

The background of the cover is a photograph of a person in a canoe on a calm body of water. The person is wearing a red jacket and a white cap, and is holding a paddle. The water is still, reflecting the light from the sky. In the background, there is a large, leafy tree. The overall mood is peaceful and serene.

SECOND EDITION

HUMAN BIOLOGY

HEALTH, HOMEOSTASIS, AND
THE ENVIRONMENT



DANIEL D. CHIRAS

SECOND
EDITION

HUMAN BIOLOGY

HEALTH, HOMEOSTASIS, AND
THE ENVIRONMENT



DANIEL D. CHIRAS

UNIVERSITY OF DENVER



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*To my wife Kathleen
and my two boys Skyler and Forrest
with love, affection,
and gratitude*



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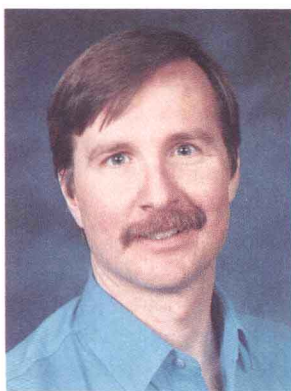
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ABOUT THE AUTHOR



DR. CHIRAS received his Ph.D. in reproductive physiology from the University of Kansas Medical School in 1976 where his research on ovarian physiology earned him the Latimer Award. In September 1976, Dr. Chiras joined the Biology Department at the University of Colorado in Denver in a teaching and research position. Since then, he has taught numerous undergraduate and graduate courses, including general biology, cell biology, histology, endocrinology, and reproductive biology. Dr. Chiras also has a strong interest in environmental issues and has taught a variety of courses on the subject.

Currently an adjunct professor at the University of Colorado in Denver and at the University of Denver, Dr. Chiras has also been a visiting professor at the University of Washington where he taught environmental science. Currently, most of his time is spent writing books and articles and lecturing on a variety of topics, including ways to build a sustainable society.

Dr. Chiras is the author of numerous technical publications on ovarian physiology, critical thinking, sustainability, and environmental education, which have appeared in the *American Biology Teacher* and other journals. He has also written numerous articles for newspapers and magazines on environmental issues. He is the author of the environment section for World Book Encyclopedia's annual publication, *Science Year*, and wrote the environment article in *Encyclopedia Americana*.

Dr. Chiras has published five college and high school textbooks, including *Biology: The Web of Life* and *Environmental Science: Action for a Sustainable Future*. He is the coauthor of *Natural Resource Conservation: An Ecological Approach* (with Oliver S. Owen). Dr. Chiras's high school textbook, *Environmental Science: A Framework for Decision Making*, was selected as the official book of the Academic Decathlon, a nationwide competition involving thousands of American high school students in over 3000 schools.

Dr. Chiras's books for general audiences include *Beyond the Fray: Reshaping America's Environmental Response* and *Lessons from Nature: Learning to Live Sustainably on the Earth*, which outlines ways to apply ecological principles to create a sustainable society. He has also recently published *Study Skills for Science Students*, and a collection of articles entitled *Readings in Human Biology*, which are available from West Publishing Company.

In addition to writing, teaching, and lecturing, Dr. Chiras plays an active role in the environmental movement. He is founder and president of the Sustainable Futures Society in Evergreen, Colorado. Dr. Chiras currently serves as an editor of *Environmental Carcinogenesis and Ecotoxicology Reviews*. Besides his active scientific and environmental pursuits, Dr. Chiras is an avid kayaker, skier, bicyclist, and organic gardener. He and his wife and two sons live in Evergreen, Colorado, overlooking the snowcapped Rocky Mountains.



Human Biology: Health, Homeostasis, and the Environment is written for the introductory human biology course in biology. This book explores the biology of human beings. It examines the marvelous architecture of cells, tissues, and organs that make up our bodies. And, it examines how these components function. The central theme of this book is homeostasis—a kind of internal balancing act that is vital for our survival. Through numerous examples, I show that human health is dependent on properly functioning homeostatic mechanisms. These, in turn, are dependent on living in a “healthy” environment.

Organization

Human Biology is divided into five parts. Part I outlines basic biological and chemical principles vital to your understanding of the human organism. Part I closes with a discussion of science and the scientific method and introduces critical thinking skills that are applied throughout the book.

Part II lays additional groundwork for understanding life as we journey through the world of the cell. The chapters in this section describe the structure and function of cells and show how cells divide and how they acquire energy. Basic principles of genetics and the fascinating, but controversial, topic of genetic engineering are also described.

Part III outlines the structure and function of human beings. The chapters in this section describe how the major organ systems operate. Homeostasis is emphasized in these chapters as a unifying principle of biology.

Part IV discusses reproduction and development. These chapters outline the evolution, structure, and function of reproductive systems in animals and portray the dramatic events that lead to the formation of new individuals.

Finally, Part V focuses on the big picture. It looks at evolution—how we got here—and basic principles of ecology, the study of ecosystems. The final chapter surveys the problems modern society has created in the natural world and offers solutions for redirecting human society onto a sustainable course—one that ensures well-functioning homeostatic mechanisms.

Special Features

Human Biology is a user-friendly book. The material is presented in a friendly style. Complex subjects are simplified

somewhat, and numerous analogies are used to make material more meaningful. For the most part, this book concentrates on basic information—key facts and concepts essential to students of human biology. You will find numerous examples that are not only relevant, but also fascinating. I’ve attempted to hold terminology down wherever possible and provided pronunciations for virtually all terms. This book is enhanced by numerous features listed below.

Study Skills

Immediately following the preface is a brief list of study skills—tips on ways students can improve their memory, get more out of what they read, take better notes, and improve their test-taking abilities. The study skills are designed to help you become more efficient and more successful in this and every other course students will take. Many of the tips will be extremely useful later in life as well. A more detailed coverage of this subject is available in *Study Skills for Science Students*, also published by West.

Scientific Discoveries That Changed the World

Science is as much a body of facts as it is a process of discovery. Many great discoveries have been made over the years. I’ve included numerous essays that highlight important breakthroughs such as the discovery of the structure of DNA. These features highlight the work of some of the world’s most important scientists. These essays help illustrate how scientific discoveries have changed our view of the world and help further students’ understanding of the scientific method. Finally, these case studies illustrate the fact that scientific advances usually require the work of many scientists, sometimes working in seemingly unrelated areas.

Health Notes

The Health Notes included in many of the chapters present some of the more exciting developments in health and medicine. These essays describe advances in medicine—for example, new procedures or discoveries that could revolutionize modern medicine. They also offer practical advice on preventing diseases through stress management, exercise, and proper diet.

Point/Counterpoints

Many discoveries in biology have had profound impacts on our lives. Today, however, new discoveries often result in controversial applications such as genetic engineering or fetal cell transplantation. This book presents a number of modern-day controversies in the Point/Counterpoint sections. Some debate social and political issues that require a good biological background and others focus on scientific debates.

Each Point/Counterpoint consists of two brief essays written by distinguished writers and thinkers. These essays present opposing views on such important issues of our times as genetic engineering, fetal cell transplantation, cancer, and global warming. Point/Counterpoints also offer students a chance to practice critical thinking skills.

Critical Thinking Skills

As noted earlier, Chapter 1 presents a number of “rules” for improving critical thinking skills. These guidelines will help students become more discerning thinkers, a skill that could prove useful in this and many other college courses—not to mention the benefit it will have in later life.

Additional emphasis is placed on critical thinking throughout the text. Each chapter, for example, contains a Thinking Critically exercise. This exercise at the beginning of the chapter outlines a problem or presents the results of a study and asks students to apply their critical thinking skills. A brief solution is offered at the end of the chapter.

As in the last edition, I’ve also included an Exercising Your Critical Thinking Skills at the end of each chapter. These exercises also call on students to use their critical thinking skills and include case studies, hypothetical scenarios, or summaries of news or scientific reports. Each exercise emphasizes one or two of the critical thinking rules presented in the first chapter. Critical thinking questions are also included after each Point/Counterpoint.

Health, Homeostasis, and the Environment Sections

The health of the Earth’s organisms and the environment in which they live are closely connected. To illustrate these connections, each chapter concludes with a Health, Homeostasis, and the Environment section. These describe the importance of homeostasis and demonstrate some of the ways in which the physical and chemical environments affect our health by upsetting homeostasis.

In-Text Summaries

To help students learn key concepts, virtually all chapter section heads are written as summary statements. These statements capture key concepts presented in the material that follows. These in-text summaries provide students a way to review major concepts in preparation for exams.

Concept Maps

This edition hosts yet another feature designed to help students grasp the major concepts of biology: Concept Maps. These diagrams illustrate key concepts and how they are linked to one another. Most chapters contain 1–2 concept maps. Students are encouraged to make their own maps as they study to increase their understanding of the material.

End-of-Chapter Summaries

At the end of each chapter is a fairly detailed summary of the material covered in the chapter. Students can use the chapter headings to glean key concepts and the summary to review the most important factual information presented in the chapter. The in-text summaries, detailed end-of-chapter summaries, and extensive questions (discussed below) should provide an excellent study guide.

Summary Tables

To help students summarize key concepts, processes, and systems, I have included summary tables in many chapters. Students can use these tables to prepare for exams or to review material after reading the chapter.

Test of Terms

To help students review key terminology in each chapter, a test of terms has been included at the end of the book in the Study Supplement. Tests of terms contain fill-in-the-blank questions and can be used to assess one’s understanding of the material presented in the chapter. Students can fill in the blanks immediately after reading the chapter or after they have spent some time studying the material. Students may find it useful to review the questions before tests.

Test of Concepts

Each chapter also contains a number of brief essay questions that enable students to assess their understanding of the material. These questions go beyond the regurgitation of facts in the test of terms.

Art Program

This book contains a remarkable collection of drawings and photographs. These colorful illustrations supplement the text and make the more complex concepts and processes understandable.

A Note to Instructors: Supplements

To help you teach this course, West Publishing Company, Professor Robert Hollenbeck at Metropolitan State College, and I have developed a supplement package that includes an instructor’s guide, a computer test bank, study skills book, a

collection of readings, transparencies, transparency masters, slides, and videos.

Instructor's guide. An instructor's guide is available from West Publishing Company. The instructor's guide contains a summary of each chapter in the text. It also includes teaching tips, food for thought, key terms, and suggested films and videos. We've also included multiple-choice, fill-in-the-blank, matching, and essay questions.

Computerized testing. The test bank is also available on computer disk. Contact your West sales representative for details.

Study Skills book. West recently published *Study Skills for Science Students* by Dr. Chiras. This book offers a wealth of ideas on ways to improve study habits and skills. *Study Skills* offers practical tips on note-taking, test-taking, reading efficiency, and concept-mapping, using computer software (tutorials), and much more. It's a must for every college student. This book is available free of charge to adopters. Contact your West sales representative for details.

Readings. West offers free of charge *Readings in Human Biology*, a collection of articles from *Science News*, *Discover*, *Scientific American*, and other magazines. These articles cover new scientific findings and in-depth looks at important topics such as breast cancer, genetics and cancer, heart disease, and nutrition. This collection, edited by Dr. Chiras, is annotated and cross-referenced to the text. Critical thinking questions are also included.

Acetates and slides. A set of acetates of key full-color art pieces and a slide set with other important pieces of art and photographs from the text are available from the publisher for adopters.

Videos. West Publishing offers a video library of films that adopters of the text may wish to use in their classes. Contact your local West sales representative for further information.

It should be noted that rather than publishing an accompanying study guide, we have integrated the materials typically found in a study guide into the book itself. This not only saves students time and money, but also makes the book a better learning tool.

Acknowledgments

A project of this magnitude is the fruit of a great many people. I wish to thank the thousands of scientists and teachers who have contributed to our understanding of human biology. A special thanks to the extraordinary teachers who have made tremendous contributions to my education, especially the late Weldon Spross, Edward Evans, Dr. H. T. Gier, Dr. Gilbert Greenwald, Dr. Floyd Foltz, Dr. Howard Matzke, and Dr. Douglas Poorman.

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Thanks also to the many authors who contributed the Point/Counterpoints in this book. Your work will make this a more exciting journey for students as they begin to appreciate different perspectives of crucial issues.

Throughout this time, my wife, Kathleen, and our two delightful sons, Skyler and Forrest, have offered considerable support and a counterbalance to the stresses and strains of a project of this magnitude. You're the light of my life. Thanks, too, to my friend Dale Whitney-Boyd for her friendship and inspiration.

Finally, a special thanks to all the reviewers who offered many useful comments throughout this project. Their insights and attention to detail have been greatly appreciated. Below is a list of those who have reviewed the manuscript for the first and second editions.

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College is a demanding time in the lives of many students. Term papers, tests, reading assignments, and classes require a new level of commitment and intellectual activity. The work load can become overwhelming and frustrating. Fortunately, there are ways to lighten the load, to manage your time efficiently, to increase your chances of getting good grades, and to improve your knowledge and understanding.

In this section I offer some suggestions to help you manage your studies and improve your mastery of the subjects you study. If you already are adept and efficient at studying and taking tests, you may still benefit from reading this section. Every suggestion you can use to your advantage will help.

To begin, read over the suggestions listed below. Pick a few that seem right for you under each category, then put them into action. Applying these ideas could pay huge dividends—not just in college, but throughout your entire life. Learning is a lifetime endeavor, and those that learn fastest seem to get the most out of life.

Mastering basic study skills will require some work at first and may require you to break some bad habits. In the long run, the additional time investment could save you lots of time, help you get better grades, and make you a more efficient learner. Most important, it could help you improve your knowledge and understanding.

General Study Skills

- Study in a quiet, well-lighted space.
- Work at a desk or table. Don't lie on a couch or bed.
- Establish a specific time each day to study and stick to your schedule.
- Study when you are most alert. Many people find they retain more if they study in the evening a few hours before bedtime.
- Let your friends and family know when you study and ask them to respect that time.
- Take frequent breaks—one every hour or so. Exercise or move around during your study breaks to help you stay alert.
- Reward yourself after a study session with an ice cream cone or a mental pat on the back.
- Study each subject every day to avoid cramming for tests. Some courses may require more hours than others, so adjust your schedule accordingly.
- Look up new terms or words that are unclear to you in the glossaries in your textbooks or in a dictionary.

Improving Your Memory

You can improve your memory by following the PMC method. The PMC method involves three simple learning steps: (1) paying attention, (2) making information memorable, and (3) correlating new information with facts you already know.

- Step 1.* Paying attention means taking an active role in your education—taking your mind out of neutral. Eliminate distractions when you study. Review what you already know and formulate questions about what you are going to learn *before* a lecture or *before* you read a chapter in the text. Reviewing and questioning help prime the mind.
- Step 2.* Making information memorable means finding ways to help you retain information in your memory. Repetition, mnemonics, and rhymes are three examples.

- Repetition can help you remember things. The more you hear or read something, the more likely you are to remember it. Scribble notes while you read or study.
- You can also use learning tools, such as mnemonics to remember lists. For example, *keep piling chocolate on for goodness* helps you remember the taxonomic classification scheme: kingdom, phylum, class, order, family, genus, and species.
- Rhymes and sayings are also helpful. If you are having trouble remembering a list of facts, try making up a rhyme.
- If you're having trouble remembering key terms, look up their roots in the dictionary. This fixes them in your memory. Use the list of prefixes, suffixes, and roots on the back endsheets of this book.
- Draw pictures and diagrams of processes.

Step 3. Correlating with things you know means typing facts together or making sense of the bits and pieces of information you are learning and have learned previously.

- Instead of filling your mind with disjointed facts and figures, try to see how they relate to previous information you have learned. Stop and scan your memory for similar facts. Correlating facts with previous knowledge enables you to comprehend the big picture. The end-of-chapter questions in this and other textbooks will assist you in this function.
- After studying your notes or reading a chapter in your textbook, determine the main points. How does the new infor-

mation you have learned fit into your view of life or the general subject under discussion? How can you use the information?

Becoming a Better Note Taker

- Spend 5–10 minutes before each lecture reviewing the material you learned in the previous lecture. This is extremely important for learning.
- Know the topic of each lecture *before* you enter the class. Spend a few minutes *before* each class reflecting on facts you already know about the subject that is to be discussed.
- If possible, read the text *before* each lecture. If not, at least look over the main headings in the chapter, read the topic sentences, and look over the figures.
- Develop a shorthand system of your own. Symbols such as = (equals), w/o (without), w (with), > (greater than), < (less than), ↑ (increase), and ↓ (decrease) can save you time and prevent you from missing important information in a lecture.
- Develop special abbreviations. For example, if you find yourself writing the word *human* over and over again in your notes, abbreviate it to “H.” Muscle could be abbreviated as “m” or “mm.” Species is sometimes abbreviated “sp.”
- Omit vowels and abbreviate words to decrease writing time (for example: omt vwls shrten wrtng tme). This takes some practice.
- Don’t take down every word your professor says, but be sure your notes contain the main points, supporting information, and important terms.
- Watch for signals from your professor indicating important material (“This is an extremely important point...”).
- If possible, sit near the front of the class to avoid distractions.
- Review your notes soon after lecture while they’re still fresh in your mind. Be sure to leave room in your notes during class to add material you missed. Recopy your notes if you have the time.
- Compare your notes with those of your classmates to be sure you understood everything and did not miss anything important.
- Attend lectures regularly.
- Use a tape recorder, if necessary and if it’s acceptable to your professor, if you have trouble catching all the points.
- If your professor talks too quickly, politely ask him or her to slow down.
- If you are unclear about a point, ask during class. Chances are other students are confused as well. If you are too shy, go up after lecture and ask, or visit your professor during his or her office hours.

How to Get the Most Out of What You Read

- Before you read a chapter or other assigned readings, preview the material by reading the main headings or chapter outline to see how the material is organized.
- Pause over each heading and ask a question or two about each main heading.

- Next, read the first sentence of each paragraph. When you have finished, turn back to the beginning of the chapter and read it thoroughly.
- Take notes in the margin or on a separate sheet of paper. Underline or highlight key points.
- Don’t skip terms that are confusing to you. Look them up in the glossary in the back of your textbook or in a dictionary. Make sure you understand each term before you move on.
- Use the study aids in your textbook, including end-of-chapter questions and summaries. Don’t just look over the questions and say, “Yeah, I know that.” Write out the answer to each question as if you were turning it in for a grade and save your answers for later study. Look up answers to questions that confuse you. This book has questions that test your understanding of the terms, concepts, and processes. Critical thinking questions are also included to help you sharpen your critical thinking skills.

Preparing for Tests

- Don’t fall behind on your reading assignments. Review lecture notes as frequently as possible during the semester.
- If you have the time, you may want to outline your notes and your assigned readings. Try to prepare the outline with your book and notes closed. Determine weak areas, then go back to your text or class notes to study those areas.
- Space your study to avoid cramming. One week before your exam, go over all of your notes. Study for two nights, then take a day off. Study again for a couple of days. Take another day off, then make one final push before the exam, being sure to study not only the facts and concepts, but also how the facts are related. Unlike cramming, which puts a lot of information into your brain for a one-time event, spacing will help you retain information for the test and for the rest of your life.
- Be certain you can define terms and give examples of how they are used.
- Draw key structures over and over until they stick in your memory.
- You may find it useful to prepare flash cards to review terms and concepts.
- After you have studied your notes and learned the material, look at the big picture—the importance of the knowledge and how the various parts fit together.
- You may want to form a study group to discuss what you are learning and to test one another.
- Attend review sessions offered by your instructor or by your teaching assistant. Study before the review session and go to the session with questions.
- See your professor or class teaching assistant with questions as they arise.
- Take advantage of free or low-cost tutoring offered by your school or, if necessary, hire a private tutor to help you through difficult material. Get help quickly, though. Don’t wait until you are way behind. Remember that learning is a two-way street. A tutor won’t help unless you are putting in the time.

- If you are stuck on a concept, it may be that you missed some important previous material. Look back over your notes or ask your tutor or professor what facts might be missing and causing you to be confused.
- If you have time, write and take your own tests. Include all types of questions.
- Study tests from previous years, if they are available legally.
- Determine how much of a test will come from notes and how much will come from the textbook.

Concept Mapping

- Study Concept Maps presented in the reading material.
- Prepare your own Concept Maps of lecture notes as well as reading material.
- Consult Concept Maps in study guides or textbooks after you've finished yours to compare your organization with the author's and to see if you've omitted any important concepts, facts, or relationships.
- In designing your own Concept Maps, begin with the more general concepts at the top of the map. More specific concepts are listed below. Concepts of equal weight are listed on the same line.
- Enclose all concepts in boxes or circles and connect them with lines that indicate the relationship. Horizontal lines show the relation of concepts on the same level. Vertical

lines connect general to specific concepts. Include a few words to explain the linkage.

- As you make Concept Maps, you'll find that you can make very simple ones that grasp key concepts, and that these maps can then be refined by adding more detail.

Taking Tests

- Eat well and get plenty of exercise and sleep before tests.
- Remain calm during the test by deep breathing.
- Arrive at the exam early or on time.
- If you have questions about the wording of a test question, ask your professor. Don't be shy.
- Look over the entire test first so you can budget your time.
- Skip questions you can't answer right away and come back to them at the end of the session if you have time.
- Read each question carefully and be sure you understand its full meaning before you answer it.
- For essay questions and definitions, organize your ideas on a piece of scrap paper or the back of the test *before* you start writing.

Now take a few moments to go back over the list. Check off those things you already do. Then, mark the new ideas you want to incorporate into your study habits. Make a separate list, if necessary, and post it by your desk or on the wall and keep track of your progress. Good luck!

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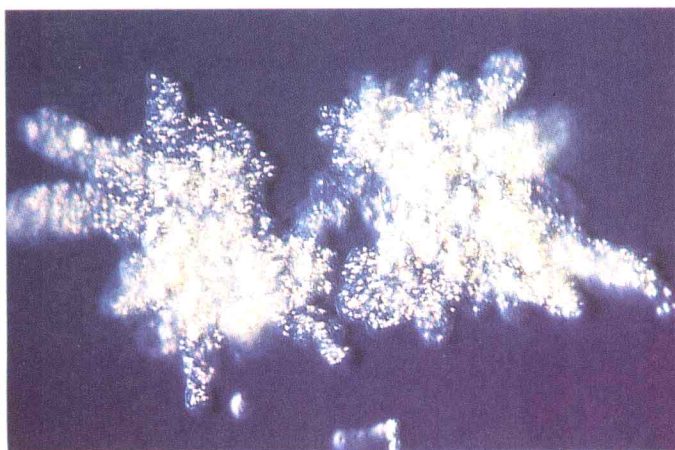
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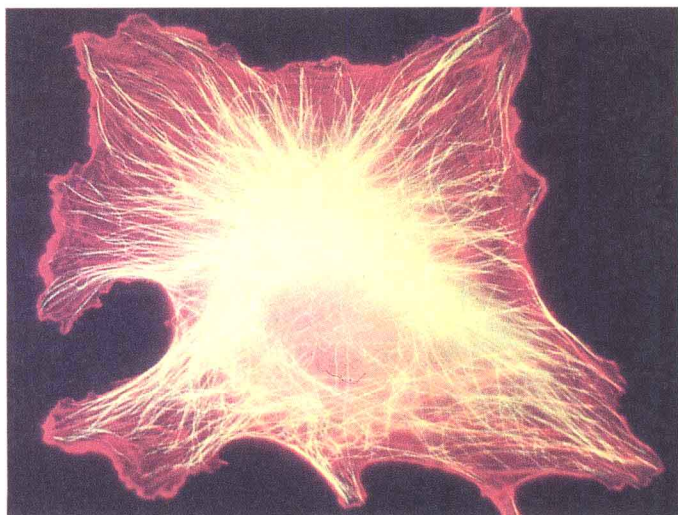
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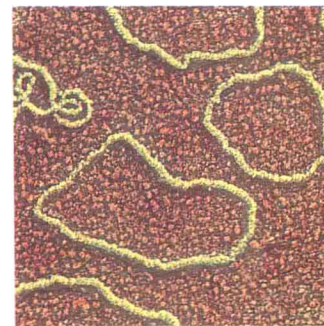
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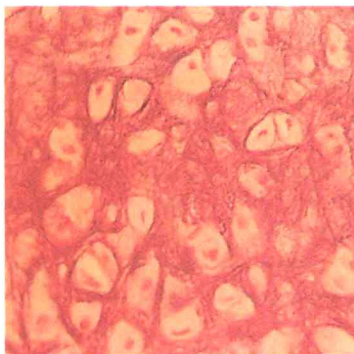
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