en.wikipedia.org/wiki/Biological_hazard).
  + Bacterial infection of the blood is [bacteremia](http://en.wikipedia.org/wiki/Bacteremia) or [sepsis](http://en.wikipedia.org/wiki/Sepsis). Viral Infection is viremia. [Malaria](http://en.wikipedia.org/wiki/Malaria) and [trypanosomiasis](http://en.wikipedia.org/wiki/Trypanosomiasis) are blood-borne parasitic infections.

**[**[**edit**](http://en.wikipedia.org/w/index.php?title=Blood&action=edit&section=23)**] Carbon monoxide poisoning**

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

Substances other than oxygen can bind to hemoglobin; in some cases this can cause irreversible damage to the body. [Carbon monoxide](http://en.wikipedia.org/wiki/Carbon_monoxide), for example, is extremely dangerous when carried to the blood via the lungs by inhalation, because carbon monoxide irreversibly binds to hemoglobin to form [carboxyhemoglobin](http://en.wikipedia.org/wiki/Carboxyhemoglobin), so that less hemoglobin is free to bind oxygen, and less oxygen can be transported in the blood. This can cause suffocation insidiously. A fire burning in an enclosed room with poor ventilation presents a very dangerous hazard, since it can create a build-up of carbon monoxide in the air. Some carbon monoxide binds to hemoglobin when smoking [tobacco](http://en.wikipedia.org/wiki/Tobacco).[[*citation needed*](http://en.wikipedia.org/wiki/Wikipedia:Citation_needed)]

**[**[**edit**](http://en.wikipedia.org/w/index.php?title=Blood&action=edit&section=24)**] Medical treatments**

**[**[**edit**](http://en.wikipedia.org/w/index.php?title=Blood&action=edit&section=25)**] Blood products**

*Further information:* [*Blood transfusion*](http://en.wikipedia.org/wiki/Blood_transfusion)

Blood for transfusion is obtained from human donors by [blood donation](http://en.wikipedia.org/wiki/Blood_donation) and stored in a [blood bank](http://en.wikipedia.org/wiki/Blood_bank). There are many different [blood types](http://en.wikipedia.org/wiki/Blood_type) in humans, the [ABO blood group system](http://en.wikipedia.org/wiki/ABO_blood_group_system), and the [Rhesus blood group system](http://en.wikipedia.org/wiki/Rhesus_blood_group_system) being the most important. Transfusion of blood of an incompatible blood group may cause severe, often fatal, complications, so [crossmatching](http://en.wikipedia.org/wiki/Crossmatching) is done to ensure that a compatible blood product is transfused.

Other blood products administered [intravenously](http://en.wikipedia.org/wiki/Intravenous) are platelets, blood plasma, cryoprecipitate, and specific coagulation factor concentrates.

**[**[**edit**](http://en.wikipedia.org/w/index.php?title=Blood&action=edit&section=26)**] Intravenous administration**

Many forms of medication (from [antibiotics](http://en.wikipedia.org/wiki/Antibiotic) to [chemotherapy](http://en.wikipedia.org/wiki/Chemotherapy)) are administered intravenously, as they are not readily or adequately absorbed by the digestive tract.

After severe acute blood loss, liquid preparations, generically known as plasma expanders, can be given intravenously, either solutions of salts (NaCl, KCl, CaCl2 etc...) at physiological concentrations, or colloidal solutions, such as dextrans, [human serum albumin](http://en.wikipedia.org/wiki/Human_serum_albumin), or fresh frozen plasma. In these emergency situations, a plasma expander is a more effective life-saving procedure than a blood transfusion, because the metabolism of transfused red blood cells does not restart immediately after a transfusion.

**[**[**edit**](http://en.wikipedia.org/w/index.php?title=Blood&action=edit&section=27)**] Bloodletting**

*Main article:* [*bloodletting*](http://en.wikipedia.org/wiki/Bloodletting)

In modern [evidence-based medicine](http://en.wikipedia.org/wiki/Evidence-based_medicine), bloodletting is used in management of a few rare diseases, including [hemochromatosis](http://en.wikipedia.org/wiki/Hemochromatosis) and [polycythemia](http://en.wikipedia.org/wiki/Polycythemia). However, [bloodletting](http://en.wikipedia.org/wiki/Bloodletting) and [leeching](http://en.wikipedia.org/wiki/Leeching) were common unvalidated interventions used until the 19th century, as many diseases were incorrectly thought to be due to an excess of blood, according to [Hippocratic](http://en.wikipedia.org/wiki/Hippocrates) medicine.

**[**[**edit**](http://en.wikipedia.org/w/index.php?title=Blood&action=edit&section=28)**] History**

According to the *Oxford English Dictionary*, the word "blood" originated before the 12th century. The word is derived from Middle English, which is derived from the Old English word *blôd*, which is akin to the Old High German word *bluot*, meaning blood. The modern German word is *(das) Blut.*

**[**[**edit**](http://en.wikipedia.org/w/index.php?title=Blood&action=edit&section=29)**] Classical Greek medicine**

In classical Greek medicine, blood was associated with air, with Springtime, and with a merry and gluttonous (*sanguine*) personality. It was also believed to be produced exclusively by the [liver](http://en.wikipedia.org/wiki/Liver).

**[**[**edit**](http://en.wikipedia.org/w/index.php?title=Blood&action=edit&section=30)**] Hippocratic medicine**

In [Hippocratic](http://en.wikipedia.org/wiki/Hippocrates) medicine, blood was considered to be one of the [four humors](http://en.wikipedia.org/wiki/Four_humors), the others being [phlegm](http://en.wikipedia.org/wiki/Phlegm), [yellow bile](http://en.wikipedia.org/wiki/Yellow_bile), and [black bile](http://en.wikipedia.org/wiki/Black_bile).

**[**[**edit**](http://en.wikipedia.org/w/index.php?title=Blood&action=edit&section=31)**] Cultural and religious beliefs**

Due to its importance to life, blood is associated with a large number of beliefs. One of the most basic is the use of blood as a symbol for family relationships through birth/parentage; to be "related by blood" is to be related by ancestry or descendance, rather than marriage. This bears closely to [bloodlines](http://en.wikipedia.org/wiki/Bloodline), and sayings such as "[blood is thicker than water](http://en.wikipedia.org/wiki/Blood_is_thicker_than_water)" and "[bad blood](http://en.wikipedia.org/wiki/Bad_blood)", as well as "[Blood brother](http://en.wikipedia.org/wiki/Blood_brother)". Blood is given particular emphasis in the Jewish and Christian religions because [Leviticus](http://en.wikipedia.org/wiki/Leviticus) 17:11 says "the life of a creature is in the blood." This phrase is part of the Levitical law forbidding the drinking of blood or eating meat with the blood still intact instead of being poured off.

Mythic references to blood can sometimes be connected to the life-giving nature of blood, seen in such events as [childbirth](http://en.wikipedia.org/wiki/Childbirth), as contrasted with the blood of injury or death.

**[**[**edit**](http://en.wikipedia.org/w/index.php?title=Blood&action=edit&section=32)**] Indigenous Australians**

In many [indigenous Australian Aboriginal peoples'](http://en.wikipedia.org/wiki/Indigenous_Australians) traditions, [ochre](http://en.wikipedia.org/wiki/Ochre) (particularly red) and blood, both high in [iron](http://en.wikipedia.org/wiki/Iron) content and considered [Maban](http://en.wikipedia.org/wiki/Maban), are applied to the bodies of dancers for ritual. As Lawlor states:

In many Aboriginal rituals and ceremonies, red ochre is rubbed all over the naked bodies of the dancers. In secret, sacred male ceremonies, blood extracted from the veins of the participant's arms is exchanged and rubbed on their bodies. Red ochre is used in similar ways in less-secret ceremonies. Blood is also used to fasten the feathers of birds onto people's bodies. Bird feathers contain a protein that is highly magnetically sensitive.[[27]](http://en.wikipedia.org/wiki/Blood#cite_note-26)

Lawlor comments that blood employed in this fashion is held by these peoples to attune the dancers to the invisible energetic realm of the Dreamtime. Lawlor then connects these invisible energetic realms and [magnetic fields](http://en.wikipedia.org/wiki/Magnetic_fields), because iron is [magnetic](http://en.wikipedia.org/wiki/Magnetism).

**[**[**edit**](http://en.wikipedia.org/w/index.php?title=Blood&action=edit&section=33)**] Indo-European paganism**

Among the [Germanic tribes](http://en.wikipedia.org/wiki/Germanic_tribe) (such as the [Anglo-Saxons](http://en.wikipedia.org/wiki/Anglo-Saxons) and the [Norsemen](http://en.wikipedia.org/wiki/Norsemen)), blood was used during their sacrifices; the [*Blóts*](http://en.wikipedia.org/wiki/Bl%C3%B3t). The blood was considered to have the power of its originator, and, after the butchering, the blood was sprinkled on the walls, on the statues of the gods, and on the participants themselves. This act of sprinkling blood was called *bleodsian* in [Old English](http://en.wikipedia.org/wiki/Old_English_language), and the terminology was borrowed by the [Roman Catholic Church](http://en.wikipedia.org/wiki/Roman_Catholic_Church) becoming *to bless* and *blessing*. The [Hittite](http://en.wikipedia.org/wiki/Hittite_language) word for blood, *ishar* was a cognate to words for "oath" and "bond", see [Ishara](http://en.wikipedia.org/wiki/Ishara). The [Ancient Greeks](http://en.wikipedia.org/wiki/Ancient_Greece) believed that the blood of the gods, [*ichor*](http://en.wikipedia.org/wiki/Ichor), was a mineral that was poisonous to mortals.

**[**[**edit**](http://en.wikipedia.org/w/index.php?title=Blood&action=edit&section=34)**] Judaism**

In [Judaism](http://en.wikipedia.org/wiki/Judaism), blood cannot be consumed even in the smallest quantity ([Leviticus](http://en.wikipedia.org/wiki/Leviticus) 3:17 and elsewhere); this is reflected in Jewish [dietary](http://en.wikipedia.org/wiki/Diet_(nutrition)) laws ([Kashrut](http://en.wikipedia.org/wiki/Kashrut)). Blood is purged from [meat](http://en.wikipedia.org/wiki/Meat) by [salting](http://en.wikipedia.org/wiki/Salting_(food)) and soaking in water.

Another ritual involving blood involves the covering of the blood of [fowl](http://en.wikipedia.org/wiki/Fowl) and [game](http://en.wikipedia.org/wiki/Game) after slaughtering ([Leviticus](http://en.wikipedia.org/wiki/Leviticus) 17:13); the reason given by the [Torah](http://en.wikipedia.org/wiki/Torah) is: "Because the life of the animal is [in] its blood" (ibid 17:14).

Also if a person of the orthodox Jewish faith suffers a violent death, religious laws order the collection of their blood for burial with them.

**[**[**edit**](http://en.wikipedia.org/w/index.php?title=Blood&action=edit&section=35)**] Christianity**

*Main article:* [*Eucharist*](http://en.wikipedia.org/wiki/Eucharist)

Some Christian churches, including [Roman Catholicism](http://en.wikipedia.org/wiki/Roman_Catholic_Church), [Eastern Orthodoxy](http://en.wikipedia.org/wiki/Eastern_Orthodox_Church), [Oriental Orthodoxy](http://en.wikipedia.org/wiki/Oriental_Orthodoxy), and the [Assyrian Church of the East](http://en.wikipedia.org/wiki/Assyrian_Church_of_the_East) teach that, when consecrated, the Eucharistic wine [actually *becomes*](http://en.wikipedia.org/wiki/Transubstantiation) the blood of [Jesus](http://en.wikipedia.org/wiki/Jesus). Thus in the consecrated wine, Jesus becomes spiritually and physically present. This teaching is rooted in [the Last Supper](http://en.wikipedia.org/wiki/The_Last_Supper), as written in the four gospels of the [Bible](http://en.wikipedia.org/wiki/Bible), in which Jesus stated to his [disciples](http://en.wikipedia.org/wiki/Twelve_Apostles) that the bread that they ate was his body, and the wine was his blood. *"This cup is the new testament in my blood, which is shed for you." (*[*Luke 22:20*](http://en.wikisource.org/wiki/Bible_(King_James)/Luke#22:20)*)*.

Various forms of Protestantism, especially those of a [Wesleyan](http://en.wikipedia.org/wiki/Wesley) or [Presbyterian](http://en.wikipedia.org/wiki/Presbyterian) lineage, teach that the wine is no more than a symbol of the blood of Christ, who is spiritually but not physically present. [Lutheran](http://en.wikipedia.org/wiki/Lutheran) theology teaches that the body and blood is [present together "in, with, and under"](http://en.wikipedia.org/wiki/Consubstantiation) the bread and wine of the Eucharistic feast.

Christ's blood is also seen as the means for [atonement](http://en.wikipedia.org/wiki/Atonement_in_Christianity) for sins for Christians.

At the [Council of Jerusalem](http://en.wikipedia.org/wiki/Council_of_Jerusalem), the [apostles](http://en.wikipedia.org/wiki/Apostles) prohibited Christians from consuming blood, probably because this was a command given to [Noah](http://en.wikipedia.org/wiki/Noah) ([Genesis](http://en.wikipedia.org/wiki/Book_of_Genesis) 9:4, see [Noahide Law](http://en.wikipedia.org/wiki/Noahide_Law)). This command continued to be observed by the [Eastern Orthodox](http://en.wikipedia.org/wiki/Eastern_Orthodox).

**[**[**edit**](http://en.wikipedia.org/w/index.php?title=Blood&action=edit&section=36)**] Islam**

Consumption of food containing blood is forbidden by [Islamic dietary laws](http://en.wikipedia.org/wiki/Islamic_dietary_laws). This is derived from the statement in the [Qur'an](http://en.wikipedia.org/wiki/Qur%27an), sura [Al-Ma'ida](http://en.wikipedia.org/wiki/Al-Ma%27ida) (5:3): "Forbidden to you (for food) are: dead meat, blood, the flesh of swine, and that on which has been invoked the name of other than Allah."

Blood is considered as unclean and in Islam cleanliness is part of the faith, hence there are specific methods to obtain physical and ritual status of cleanliness once bleeding has occurred. Specific rules and prohibitions apply to [menstruation](http://en.wikipedia.org/wiki/Menstruation), postnatal bleeding and irregular vaginal bleeding.

**[**[**edit**](http://en.wikipedia.org/w/index.php?title=Blood&action=edit&section=37)**] Jehovah's Witnesses**

*Main article:* [*Jehovah's Witnesses and blood*](http://en.wikipedia.org/wiki/Jehovah%27s_Witnesses_and_blood)

Based on their interpretation of scriptures such as Acts 15:28, 29 ("Keep abstaining...from blood."), [Jehovah's Witnesses](http://en.wikipedia.org/wiki/Jehovah%27s_Witnesses) neither consume blood nor accept transfusions of whole blood or its major components: red blood cells, white blood cells, platelets (thrombocytes), and plasma. Members may personally decide whether they will accept medical procedures that involve their own blood or substances that are further fractionated from the four major components.[[28]](http://en.wikipedia.org/wiki/Blood#cite_note-27)

**[**[**edit**](http://en.wikipedia.org/w/index.php?title=Blood&action=edit&section=38)**] Chinese and Japanese culture**

In Chinese popular culture, it is often said that, if a man's nose produces a small flow of blood, this signifies that he is experiencing sexual desire. This often appears in [Chinese-language](http://en.wikipedia.org/wiki/China) and [Hong Kong](http://en.wikipedia.org/wiki/Hong_Kong) [films](http://en.wikipedia.org/wiki/Film) as well as in [Japanese](http://en.wikipedia.org/wiki/Japan) culture parodied in [anime](http://en.wikipedia.org/wiki/Anime) and [manga](http://en.wikipedia.org/wiki/Manga). Characters, mostly males, will often be shown with a [nosebleed](http://en.wikipedia.org/wiki/Epistaxis) if they have just seen someone [nude](http://en.wikipedia.org/wiki/Nude) or in little clothing, or if they have had an erotic thought or fantasy; this is based on the idea that a male's blood pressure will spike dramatically when aroused.[[29]](http://en.wikipedia.org/wiki/Blood#cite_note-28)

**[**[**edit**](http://en.wikipedia.org/w/index.php?title=Blood&action=edit&section=39)**] Blood libel**

*Main article:* [*Blood libel*](http://en.wikipedia.org/wiki/Blood_libel)

Various religious and other groups have been falsely accused of using human blood in rituals; such accusations are known as [blood libel](http://en.wikipedia.org/wiki/Blood_libel). The most common form of this is [blood libel against Jews](http://en.wikipedia.org/wiki/Blood_libel_against_Jews). Although there is no ritual involving human blood in Jewish law or custom, fabrications of this nature (often involving the murder of children) were widely used during [the Middle Ages](http://en.wikipedia.org/wiki/Middle_Ages) to justify [Antisemitic](http://en.wikipedia.org/wiki/Antisemitism) persecution.

**[**[**edit**](http://en.wikipedia.org/w/index.php?title=Blood&action=edit&section=40)**] Vampire legends**

*Main article:* [*Vampire*](http://en.wikipedia.org/wiki/Vampire)

[Vampires](http://en.wikipedia.org/wiki/Vampire) are mythical creatures that drink blood directly for sustenance, usually with a preference for human blood. Cultures all over the world have myths of this kind; for example the '[Nosferatu](http://en.wikipedia.org/wiki/Nosferatu)' legend, a human who achieves damnation and immortality by drinking the blood of others, originates from Eastern European folklore. [Ticks](http://en.wikipedia.org/wiki/Ticks), [leeches](http://en.wikipedia.org/wiki/Leeches), female [mosquitoes](http://en.wikipedia.org/wiki/Mosquito), [vampire bats](http://en.wikipedia.org/wiki/Vampire_bat), and an assortment of other natural creatures do drink blood, but only bats are associated with vampires. This has no relation to vampire bats, which are [new world](http://en.wikipedia.org/wiki/New_world) creatures discovered well after the origins of the European myths.

**[**[**edit**](http://en.wikipedia.org/w/index.php?title=Blood&action=edit&section=41)**] Applications**

**[**[**edit**](http://en.wikipedia.org/w/index.php?title=Blood&action=edit&section=42)**] In the applied sciences**

[Blood residue](http://en.wikipedia.org/wiki/Blood_residue) can help [forensic](http://en.wikipedia.org/wiki/Forensic) investigators identify weapons, reconstruct a criminal action, and link suspects to the crime. Through [bloodstain pattern analysis](http://en.wikipedia.org/wiki/Bloodstain_pattern_analysis), forensic information can also be gained from the spatial distribution of bloodstains.

Blood residue analysis is also a technique used in [archeology](http://en.wikipedia.org/wiki/Archeology).

**[**[**edit**](http://en.wikipedia.org/w/index.php?title=Blood&action=edit&section=43)**] In art**

Blood is one of the body fluids that has been used in art.[[30]](http://en.wikipedia.org/wiki/Blood#cite_note-29) In particular, the performances of [Viennese Actionist](http://en.wikipedia.org/wiki/Viennese_Actionism) [Hermann Nitsch](http://en.wikipedia.org/wiki/Hermann_Nitsch), [Franko B](http://en.wikipedia.org/wiki/Franko_B), [Lennie Lee](http://en.wikipedia.org/wiki/Lennie_Lee), [Ron Athey](http://en.wikipedia.org/wiki/Ron_Athey), [Yang Zhichao](http://en.wikipedia.org/wiki/Yang_Zhichao), and [Kira O' Reilly](http://en.wikipedia.org/wiki/Kira_O%27_Reilly), along with the photography of [Andres Serrano](http://en.wikipedia.org/wiki/Andres_Serrano), have incorporated blood as a prominent visual element. [Marc Quinn](http://en.wikipedia.org/wiki/Marc_Quinn) has made sculptures using frozen blood, including a cast of his own head made using his own blood.

**[**[**edit**](http://en.wikipedia.org/w/index.php?title=Blood&action=edit&section=44)**] In genealogy & family history**

The term, *blood*, is used in [genealogical circles](http://en.wikipedia.org/wiki/Genealogy) to refer to one's [ancestry](http://en.wikipedia.org/wiki/Ancestor), [origins](http://en.wikipedia.org/wiki/Human_evolution), and [ethnic background](http://en.wikipedia.org/wiki/Ethnic_group), as in the word, [*bloodline*](http://en.wikipedia.org/wiki/Heredity). Other terms where blood is used in a family history sense are [*blue-blood*](http://en.wikipedia.org/wiki/Nobility#.22Blue.22_blood), [*royal blood*](http://en.wikipedia.org/wiki/Royal_descent), [*mixed-blood*](http://en.wikipedia.org/wiki/Mixed-blood) and [*blood relative*](http://en.wikipedia.org/wiki/Kinship_terminology).

[Oct-1-en-3-one](http://en.wikipedia.org/wiki/Oct-1-en-3-one) ("Smel