



## 19.3 RED BLOOD CELLS

### OBJECTIVE

- Describe the structure, functions, life cycle, and production of red blood cells.

**Red blood cells (RBCs) or erythrocytes** (*e-riTH-ē-sēts*; *eryth-* = red; *-cyte* = cell) contain the oxygen-carrying protein **hemoglobin**, which is a pigment that gives whole blood its red color. A healthy adult male has about 5.4 million red blood cells per microliter ( $\mu\text{L}$ ) of blood,\* and a healthy adult female has about 4.8 million. (One drop of blood is about  $50 \mu\text{L}$ .) To maintain normal numbers of RBCs, new mature cells must enter the circulation at the astonishing rate of at least 2 million per second, a pace that balances the equally high rate of RBC destruction.

### RBC Anatomy

RBCs are biconcave discs with a diameter of 7–8  $\mu\text{m}$  (Figure 19.4a). Recall that  $1 \mu\text{m} = 1/25,000$  of an inch or  $1/10,000$  of a centimeter or  $1/1,000$  of a millimeter. Mature red blood cells have a simple structure. Their plasma membrane is both strong and flexible, which allows them to deform without rupturing as they squeeze through narrow capillaries. As you will see later, certain glycolipids in the plasma membrane of RBCs are antigens that account for the various blood groups such as the ABO and Rh groups. RBCs lack a nucleus and other organelles and can neither reproduce nor carry on extensive metabolic activities. The cytosol of RBCs contains hemoglobin molecules; these important mole-

cules are synthesized before loss of the nucleus during RBC production and constitute about 33% of the cell's weight.

### RBC Physiology

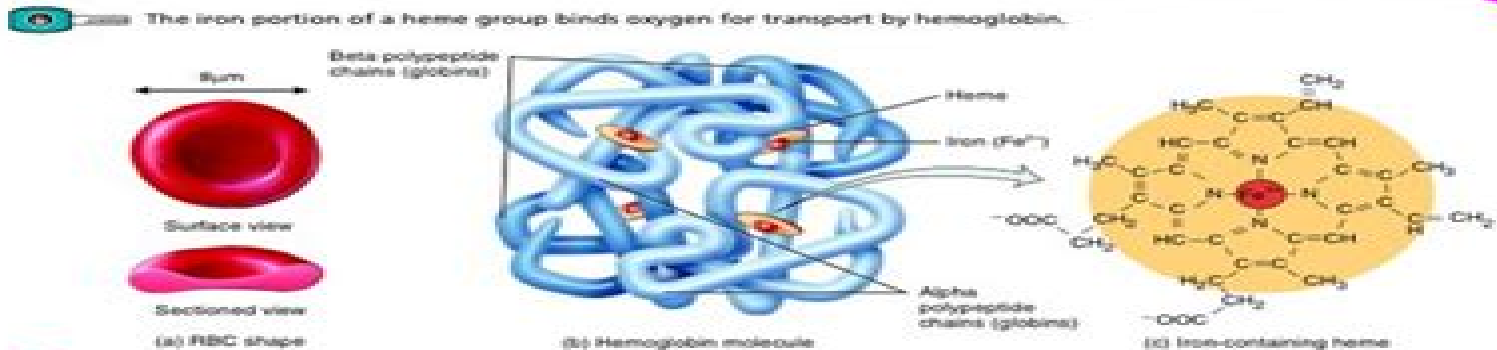
Red blood cells are highly specialized for their oxygen transport function. Because mature RBCs have no nucleus, all their internal space is available for oxygen transport. Because RBCs lack mitochondria and generate ATP anaerobically (without oxygen), they do not use up any of the oxygen they transport. Even the shape of an RBC facilitates its function. A biconcave disc has a much greater surface area for the diffusion of gas molecules into and out of the RBC than would, say, a sphere or a cube.

Each RBC contains about 280 million hemoglobin molecules. A hemoglobin molecule consists of a protein called **globin**, composed of four polypeptide chains (two alpha and two beta chains); a ring-like nonprotein pigment called a **heme** (Figure 19.4b) is bound to each of the four chains. At the center of each heme ring is an iron ion ( $\text{Fe}^{2+}$ ) that can combine reversibly with one oxygen molecule (Figure 19.4c), allowing each hemoglobin molecule to bind four oxygen molecules. Each oxygen molecule picked up from the lungs is bound to an iron ion. As blood flows through tissue capillaries, the iron–oxygen reaction reverses. Hemoglobin releases oxygen, which diffuses first into the interstitial fluid and then into cells.

Hemoglobin also transports about 23% of the total carbon dioxide, a waste product of metabolism. (The remaining carbon dioxide is dissolved in plasma or carried as bicarbonate ions.) Blood flowing through tissue capillaries picks up carbon dioxide, some of which combines with amino acids in the globin part of hemoglobin. As blood flows through the lungs, the carbon dioxide is released from hemoglobin and then exhaled.

\*  $1 \mu\text{L} = 1 \text{mm}^3 = 10^{-6} \text{ liter}$ .

**Figure 19.4** The shapes of a red blood cell (RBC) and a hemoglobin molecule. In (b), note that each of the four polypeptide chains of a hemoglobin molecule (blue) has one heme group (gold), which contains an iron ion ( $\text{Fe}^{2+}$ ), shown in red.



How many molecules of  $\text{O}_2$  can one hemoglobin molecule transport?

# **Anatomy And Physiology Chapter 19**

**Leslie Aiello, Christopher Dean**



# Anatomy And Physiology Chapter 19

**Anatomy and Physiology** J. Gordon Betts, Peter DeSaix, Jody E. Johnson, Oksana Korol, Dean H. Kruse, Brandon Poe, James A. Wise, Mark Womble, Kelly A. Young, 2013-04-25 *Anatomy & Physiology* Lindsay Biga, Devon Quick, Sierra Dawson, Amy Harwell, Robin Hopkins, Joel Kaufmann, Mike LeMaster, Philip Matern, Katie Morrison-Graham, Jon Runyeon, 2019-09-26 A version of the OpenStax text [COVID-19 and the Heart: A Case-Based Pocket Guide](#) Muhammad Saad, Timothy J. Vittorio, 2021-10-07 From frontline experts on the topic everything you need to know about COVID 19 and how it affects the heart COVID 19 s effect on the cardiovascular system continues to drive increases in morbidity and mortality Building a solid understanding of the disease spectrum is critical for accurately diagnosing treating and managing patients with heart issues in the time of COVID Written by a team of experts who worked on the frontlines in New York City throughout the worst of the pandemic COVID 19 and the Heart A Case Based Pocket Guide is a one of a kind resource for providing safe effective care for COVID 19 related heart conditions Designed for quick and easy learning and on the spot clinical decision making this practical guide is organized into chapters based on genuine clinical cases and provides the best approach for each one The authors highlight key points throughout the clinical content for easy review and provide up to date information on clinical trials vaccines diagnostic and treatment algorithms therapeutics monitoring and patient education Ideal for healthcare workers actively engaged in the ongoing pandemic and students seeking to build their expertise COVID 19 and the Heart is the go to guide to making the right clinical judgments with respect to the cardiac manifestations of COVID 19 COVID 19 and the Heart starts with the physiology of COVID related heart disease and walks you through COVID s effect on ACS Valvular heart disease Arrhythmia Pericardial disease Heart failure Shock Thromboembolism Hypertension **Vaughan & Asbury's General Ophthalmology** Paul Riordan-Eva, John P. Whitcher, 2007-11-08 The classic reference covering the diagnosis and treatment of all major ophthalmic diseases as well as neurological and systemic diseases causing visual disturbance extensively revised and updated Features State of the art coverage of diagnostic techniques and therapeutic interventions for the full range of ophthalmic disorders Chapters dedicated to ophthalmic therapeutics neuro ophthalmology ocular disorders associated with systemic diseases immunologic diseases of the eye pediatrics genetics preventive ophthalmology and lasers The latest clinical perspectives on such topics as Treatments for age related macular degeneration including anti VEGF therapies Intraocular steroid injections for retinal diseases Immunomodulatory drugs Treatment of corneal infections Medical and surgical treatments for glaucoma Detailed appendices on visual standards practical factors in illumination rehabilitation of the visually handicapped and special services available to the blind Latest references [Understanding Anatomy & Physiology](#) Gale Sloan Thompson, 2019-10-02 How do you learn A P best Whatever your learning style by reading listening or doing or a little bit of each the 3rd Edition of this new approach to anatomy physiology is designed just for you Tackle a

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reflects the clinical experiences of anesthesia experts at Harvard Medical School as well as individually known national experts in the field of anesthesiology This practical review is an invaluable resource for anesthesiologists in training and practice whether studying for board exams or as part of continuing education and ABA recertification

**The Cerebral Circulation** Marilyn J. Cipolla, 2016-07-28 This e book will review special features of the cerebral circulation and how they contribute to the physiology of the brain It describes structural and functional properties of the cerebral circulation that are unique to the brain an organ with high metabolic demands and the need for tight water and ion homeostasis Autoregulation is pronounced in the brain with myogenic metabolic and neurogenic mechanisms contributing to maintain relatively constant blood flow during both increases and decreases in pressure In addition unlike peripheral organs where the majority of vascular resistance resides in small arteries and arterioles large extracranial and intracranial arteries contribute significantly to vascular resistance in the brain The prominent role of large arteries in cerebrovascular resistance helps maintain blood flow and protect downstream vessels during changes in perfusion pressure The cerebral endothelium is also unique in that its barrier properties are in some way more like epithelium than endothelium in the periphery The cerebral endothelium known as the blood brain barrier has specialized tight junctions that do not allow ions to pass freely and has very low hydraulic conductivity and transcellular transport This special configuration modifies Starling s forces in the brain microcirculation such that ions retained in the vascular lumen oppose water movement due to hydrostatic pressure Tight water regulation is necessary in the brain because it has limited capacity for expansion within the skull Increased intracranial pressure due to vasogenic edema can cause severe neurologic complications and death

**An Introduction to Human Evolutionary Anatomy** Leslie Aiello, Christopher Dean, 1990-09-11 An anthropologist and an anatomist have combined their skills in this book to provide students and research workers with the essentials of anatomy and the means to apply these to investigations into hominid form and function Using basic principles and relevant bones conclusions can be reached regarding the probable musculature stance brain size age weight and sex of a particular fossil specimen The sort of deductions which are possible are illustrated by reference back to contemporary apes and humans and a coherent picture of the history of hominid evolution appears Written in a clear and concise style and beautifully illustrated An Introduction to Human Evolutionary Anatomy is a basic reference for all concerned with human evolution as well as a valuable companion to both laboratory practical sessions and new research using fossil skeletons

**Smith and Tanagho's General Urology, 19th Edition** Jack W. McAninch, Tom F. Lue, 2020-03-27 The definitive guide to understanding diagnosing and treating urologic disorders now in full color for the first time A Doody s Core Title for 2023 Smith Tanagho s General Urology Nineteenth Edition offers a complete overview of the diagnosis and treatment of the diseases and disorders managed by urologic surgeons This trusted classic delivers a clear concise presentation of the etiology pathogenesis clinical findings differential diagnosis and medical and surgical treatment of all major urologic conditions The well organized user friendly

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Principles of Anatomy and Physiology Gerard J. Tortora, Bryan Derrickson, 2021 *Regulation of Tissue Oxygenation, Second Edition* Roland N. Pittman, 2016-08-18 This presentation describes various aspects of the regulation of tissue oxygenation including the roles of the circulatory system respiratory system and blood the carrier of oxygen within these components of the cardiorespiratory system The respiratory system takes oxygen from the atmosphere and transports it by diffusion from the air in the alveoli to the blood flowing through the pulmonary capillaries The cardiovascular system then moves the oxygenated blood from the heart to the microcirculation of the various organs by convection where oxygen is released from hemoglobin in the red blood cells and moves to the parenchymal cells of each tissue by diffusion Oxygen that has diffused into cells is then utilized in the mitochondria to produce adenosine triphosphate ATP the energy currency of all cells The mitochondria are able to produce ATP until the oxygen tension or PO<sub>2</sub> on the cell surface falls to a critical level of about 4.5 mm Hg Thus in order to meet the energetic needs of cells it is important to maintain a continuous supply of oxygen to the mitochondria at or above the critical PO<sub>2</sub> In order to accomplish this desired outcome the cardiorespiratory system including the blood must be capable of regulation to ensure survival of all tissues under a wide range of circumstances The purpose of this presentation is to provide basic information about the operation and regulation of the cardiovascular and respiratory systems as well as the properties of the blood and parenchymal cells so that a fundamental understanding of the regulation of tissue oxygenation is achieved

**Prentice Hall Biology** Kenneth Raymond Miller, Joseph S. Levine, 2007 **Molecular Biology of the Cell**, 2002 **Essentials of Medical Physiology** K Sembulingam, Prema Sembulingam, 2012-09-30 **Anatomy & Physiology** Michael P. McKinley, Valerie Dean O'Loughlin, Theresa Stouter Bidle, 2021 Human anatomy and physiology is a fascinating subject However students can be overwhelmed by the complexity the interrelatedness of concepts from different chapters and the massive amount of material in the course Our goal was to create a textbook to guide students on a clearly written and expertly illustrated beginner's path through the human body An Integrative Approach One of the most daunting challenges that students face in mastering concepts in an anatomy and physiology course is integrating related content from numerous chapters Understanding a topic like blood pressure for example requires knowledge from the chapters on the heart blood vessels kidneys and how these structures are regulated by the nervous and endocrine systems The usefulness of a human anatomy and physiology text is dependent in part on how successfully it helps students integrate these related concepts Without this students are only acquiring what seems like unrelated facts without seeing how they fit into the whole To adequately explain such complex

concepts to beginning students in our own classrooms we as teachers present multiple topics over the course of many class periods all the while balancing these detailed explanations with refreshers of content previously covered and intermittent glimpses of the big picture Doing so ensures that students learn not only the individual pieces but also how the pieces ultimately fit together This book represents our best effort to replicate this teaching process In fact it is the effective integration of concepts throughout the text that makes this book truly unique from other undergraduate anatomy and physiology texts *Physiology in Childbearing* Dorothy Stables, Jean Rankin, 2010-04-19 This ISBN is now out of print A new edition with e book is available under ISBN 9780702044762 The third edition of this popular textbook gives a clear easy to read account of anatomy and physiology at all stages of pregnancy and childbirth Each chapter covers normal physiology changes to the physiology in pregnancy and application to practice The physiology of childbearing is placed within a total biological context drawing on evolution ecology biochemistry and cell biology Follows childbearing from preconception to postnatal care and the neonate Logical progression through the body systems Highly illustrated with simple diagrams Emphasises links between knowledge and practice to promote clinical skills Main points summarised to aid study Website 10 multiple choice questions per chapter for self testing Downloadable illustrations with and without labels Fully searchable

*Equine Reproductive Physiology, Breeding and Stud Management, 5th Edition* Mina C.G. Davies Morel, 2020-11-02 Equine Reproductive Physiology Breeding and Stud Management 5th Edition provides a thorough grounding in equine reproductive anatomy and physiology and applies it to all aspects of breeding and stud management This includes detailed coverage of the management of mares stallions and foals as well as stud management practicalities such as infertility artificial insemination and advanced reproductive techniques This textbook which has been updated throughout with additional material and references continues to provide an authoritative treatise on equine reproduction for students practising veterinary surgeons and stud managers *Biology for AP® Courses* Julianne Zedalis, John Eggebrecht, 2017-10-16 Biology for AP courses covers the scope and sequence requirements of a typical two semester Advanced Placement biology course The text provides comprehensive coverage of foundational research and core biology concepts through an evolutionary lens Biology for AP Courses was designed to meet and exceed the requirements of the College Board's AP Biology framework while allowing significant flexibility for instructors Each section of the book includes an introduction based on the AP curriculum and includes rich features that engage students in scientific practice and AP test preparation it also highlights careers and research opportunities in biological sciences

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