To Maggie, the love of my life.
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Welcome to the Ninth Edition of Biopsychology! This edition builds on the strengths of its predecessors, but it also takes important new steps: In addition to covering many new cutting-edge research topics, it sharpens its focus on the human element of biopsychology and on promoting student thinking. Most importantly, this is the first edition of Biopsychology to focus on epigenetics. It introduces this new field, summarizes current knowledge, and most importantly stresses the relevance of epigenetic concepts to issues of human brain and behavior.

The Ninth Edition of Biopsychology is a clear, engaging introduction to current biopsychological theory and research. It is intended for use as a primary text in one- or two-semester courses in biopsychology—variously titled Biopsychology, Physiological Psychology, Brain and Behavior, Psychobiology, Behavioral Neuroscience, or Behavioral Neurobiology.

The defining feature of Biopsychology is its unique combination of biopsychological science and personal, reader-oriented discourse. It is a textbook that is “un-textbooklike.” Instead of presenting the concepts of biopsychology in the usual textbook fashion, it addresses students directly and interweaves the fundamentals of the field with clinical case studies, social issues, personal implications, useful metaphors, and memorable anecdotes.

Key Features Maintained in the Ninth Edition

The following are features that have characterized recent editions of Biopsychology and have been maintained or expanded in this edition.

**Emphasis on Broad Themes** The emphasis of Biopsychology is “the big picture.” Four broad themes are highlighted throughout the text by distinctive tabs: (1) thinking creatively, (2) clinical implications, (3) evolutionary perspective, and (4) neuroplasticity. A Themes Revisited section at the end of each chapter briefly summarizes how each theme was developed in that chapter. The four major themes provide excellent topics for essay assignments and exam questions.

**Effective Use of Case Studies** Biopsychology features many carefully selected case studies, which are highlighted in the text. These provocative cases stimulate interest, promote retention, and allow students to learn how biopsychological principles apply to the diagnosis and treatment of brain disorders.

**Remarkable Illustrations** The illustrations in Biopsychology are special. Each one was conceptualized and meticulously designed to clarify and reinforce the text by a uniquely qualified scientist–artist team: Pinel and his artist/designer wife, Maggie Edwards.

**Focus on Behavior** In some biopsychological textbooks, the coverage of neurophysiology, neurochemistry, and neuroanatomy subverts the coverage of behavioral research. Biopsychology gives top billing to behavior: It stresses that neuroscience is a team effort and that the unique contribution made by biopsychologists to this effort is their behavioral expertise.

**Emphasis on the Scientific Method** Biopsychology emphasizes the scientific method. It portrays the scientific method as a means of answering questions that is applicable in daily life as in the laboratory. And Biopsychology emphasizes that being a scientist is fun.

**Discussion of Personal and Social Implications** Several chapters of Biopsychology—particularly those on eating, sleeping, sex, and drug addiction—carry strong personal and social messages. In these chapters, students are encouraged to consider the relevance of biopsychological research to their lives outside the classroom.

**Engaging, Inspiring Voice** Arguably the strongest pedagogical feature of Biopsychology is its personal tone. Pinel addresses students directly and talks to them with warmth, enthusiasm, and good humor about recent advances in biopsychological science. Many students report being engaged and inspired by this approach.

Additions to the Ninth Edition

Four new or expanded features appear in the Ninth Edition of Biopsychology.

**NEW! Chapter-Opening Study Objectives** Each chapter begins with a list of study objectives designed to direct students’ reading and studying.
NEW! Blog-On!  *Biopsychology* now comes with an accompanying author-run blog and website (www.biopsyc.com). The blog contains discussions of exciting new biopsychological research and theoretical issues not covered in the text. In addition to the blog, the website also contains a wide variety of links and materials to help students in their studying.

NEW! Even More MyPsychLab (www.mypsychlab.com)  MyPsychLab is an online study resource that offers a wealth of animations and practice tests as well as additional study and research tools. This edition adds even more exciting content to MyPsychLab for students.

NEW! More Illustrations and Brain Images  Building on *Biopsychology*’s strong art package, a number of new illustrations and brain images have been added. These have been carefully selected, designed, and positioned to support interest, clarity, and memorability.

New Coverage in the Ninth Edition  
*Biopsychology* remains one of the most rapidly progressing scientific fields. Like previous editions, the Ninth Edition of *Biopsychology* has meticulously incorporated recent developments in the field—it contains more than 750 citations of articles or books that did not appear in the preceding edition. These recent developments have dictated changes to many parts of the text. The following list presents some of the content changes to this edition, organized by chapter.

**Chapter 1: Biopsychology as a Neuroscience**  
- 3 new citations

**Chapter 2: Evolution, Genetics, and Experience**  
- New section on epigenetics  
- A figure illustrating and emphasizing epigenetic mechanisms  
- Summary of important recent discoveries of hominin fossils  
- New summary of the human genome project, emphasizing the small number of human genes  
- Clear statement of the failure to find major links between genes and neurological disorders  
- Updated coverage of heritability estimates  
- 50 new citations

**Chapter 3: Anatomy of the Nervous System**  
- Updated coverage of glial function  
- 15 new citations

**Chapter 4: Neural Conduction and Synaptic Transmission**  
- Simplified explanation of the resting potential  
- Recent discovery that action potentials originate in the axon initial segment  
- Role of glia in synaptic transmission  
- Additional coverage of gap junctions  
- 22 new citations

**Chapter 5: The Research Methods of Biopsychology**  
- Use of PET to determine the distribution in the brain of particular molecules  
- Introduction of diffusion tensor imaging with a new illustration  
- Simplified coverage of reversible brain lesions  
- Updated coverage of gene replacement  
- 19 new citations

**Chapter 6: The Visual System**  
- Simplified coverage of the organization of neurons in the primary visual cortex  
- Explanation of the role of context on the responses of visual neurons  
- Improved discussion of dorsal and ventral streams  
- Comparison of MT and fusiform face area  
- 24 new citations

**Chapter 7: Mechanisms of Perception: Hearing, Touch, Smell, Taste, and Attention**  
- Updated coverage of primary auditory cortex  
- Statement of the role of cutaneous receptors in particular sensations  
- More comparisons of auditory and visual cortex  
- Discussion of rubber-hand illusion and bimodal neurons  
- Improved coverage of the olfactory system  
- Updated and clearer coverage of the gustatory system  
- Updated coverage of attention  
- 62 new citations

**Chapter 8: The Sensorimotor System**  
- Shorter but clearer coverage of contralateral neglect  
- Recent research on mirror neurons  
- Discussion of evidence for mirror neurons in humans  
- Updated discussion of functions of the cerebellum  
- Simplified discussion of functional brain imaging studies of sensorimotor learning  
- 37 new citations

**Chapter 9: Development of the Nervous System**  
- Updated description of increased cell fate specification and related stem cell terminology
Preface

• New description of interaction of glial and neural development
• Discovery that radial glial cells develop into neurons
• Overall editing designed to shorten and simplify
• 59 new citations

Chapter 10: Brain Damage and Neuroplasticity

• Definition of gliomas
• Improved coverage of strokes
• Updated discussion of genetic factors and neurological disorders
• Introduction of the term absence seizures
• More concise coverage of the etiology of multiple sclerosis
• Concise summary of genes linked to Alzheimer’s disease
• Role of microbleeds in Alzheimer’s disease
• Importance of early diagnosis in the treatment of Alzheimer’s disease
• Improved coverage of MPTP model
• Revised coverage of recovery of function
• Neurotransplantation is revised, updated, and out in a historical perspective
• 95 new citations

Chapter 11: Learning, Memory, and Amnesia

• Tightened up coverage of HM
• New discussion of transient global amnesia
• Tightened up and updated discussion of consolidation
• New section on evolving perspectives of the role of the hippocampus in memory
• New section on neurons of the medial temporal lobes and memory
• Updated coverage of place cells and grid cells
• Introduction and focus on Jennifer Aniston neurons
• Tightened up coverage of LTP
• 35 new citations

Chapter 12: Hunger, Eating, and Health

• Shortened and simplified by aggressive editing
• 10 new citations

Chapter 13: Hormones and Sex

• New section on the modern perspective of sex differences in the brain
• New section on development of sex differences in human behavior
• Discussion of sex differences in susceptibility to disease
• Updated coverage of anabolic steroid use
• New coverage of human sexual arousal and the brain
• 56 new citations

Chapter 14: Sleep, Dreaming, and Circadian Rhythms

• Updated coverage of the relationship between REM sleep and dreaming
• Circadian activity cycles of SCN neurons
• 33 new citations

Chapter 15: Drug Addiction and the Brain’s Reward Circuits

• International statistics of drug use
• Increased coverage of the therapeutic effects of THC
• Increased coverage of the effects of MDMA
• Updated description of the treatment of heroin addiction
• Section on critical thinking about illegal drugs
• Major revision of discussion of early theories of addiction
• Major update of current approaches to the study of addiction
• 102 new citations

Chapter 16: Lateralization, Language, and the Split Brain

• Discussion of the interactions between the hemispheres of split brains
• Current status of the theory that right hemispheres are specialized for emotion
• Update of research on neuroanatomical asymmetries in the brain
• Improved coverage of the motor theory of speech perception
• 24 new citations

Chapter 17: Biopsychology of Emotion, Stress, and Health

• Chapter reorganized by moving Stress and Health to the end
• Reference to bullying
• Updated and simplified coverage of the neural mechanisms of emotion
• New section on current perspectives of neural mechanism of human emotion
• New description of the immune system
• 45 new citations

Chapter 18: Biopsychology of Psychiatric Disorders

• Introduction of the anticipated DSM-V and the need for continual refinement of diagnoses
• New section on the current research and treatment of schizophrenia
• Updated coverage of treatments for depression
• Updated discussion of the monoamine theory of depression
• New description of the neuroplasticity theory of depression
• Discussion of current treatments for anxiety
• Discussion of problems with current system of diagnosis
Themes Revisited

- Introduction to the idea that pharmaceutical companies suppress negative findings
- 60 new research citations

Pedagogical Learning Aids

Biopsychology has several features expressly designed to help students learn and remember the material:

- **Scan Your Brain** study exercises appear within chapters at key transition points, where students can benefit most from pausing to consolidate material before continuing.

```
Scan Your Brain

If you have not previously studied the gross anatomy of the brain, your own brain is probably staring under the burden of new terms. To determine whether you are ready to proceed, scan your brain by filling in the following intellectual view of a real human. You may find it challenging to match your internal diagram to a photograph of a real brain.

The correct answers are provided at the end of the exercise. Before proceeding, review material related to your scans and scan here. Notice that Figure 3.29 includes all the brain anatomy terms that have appeared in bold type in this section and thus is an excellent review tool.
```

- **Think about It** discussion questions at the end of each chapter challenge students to think critically and creatively about the content.

- **Check It Out** demonstrations apply biopsychological phenomena and concepts for students to experience themselves.

```
Check It Out

The Position of Eyes

Here you see three animals whose eyes are on the front of their heads (a human, an owl, and a bird); and three whose eyes are on the sides of their heads (an antelope, a caracal, and a squirrel). Why do a few vertebrates have their eyes side by side on the front of the head while most mammals have one eye on each side?

In general, predators tend to have the ability to see predators approaching from more directions. Humans and other primates have the ability to see predators approaching from more directions.
```

- **Themes Revisited** section at the end of each chapter summarizes the ways in which the book's four major themes relate to that chapter's subject matter.

- **Key Terms** appear in **boldface**, and other important terms of lesser significance appear in **italics**.

- **Appendices** serve as convenient sources of additional information for students who want to expand their knowledge of selected biopsychology topics.

Ancillary Materials Available with Biopsychology

For Instructors

Pearson Education is pleased to offer the following supplements to qualified adopters.

**Test Bank** (0205979823) The test bank for the Ninth Edition of Biopsychology comprises more than 2,000 multiple-choice questions, including questions about accompanying brain images. The difficulty of each item is rated—easy (1), moderate (2), or difficult (3)—to assist instructors with test construction. Each item is also labeled with a topic and a page reference so that instructors can easily select appropriate questions for their tests. Textbook authors rarely prepare their own test banks; the fact that Pinel insists on preparing the Biopsychology test bank attests to its consistency with the text—and his commitment to helping students learn.

**MyTest Test Bank** (0205986153) This test bank is available in computerized format, which allows instructors to create and print quizzes and exams. Questions and tests can be authored online, allowing instructors maximum flexibility and the ability to efficiently manage assessments anytime, anywhere. Instructors can easily access existing questions and edit, create, and store questions using simple drag-and-drop controls. For more information, go to www.PearsonMyTest.com.

**Instructor’s Manual** (0205987710) The instructor’s manual contains helpful teaching tools, including at-a-glance grids, activities and demonstrations for the classroom, handouts, lecture notes, chapter outlines, and other valuable course organization material for new and experienced instructors. Additional resources have been added for the Ninth Edition, including information on MyPsychLab video assets and the Visual Brain.

**Interactive PowerPoint Slides** These slides, available on the Instructor’s DVD (0205986129), bring highlights of this edition of Biopsychology right into the classroom, drawing students into the lecture and providing engaging interactive activities, visuals, and videos.

**Standard Lecture PowerPoint Slides** (0205986145) These slides have a more traditional format, with excerpts of the text material and artwork, and are available on the Instructor’s DVD (0205986129) as well as online at www.pearsonhighered.com/irc.
NEW! MyPsychLab (www.mypsychlab.com)
MyPsychLab is an online homework, tutorial, and assessment program that truly engages students in learning. It helps students better prepare for class, quizzes, and exams—resulting in better performance in the course. It provides educators a dynamic set of tools for gauging individual and class performance.

NEW! The Visual Brain
Available within MyPsychLab, the new Visual Brain is an interactive virtual brain designed to help students better understand neuroanatomy, physiology, and human behavior. Fifteen new modules bring to life many of the most difficult topics typically covered in the biopsychology course. Every module includes sections that explore relevant anatomy, physiological animations, and engaging case studies that bring behavioral neuroscience to life. At the end of each module, students can take an assessment that will help measure their understanding. This hands-on experience engages students and helps make course content and terminology relevant. References throughout the text direct students to content in MyPsychLab, and a new feature at the end of each chapter directs students to MyPsychLab Brain modules.

For Students
MyPsychLab (0205988288) With this exciting new tool, students are able to self-assess using embedded diagnostic tests and instantly view results along with a customized study plan.

The customized study plan will focus on the student’s strengths and weaknesses, based on the results of the diagnostic testing, and present a list of activities and resources for review and remediation, organized by chapter section. Some study resources intended for use with portable electronic devices, such as key terms flashcards and video clips, are made available exclusively through MyPsychLab. Students will be able to quickly and easily analyze their own comprehension level of the course material and study more efficiently, leading to exceptional exam results! An access code is required and can be purchased at www.pearsonhighered.com or at www.mypsychlab.com.

CourseSmart eTextbook (ISBN: 0205987931)
CourseSmart offers students an online subscription to The World of Children, 3/e, at up to 60% savings. With the CourseSmart eTextbook, students can search the text, make notes online, print reading assignments that incorporate lecture notes, and bookmark important passages. Ask your Pearon sales representative for details or visit www.coursesmart.com.

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Two people deserve special credit for helping me create this edition of *Biopsychology*: Maggie Edwards and Steven Barnes. Maggie is an artist/designer/writer/personal trainer, who is my partner in life. She is responsible for the design of most of the illustrations in this book. Steven is a colleague/artist/computer wizard, whose contributions to this edition were immense. He kept my writing on schedule, prepared the manuscripts, compiled the reference list, did some editing and writing, designed all the new illustrations, created the author-run blog and website, and compiled all of the electronic links. It exhausts me just thinking about it.

Pearson Education did a remarkable job of producing this book. They shared my dream of a textbook that meets the highest standards of pedagogy but is also personal, attractive, and enjoyable. Thank you to Bill Barke, Stephen Frail, Susan Hartman, and other executives for having faith in *Biopsychology* and providing the financial and personal support necessary for it to stay at the forefront of its field. Special thanks also go to Joan Foley, Amber Chow, Diane Szulecki, and Judy Casillo at Pearson and Angel Chavez at Integra for coordinating the production—an excruciatingly difficult and often thankless job.

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Michael A. Dowdle, Mt. San Antonio College
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Gregory Ervin, Brigham Young University
Robert B. Fischer, Ball State University
Allison Fox, University of Wollongong
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Thomas Goetttsche, SAS Institute, Inc.
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Melody Smith Harrington, St. Gregory's University
Theresa D. Hernandez, University of Colorado
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In the 1960s, I was, in the parlance of the times, “turned on” by an undergraduate course in biopsychology. I could not imagine anything more interesting than a field of science dedicated to studying the relation between psychological processes and the brain. My initial fascination led to a long career as a student, researcher, teacher, and writer of biopsychological science. *Biopsychology* is my attempt to share my fascination with you.

I have tried to make *Biopsychology* a different kind of textbook, a textbook that includes clear, concise, and well-organized explanations of the key points but is still interesting to read—a book from which you might suggest suitable sections to an interested friend or relative. To accomplish this goal, I thought about what kind of textbook I would have liked when I was a student, and I decided to avoid the stern formality and ponderous style of conventional textbook writing and to focus on ideas of relevance to your personal life.

I wanted *Biopsychology* to have a relaxed and personal style. In order to accomplish this, I imagined that you and I were chatting as I wrote, and that I was telling you—usually over a glass of something—about the interesting things that go on in the field of biopsychology. Imagining these chats kept my writing from drifting back into conventional “textbookese,” and it never let me forget that I was writing this book for you.

Creative thinking is one of the major themes of this edition. Often science and creativity are considered to be opposites, but in my experience many of the major advances in biopsychological science have resulted from creative thinking. These major advances have been made by biopsychologists who have recognized that there are alternatives to the conventional ways of thinking about biopsychological issues that have been engrained in them by their culture and training and who have adopted creative new approaches. Two things in particular have fascinated me about the interplay between creative thinking and biopsychological science: how difficult it is to identify and shed conventional approaches even when they clearly haven’t been working, and how often solutions to long-standing problems become apparent when approached from a new perspective. The focus of this edition on creative thinking is intended to make the study of biopsychology more interesting for you and to encourage you become a more creative thinker.

I hope that *Biopsychology* teaches you much of relevance to your personal life and that reading it generates in you the same positive feelings that writing it did in me.

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**To the Student**

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**About the Author**

John Pinel, the author of *Biopsychology*, obtained his Ph.D. from McGill University in Montreal and worked briefly at the Massachusetts Institute of Technology before taking a faculty position at the University of British Columbia in Vancouver, where he is currently Professor Emeritus. Professor Pinel is an award-winning teacher and the author of more than 200 scientific papers. However, he feels that *Biopsychology* is his major career-related accomplishment: “It ties together everything I love about my job: students, teaching, writing, and research.”

Pinel attributes much of his success to his wife, Maggie, who has at various times been a professional artist, designer, and personal trainer. Over the years, they have collaborated on many projects, and the high quality of *Biopsychology*’s illustrations is largely attributable to her skill and effort.

Pinel is an enthusiastic West African drummer who performs at local clubs, festivals, and drum circles with Nigerian drum master Kwasi Iruoje. For relaxation, he loves to cuddle his three cats: Rastaman, Sambala, and Squeak.