

Dukes' Physiology of Domestic Animals, Thirteenth Edition offers a thorough update to the classic comprehensive text on domestic animal physiology. Now in full color throughout, the book has been fully revised to provide an increased clinical focus, more pedagogical features, and online supplements to promote learning and increase the book's usefulness in the classroom and in the clinic. Each chapter includes outlines, introductions, key terms, more images, questions addressing important information, and self-evaluation exercises.

Throughout the book, domestic animal structure and dysfunction is applied to the practice setting, with clinical correlations, notes of relevance, and exercises featuring clinical situations to demonstrate the practical relevance. Presenting detailed, complete descriptions of mammalian and avian function, *Dukes' Physiology of Domestic Animals* is equally useful as a primary text for veterinary students, as a practice reference for clinicians, and as a basic resource for researchers.

KEY FEATURES

- Presents in-depth, comprehensive descriptions of domestic animal function and dysfunction
- Emphasizes clinical relevance, with clinical correlations, notes of relevance, and self-assessment questions featuring situations likely to be faced in practice
- Offers pedagogical features, including chapter outlines and introductions, key terms throughout the book, additional images, questions to enhance learning, and self-assessment exercises
- Distills the most useful information for ease of use, with improved continuity and reduced repetition
- Acts as a reference for students learning physiological concepts, practitioners applying physiology to the clinical setting, and researchers requiring a resource for mammalian and avian physiology



This book is accompanied by a companion website: www.wiley.com/go/reece/physiology

- The website includes:
- Review questions and self-evaluation exercises from the book
 - Powerpoints of all figures from the book for downloading
 - PDFs of all tables from the book for downloading

THE EDITORS

William O. Reece, DVM, PhD, is University Professor Emeritus in the Department of Biomedical Sciences, College of Veterinary Medicine, Iowa State University, Ames, Iowa, USA.

Howard H. Erickson, DVM, PhD, is Professor Emeritus of Physiology in the Department of Anatomy and Physiology, College of Veterinary Medicine, Kansas State University, Manhattan, Kansas, USA.

Jesse P. Goff, DVM, PhD, is Professor and Anderson Chair in the Department of Biomedical Sciences, College of Veterinary Medicine, Iowa State University, Ames, Iowa, USA.

Etsuro E. Uemura, DVM, MS, PhD, is Professor in the Department of Biomedical Sciences, College of Veterinary Medicine, Iowa State University, Ames, Iowa, USA.

www.wiley.com/go/veterinary

WILEY Blackwell

Also available as an e-book



Reece
Erickson
Goff
Uemura

DUKES' PHYSIOLOGY
OF DOMESTIC ANIMALS

13th
Edition



WILEY Blackwell

13th Edition DUKES' PHYSIOLOGY OF DOMESTIC ANIMALS



Editor

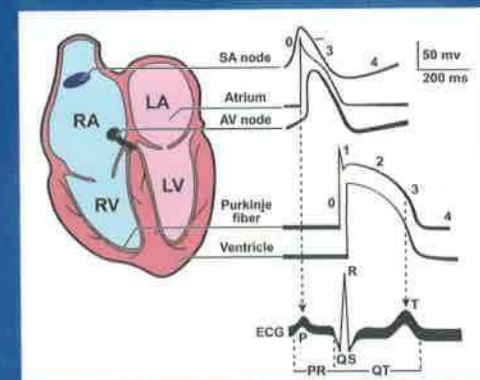
William O. Reece

Associate Editors

Howard H. Erickson

Jesse P. Goff

Etsuro E. Uemura



WILEY Blackwell

This book is dedicated to my wife Shirley Ann Bruckner Reece, born 12/03/1932, died 09/29/1999.

Thanks to God for the gift of Shirley for the 46 years of our marriage and for the seven children (Mary Kay, Kathy Ann, Barbara Jean, Sara Lucinda, Anna Marie, Susan Theresa and William Omar II) we were privileged to bring forth. Shirley was raised in Chicago, and received her BS in Foods and Nutrition at Iowa State University. We were united in marriage prior to receiving our degrees in 1954.

Shirley was a model wife and mother. At every age, she had wisdom beyond her years and was admired by all who knew her. She personified joy, received by grace through God, enjoyed life and loved Ames. Because of her example, support for my vocation, and enthusiasm for family, church, community, and the veterinary profession, I have been encouraged to continue with *Dukes' Physiology of Domestic Animals* and thereby give honor for her presence throughout much of my life.

W.O.R.



Dukes' Physiology of Domestic Animals

Thirteenth Edition

Editor

William O. Reece DVM, PhD

University Professor Emeritus
Department of Biomedical Sciences
College of Veterinary Medicine
Iowa State University, Ames, Iowa
USA

Associate Editors

Howard H. Erickson DVM, PhD

Professor Emeritus of Physiology
Department of Anatomy and Physiology
College of Veterinary Medicine
Kansas State University, Manhattan, Kansas
USA

Jesse P. Goff DVM, PhD

Professor and Anderson Chair
Department of Biomedical Sciences
College of Veterinary Medicine
Iowa State University, Ames, Iowa
USA

Etsuro E. Uemura DVM, MS, PhD

Professor
Department of Biomedical Sciences
College of Veterinary Medicine
Iowa State University, Ames, Iowa
USA

WILEY Blackwell

This edition first published 2015 © 2015 by John Wiley & Sons, Inc.
© 1933 by H.H. Dukes
© 1934, 1935, 1937, 1942 and 1947 by Comstock Publishing Company, Inc.
© 1955, 1970, 1977, 1984, 1993 and 2004 by Cornell University Press

The first through twelfth editions of this volume were published by Comstock Publishing Associates, an imprint of Cornell University Press. Publication of the 13th edition has been made possible by arrangement with Cornell University Press.

Editorial Offices

1606 Golden Aspen Drive, Suites 103 and 104, Ames, Iowa 50010, USA
The Atrium, Southern Gate, Chichester, West Sussex, PO19 8SQ, UK
9600 Garsington Road, Oxford, OX4 2DQ, UK

For details of our global editorial offices, for customer services and for information about how to apply for permission to reuse the copyright material in this book please see our website at www.wiley.com/wiley-blackwell.

Authorization to photocopy items for internal or personal use, or the internal or personal use of specific clients, is granted by Blackwell Publishing, provided that the base fee is paid directly to the Copyright Clearance Center, 222 Rosewood Drive, Danvers, MA 01923. For those organizations that have been granted a photocopy license by CCC, a separate system of payments has been arranged. The fee codes for users of the Transactional Reporting Service are ISBN-13: 978-0-1185-0139-9/2015.

Designations used by companies to distinguish their products are often claimed as trademarks. All brand names and product names used in this book are trade names, service marks, trademarks or registered trademarks of their respective owners. The publisher is not associated with any product or vendor mentioned in this book.

The contents of this work are intended to further general scientific research, understanding, and discussion only and are not intended and should not be relied upon as recommending or promoting a specific method, diagnosis, or treatment by health science practitioners for any particular patient. The publisher and the author make no representations or warranties with respect to the accuracy or completeness of the contents of this work and specifically disclaim all warranties, including without limitation any implied warranties of fitness for a particular purpose. In view of ongoing research, equipment modifications, changes in governmental regulations, and the constant flow of information relating to the use of medicines, equipment, and devices, the reader is urged to review and evaluate the information provided in the package insert or instructions for each medicine, equipment, or device for, among other things, any changes in the instructions or indication of usage and for added warnings and precautions. Readers should consult with a specialist where appropriate. The fact that an organization or Website is referred to in this work as a citation and/or a potential source of further information does not mean that the author or the publisher endorses the information the organization or Website may provide or recommendations it may make. Further, readers should be aware that Internet Websites listed in this work may have changed or disappeared between when this work was written and when it is read. No warranty may be created or extended by any promotional statements for this work. Neither the publisher nor the author shall be liable for any damages arising herefrom.

Library of Congress Cataloging-in-Publication Data

Dukes' physiology of domestic animals. – 13th edition / editor, William O. Reece ; associate editors, Howard H. Erickson, Jesse P. Goff, Etsuro E. Uemura.

p. ; cm.
Physiology of domestic animals
Preceded by Dukes' physiology of domestic animals. 12th ed. / edited by William O. Reece. Ithaca, N.Y. : Comstock Pub./Cornell University Press, 2004.

Includes bibliographical references and index.

ISBN 978-1-118-50139-9 (cloth)

I. Reece, William O., editor. II. Erickson, Howard H., 1936- , editor. III. Goff, Jesse P., editor. IV. Uemura, Etsuro E., editor.

V. Title: Physiology of domestic animals.

[DNLM: 1. Animals, Domestic—physiology. 2. Physiology, Comparative. SF 768]

SF768
636.089'2—dc23

2014050190

A catalogue record for this book is available from the British Library.

Wiley also publishes its books in a variety of electronic formats. Some content that appears in print may not be available in electronic books.

Set in 9.5/12pt Minion by SPi Publisher Services, Pondicherry, India
Printed and bound in Singapore by Markono Print Media Pte Ltd

Contents

List of contributors, vii

Preface, ix

Acknowledgments, x

Tributes, xi

About the companion website, xii

Section I: Neurophysiology

(Section Editor: Etsuro E. Uemura)

- 1 Nervous Tissue, 3
Etsuro E. Uemura
- 2 Electrochemical Basis of Neuronal Function, 13
Etsuro E. Uemura
- 3 Synaptic Transmission, 23
Etsuro E. Uemura
- 4 Somatic and Visceral Senses, 32
Etsuro E. Uemura
- 5 Olfaction and Gustation, 43
Etsuro E. Uemura
- 6 Auditory System, 49
Etsuro E. Uemura
- 7 Visual System, 57
Etsuro E. Uemura
- 8 Motor System, 68
Etsuro E. Uemura
- 9 Vestibular System, 79
Etsuro E. Uemura
- 10 Autonomic Nervous System, 89
Etsuro E. Uemura

Section II: Body Fluids and Homeostasis

(Section Editor: William O. Reece)

- 11 Body Water: Properties and Functions, 103
William O. Reece
- 12 The Composition and Functions of Blood, 114
William O. Reece

13 Fundamentals of Acid–Base Balance, 137
William O. Reece

14 Body Temperature and Its Regulation, 149
William O. Reece

Section III: The Kidneys and Urinary System

(Section Editor: William O. Reece)

- 15 The Renal System: Structures and Function, 157
William O. Reece
- 16 Glomerular Filtration and Tubular Transport, 166
William O. Reece
- 17 Maintenance of Extracellular Fluid Hydration, 173
William O. Reece
- 18 Kidney Regulation of Extracellular Volume and Electrolytes, 180
William O. Reece
- 19 Micturition, Characteristics of Urine, and Renal Clearance, 188
William O. Reece
- 20 Kidney Function in Birds, 193
William O. Reece

Section IV: Respiration

(Section Editor: William O. Reece)

- 21 Overview of the Respiratory System, 203
William O. Reece
- 22 Physical and Mechanical Aspects of Respiration, 213
William O. Reece
- 23 Pulmonary Ventilation and Transport of Gases, 222
William O. Reece
- 24 Regulation of Respiration, 232
William O. Reece
- 25 Other Functions of the Respiratory System, 239
William O. Reece
- 26 Respiration in Birds, 245
John W. Ludders

Section V: Muscle Physiology

(Section Editor: William O. Reece)

- 27 Physiology of Skeletal Muscle, 263
William O. Reece
- 28 Physiology of Smooth Muscle, 274
William O. Reece
- 29 Physiology of Cardiac Muscle, Muscle Adaptations, and Muscle Disorders, 279
William O. Reece

Section VI: The Cardiovascular System

(Section Editor: Howard H. Erickson)

- 30 The Heart and Vasculature: Gross Structure and Basic Properties, 287
Dean H. Riedesel and Richard L. Engen
- 31 Electrophysiology of the Heart, 304
Robert F. Gilmour, Jr
- 32 The Electrocardiogram and Cardiac Arrhythmias, 315
Robert F. Gilmour, Jr and N. Sydney Moise
- 33 Mechanical Activity of the Heart, 327
Dean H. Riedesel
- 34 Regulation of the Heart, 341
David D. Kline, Eileen M. Hasser and Cheryl M. Heesch
- 35 Control Mechanisms of the Circulatory System, 352
Cheryl M. Heesch, David D. Kline and Eileen M. Hasser
- 36 Microcirculation, Lymph, and Edema, 372
Luis A. Martinez-Lemus and M. Harold Laughlin
- 37 Pulmonary Circulation, 386
David C. Poole and Howard H. Erickson
- 38 Special Circulations, 399
Eileen M. Hasser, Cheryl M. Heesch, David D. Kline and M. Harold Laughlin
- 39 Heart Sounds and Murmurs, 417
Michele Borgarelli and Jens Haggström
- 40 Hypertension, Heart Failure, and Shock, 429
Scott A. Brown
- 41 Exercise Physiology of Terrestrial Animals, 443
David C. Poole and Howard H. Erickson

Section VII: Digestion, Absorption, and Metabolism

(Section Editor: Jesse P. Goff)

- 42 Gastrointestinal Motility, 467
Jesse P. Goff

- 43 Secretory Activities of the Gastrointestinal Tract, 484
Jesse P. Goff

- 44 Digestion and Absorption of Nutrients, 502
Jesse P. Goff

- 45 Ruminant Digestive Physiology and Intestinal Microbiology, 522
Jesse P. Goff

- 46 Avian Digestion, 532
William O. Reece and Darrell W. Trampel

- 47 Disorders of Carbohydrate and Fat Metabolism, 541
Jesse P. Goff

- 48 Vitamins, 551
Jesse P. Goff

Section VIII: Minerals, Bones, and Joints

(Section Editor: Jesse P. Goff)

- 49 Minerals, 567
Jesse P. Goff

- 50 Cartilage, Bones, and Joints, 593
Jesse P. Goff

Section IX: Endocrinology, Reproduction, and Lactation

(Section Editor: Jesse P. Goff)

- 51 The Endocrine System, 617
Jesse P. Goff

- 52 Male Reproduction in Mammals, 654
William O. Reece

- 53 Female Reproduction in Mammals, 670
William O. Reece

- 54 Lactation, 694
Patrick J. Gorden and Leo L. Timms

- 55 Avian Reproduction, 715
Patricia A. Johnson

Index, 727

List of Contributors**Michele Borgarelli DMV, PhD**

Diplomate
European College of Veterinary Internal Medicine (Cardiology)
Associate Professor of Cardiology
Virginia-Maryland Regional College of Veterinary Medicine
Blacksburg, VA
USA
(Senior author of Chapter 39)

Scott A. Brown VMD, PhD

Diplomate
American College of Veterinary Internal Medicine
Edward H. Gunst Professor of Small Animal Studies and Josiah Meigs Distinguished Teaching Professor
Departments of Physiology and Pharmacology and Small Animal Medicine and Surgery
College of Veterinary Medicine
University of Georgia
Athens, GA
USA
(Author of Chapter 40)

Richard L. Engen MS, PhD

Professor Emeritus
Department of Biomedical Sciences
College of Veterinary Medicine
Iowa State University
Ames, IA
USA
(Coauthor of Chapter 30)

Howard H. Erickson DVM, PhD

Emeritus Professor
Department of Anatomy and Physiology
College of Veterinary Medicine
Kansas State University
Manhattan, KS
USA
(Coauthor of Chapters 37 and 41; Editor of Section VI; volume Associate Editor)

Robert F. Gilmour, Jr PhD

Vice President, Research and Graduate Studies
Professor of Biomedical Sciences
University of Prince Edward Island
Charlottetown, PE
Canada
(Senior author of Chapters 31 and 32)

Jesse P. Goff DVM, PhD

Professor and Anderson Chair
Department of Biomedical Sciences
College of Veterinary Medicine
Iowa State University
Ames, IA
USA
(Author of Chapters 42–45, 47–50, and 51; Editor of Sections VII, VIII, and IX; volume Associate Editor)

Patrick J. Gorden DVM

Director
Food Supply Veterinary Medicine
Veterinary Diagnostic and Production Animal Medicine
College of Veterinary Medicine
Iowa State University
Ames, IA
USA
(Senior author of Chapter 54)

Jens Haggström DVM, PhD

Diplomate
European College of Veterinary Internal Medicine (Cardiology)
Department of Clinical Sciences
Faculty of Veterinary Medicine and Animal Science
Swedish University of Agricultural Sciences
Uppsala
Sweden
(Coauthor of Chapter 39)

Eileen M. Hasser PhD

Professor
Department of Biomedical Sciences, College of Veterinary Medicine
Department of Medical Pharmacology and Physiology
Resident Investigator, Dalton Cardiovascular Research Center
University of Missouri
Columbia, MO
USA
(Coauthor of Chapters 34 and 35; Senior author of Chapter 38)

Cheryl M. Heesch PhD

Professor
Department of Biomedical Sciences, College of Veterinary Medicine
Resident Investigator, Dalton Cardiovascular Research Center
University of Missouri
Columbia, MO
USA
(Senior author of Chapter 35; Coauthor of Chapters 34 and 38)

the left ovary is believed to inhibit the action of AMH on the left oviduct.

- 5 This surge is stimulated by progesterone, secreted primarily by the largest follicle. In the hen, a preovulatory LH surge precedes ovulation by about 4–6 hours. The granulosa layer of the largest follicle is

the primary source of progesterone and the capacity of this layer to secrete progesterone increases with follicle development. The initiation of the LH surge seems to be restricted to the dark phase in chickens and, as a result, LH surges, ovulation and hence oviposition are generally restricted to a particular part of the day.

Index

Page numbers in *italics* denote figures, those in **bold** denote tables.

- A bands 265
 aardvarks, milk composition **711**
 abdominal breathing 208
 abdominal/pelvic viscera, autonomic innervation 92–4, 94
 abductors 264
 abomasum 522
 contraction 528–9
 displacement 528–9
 abscess 119
 absorption 541–2, 649–50
 birds 537
 carbohydrates 512–13, 513, 542
 electrolytes 508, **508**
 fat 514–16, 514, 515, 542
 volatile fatty acids 525–6, 525, 526
 accentuated antagonism 348
 accessory sex organs 659–60, 659
 birds 717–18
 accommodation 58, 59
 ACE inhibitors 434
 acetazolamide **183**
 acetyl-CoA carboxylase 705
 acetylcholine 23–4, 24, 25, 96, 268, 277, 345, 353, 379
 cardiac effects **350**
 receptors 25–6, 26, 96
 acetylcholinesterase 24, 269
 acid-base balance 137–48
 disturbances of 144–6
 exercise response 453–4, 454
 K⁺ 142–4, 143, 144
 maintenance of 138–42
 respiratory role 140, 141, 234–5
 acid-base status 146–8, 147
 acidemia 137
 acidosis 138
 hypercapnic 394
 metabolic 144, 145, 147, 234, 453
 respiratory 144, 145–6, 146, 222, 234, 453
 acids 137
 acoustic stapedius reflex 55, 55
 acoustic stria 55
 acromegaly 613, 626
 iatrogenic 627
 acrosin 686
 acrosome 686
 ACTH, cardiac effects **350**
 ACTH-releasing hormone 635
 actin 131, 265, 269–70, 270, 271, 274, 297
 action potential 17–21, 18–21
 cardiac *see* cardiac action potential
 hyperpolarization 16, 19
 Na⁺/K⁺-ATPase 19
 overshoot 16, 19
 propagation 20–1, 20, 21
 refractory period 19, 19
 rising phase 18–19, 19
 trigger zone 15, 20
 voltage-gated sodium channels 17–18, 18
 activated B cells 120
 active transport 104, 505
 adaptation 34, 35
 Addison's disease (hypoadrenocorticism) 579, 636–7
 adductors 264
 adenohipophysis 624, 624
 pars intermedia 638
 adenohipophysis gonadotropin-sex steroid axis 637–8, 638
 adenosine 402
 adenosine triphosphatase (ATPase) 270
 adenosine triphosphate (ATP) 457
 adenylate cyclase 574
 adipose tissue 643
 energy metabolism 650, 651
 insulin effects 641
 adrenal gland 633
 exercise response 460, 460
 adrenal medulla 90, 355, 638–9
 autonomic innervation **91**, 93–4
 cardiovascular control 359
 adrenergic receptors 27, 27, 96, 98
 cardiovascular system **355**
 classification
 α **91**, 96, 345, 401
 α₁ 355, 403
 α₂ 353, 355, **355**, 403
 β **91**, 96, 345, 403
 β₁ 353, 355
 β₂ **355**
 heart 345
 adrenocortical hormones 633–6, 633–5
 glucocorticoids 460, 633, 635–6, 635
 mineralocorticoids **350**, 633–5, 634
 redundancy in 636
 adrenocorticotrophic hormone *see* ACTH
 adventitious sounds 211
 aerobic capacity in diving birds 255
 aerobic scope 446
 aerodynamic valves 250
 afterdepolarization 321
 afterload 288, 328, 337–8, 341, 448
 increased 433
 agglutination 120
 agonists 129
 agranulocytes 116
 air capillaries in birds 248, 248
 air sacs in birds 152, 249
 airways 204–6, 204–7
 birds 246–9, 246–9
 albumin 133
 aldosterone 170, 184, 196, 360, 576, 633–5
 aldosterone inhibitors **183**
 aliphatic disulfides 584, 631
 alkalemia 137
 alkali disease 588
 alkalosis 138
 metabolic 144, 145, 147, 235
 respiratory 144, 146, 222, 234
 allantois 687, 687
 alopecia 561
 alpha-globulins 133
 alveolar clearance 240–1
 alveolar pressure 217
 alveolar pulmonary emphysema 223
 alveolar ventilation 446
 alveolar-capillary oxygen diffusion limitation 453
 alveoli
 of mammary gland 696
 pulmonary 206–7, 209, 386
 ambient hypoxia 243
 ameiboid movement 119
 amine neurotransmitters 24, 24
 amino acids
 absorption 542–3
 glucogenic 648
 glycolysis 648

- amino acids (*cont'd*)
 nitrogen 134
 reabsorption 170, 170
see also proteins
- aminoglycoside antibiotics, ototoxicity 53
 aminopeptidases 536
 ammonia 196
 amnion 687, 687
 amniotic fluid 687, 687
 amorphous ground substance 109
 amprolium toxicity 562
 ampulla 79
 α -amylase 512
 amylopectin 536
 amylose 536
 anaerobic phosphorylation 457
 anaerobiosis, obligatory 457
 anal sphincter
 external 99
 internal 99
 anaphylactic shock 440
 anaphylaxis 393
 Andean goose, blood values 253
 androgens 633, 636, 679, 722
 C-16 unsaturated 666
 cardiovascular effects 361
 androgen-binding protein 665
 anemia 125
 aplastic 125
 iron-deficiency 125, 586
 macrocytic hypochromic 560
 in piglets 586
 anemic hypoxia 243
 anesthetic shock 440
 anestrus 682, 683
 angiogenesis 401
 angiotensin I 181, 360, 379, 393, 576, 634
 cardiac effects 350
 angiotensin II 112, 168, 181, 196, 360, 379, 393, 576, 634
 cardiac effects 350
 vasoconstrictor effects 360
 angiotensin receptor blockers 434
 angiotensin-converting enzyme (ACE) 168, 181, 379
 angiotensinogen 168, 168, 181, 379, 576, 634
 angular acceleration/deceleration 83-4, 83
 anion gap 147-8
 anosmia 45
 anoxia 243
 ansa subclavia 92
 anthracosis 241
 anti-Müllerian hormone 719
 antibodies 120, 133
 anticoagulants 132
 antidiuretic hormone 176-7, 639, 640
 birds 194
 in heart failure 437
 antidiuretic hormone-thirst system 184, 185
 antiporters 14
 antithrombin III 131
 antrum 679
 anus in birds 534
 aortic arch baroreceptors 362
 aortic bodies 235, 363
 aortic flow 336
 aortic insufficiency 426
 aortic nerve 362
 aortic pressure 336
 aortic sinus 400, 400
 aplastic anemia 125
 apnea 210
 apneusis 233
 apneustic center 232
 apocrine sweat glands 90, 91, 151, 151
 apotransferrin 124
 appendicular skeleton 121
 arachidonic acid 379
 area centralis 61
 arginine 626
 arginine vasotocin 194
 aromatase 722
 arrector pili 91
 arterial baroreceptors 362
 in heart failure 437
 arterial baroreflexes 363-6
 function of 363-5, 364, 365
 pathways 363, 363
 arterial blood pressure *see* blood pressure
 arterial chemoreflex 367
 arterial hypoxemia 453
 arterial oxygen pressure 236
 arteries *see individual arteries*
 arteriogenesis 401
 arterioles 378-80, 379, 380
 innervation 91
 precapillary 390
 arteriovenous anastomoses 407
 artificial insemination 719
 asbestosis 241
 ascending auditory pathways 54-5
 ascending sensory pathways 37, 39, 39-41
 ascites 224, 394
 ascorbic acid 562-3
 asparagine 190
 aspartate 24, 24
 asphyxia 217, 243
 astrocytes 6-7, 6
 ataxia 73
 atelectasis 243
 atelectic areas 393
 atria 295, 295
 contraction 336
 innervation 343-4
 atrial fibrillation 324, 450-1, 450
 atrial natriuretic peptide (ANP) 182, 196, 360, 576, 635
 atrial pressure waves 333, 336
 atrioventricular block 323
 first-degree 450
 second-degree 450, 450
 atrioventricular conduction 349
 atrioventricular valves 295, 296, 332
 atropine 96, 450
 auditory cortex 55
 auditory reflex 55, 55
 auditory system 49-56
 central pathways for hearing 53-5, 54
 external and middle ears 49-50, 50
 inner ear 50²-3, 51-3
 auditory tubes 532
 Auerbach's plexus 470, 493
 auscultation 210-11, 417, 450
 autocrines 359
 autoimmune thyroiditis 631
 automaticity 311-13, 312, 313
 abnormal 320, 321
 autonomic nervous system 3, 89-100, 277
 apneustic center 232
 cardiovascular control 353, 354, 354, 355
 pathways 363, 363
 active vasodilation 356-7
 central nervous system sites 357-9, 357
 sympathetic vasoconstrictor fibers 355-6, 356
 gastrointestinal innervation 91, 471-4, 472
 micturition 98-9
 neurotransmitters 96-8, 97, 98
 organization of 89, 90, 91
 parasympathetic division *see*
 parasympathetic nervous system
 sympathetic division *see* sympathetic
 nervous system
see also smooth muscle
- autoregulation
 capillaries 376-8, 377, 378
 cerebral blood flow 406, 432
 coronary blood flow 403-4, 403
 glomerular filtration rate 167-8
 hepatic circulation 412
 heterometric 337, 337, 341
 homeometric 337, 337, 341, 342-3, 342
 intestinal circulation 410
 pulmonary circulation 393
 autotransfusion 445
 avian *see* birds
 axial skeleton 121
 axon hillock 4
 axons 4, 21, 268
 dendrites 4, 4
 initial segment 4
 azotemia 438
 azoturia 459
 azurophilic granules 118
- B cells 120
see also specific types
Bacteroides spp. 523
 ballottement 689
 band neutrophils 117
 bar-headed goose, blood values 253
 baroreceptor function curve 365, 366
 baroreceptors
 aortic arch 362
 arterial 362, 437
 cardiac 181
 carotid sinus 362
 modification of respiration 234
 baroreflex function curve 365
 baroreflexes
 arterial 363-6, 363-6
 carotid sinus 364, 364
 basal lamina 277
 basal metabolism 110
 basal nuclei 71-2
 bases 137
 basilar membrane of ear 52, 52, 54
 basophil erythroblasts 117
 basophils 116, 116
 function 119
 bathmotropic action 345
 bats, milk composition 711
 beans 662
 bears
 maximum speed 444
 milk composition 711
 reproductive organs 660
 beavers, renal concentrating capacity 177
 Bedlington terrier, copper-associated
 hepatitis 583
 bellying down 689
 benazepril 434
 Bernard, Claude 355
 beta-globulins 133
 bicarbonate buffer system 138-9, 139
 bile secretion 490-1
 bilirubin 115, 124, 190, 491
 blood 134
 biliverdin 124
 biotin 558-9
 bipedal locomotion 453
 bipolar neurons 5
 birds
 blood values 253
 gas exchange 251-5, 251, 252, 252, 253
 diving 254-5
 flight and altitude 253-4, 254
 gastrointestinal system 532-40
 absorption 537
 esophagus and crop 533
 food and water balance 538-9
 large intestine 534
 motility 535, 537
 ontogeny 538
 oropharynx 532-3
 prehension and deglutition 534-5
 rectum and cloaca 534, 534
 secretions and digestion 535-7
 small intestine 534
 stomach 533-4, 534
 yolk utilization 537-8
 kidneys 193-4, 194
 pulmonary defense mechanisms 256-7
 reproductive system 715-26
 female 719-24
 male 717-19
 photoperiodism 715-17, 716, 717
 respiration 245-59
 air sacs 152, 249
 anatomy 245-9, 246-9
 applied physiology 257-8
 control of ventilation 255-6
 muscles of respiration 249-51, 250
 salt gland 197-8, 198
 syrinx 205
 thoracic skeleton 249-51, 250
 urine formation 194-5, 195
see also individual species
 black duck (*Anas rubripes*), gas exchange
 variables 252
 bladder *see* urinary bladder
 blind staggers 588
 blindness 86
 bloat 527-8, 528
 blood 114-36, 444-5
 coagulation time 122
 color 115
 distribution 290
 erythrocytes 121-6
 exercise-induced hyperviscosity 454
 flow 293, 293
 hematocrit 114-15, 115
 hemostasis 126-31
 loss, prevention of *see* hemostasis
 pH 115, 122
 plasma 133-5, 134, 134
 red cells *see* erythrocytes
 specific gravity 122
 velocity 293
 viscosity 293
 volume 445
 white cells *see* leukocytes
 blood clot 129
 growth 131
 retraction 131
 blood coagulation *see* coagulation
 blood flow
 capillary 375
 exercise response 448
 local regulation 352-3
 pulmonary 390-2, 391
 blood gases, exercise response 453-4, 454
 blood pressure 288, 352, 353, 447
 adverse effects 432-3
 cardiovascular 433
 central nervous system 432-3
 eyes 432
 kidneys 432
 capillary 374-5
 exercise response 446, 448-9, 449
 exercise training 449
 high *see* hypertension
 measurement 291-3, 292, 431-2, 431
 regulation 370, 429-30
 set point 365
 species differences 292
 blood urea nitrogen (BUN) 134
 blood vessels 372-81
 blood distribution 490
 classification by function 372, 373
 innervation 90, 91
 microcirculation 372-81, 373, 374, 377, 378, 379, 380
 blood volume 115, 122
 distribution 290, 291
 exercise training 449
 pulmonary 389-90
 vs. body weight 289-90
 blood-brain barrier 9-11, 10, 404-5
 blood-CSF barrier 8-9, 8
 blood-gas barrier 389
 harmonic mean thickness 248
 boar
 reproductive organs 661, 662
 spermatozoa 665
 taint 666
 body temperature 149-50
 and cardiac regulation 342-3
 diurnal 149-50, 150
 gradients of 149
 species differences 150
 body water 103-13
 balance 110-11, 110, 111
 distribution 108-11
 Bohr effect 227, 453
 bone
 anatomy 595-6, 595, 596
 composition 596-9, 597, 598
 formation 599-600, 600
 fractures 605, 606
 growth
 in diameter 601-2
 in length 600-1, 601
 metabolism and homeostasis 605-7
 percentage by weight 455
 remodeling 602-4, 603, 604
 activation 602
 formation 602, 604
 resorption 602
 reversal 602
 syndromes affecting 609-13
see also specific syndromes
 bone morphogenetic factor-15 723
 botulism 29
 bouts on passage 26, 27, 29-30
 parasympathetic nervous system
 29-30
 sympathetic nervous system 29
 bovine parturient paresis 281
 bovines *see* cattle
 Bowman, William 188
 Bowman-Heidenhain theory 188
 Bowman's capsule 160, 188
 Boyle's law 213
 brachydont teeth 468
 bracken-fern poisoning 562
 bradycardia
 diving birds 254-5
 sinus 320, 320, 449
 bradykinin 361, 393
 bradypnea 210
 brain
 edema 576
 energy metabolism 650-1
see also central nervous system
 brainstem motor nuclei 70-1, 70, 71, 72
 braking effect 236
 breath sounds 211

- breathing
 metabolic cost 220
 resistance to airflow 220
 respiratory frequency 210, 210
 states of 208, 210, 210
 types of 208
- brisket disease 224, 394-5
- broad ligament 671, 672
- bronchi in birds 246-9, 246-9
- bronchial vessels 387
- bronchitis, chronic 223
- bronchoalveolar lavage (BAL) 454
- broodiness in birds 725
- brown fat 152, 153
- Brownian motion 103, 240
- Brunner's glands 493
- buffalo, milk composition 711
- buffer base 144
- buffer systems 138-40
 bicarbonate 138-9, 139
 hemoglobin 139-40, 139, 140
 isohydric principle 140
 phosphate 139
- bulbospongiosus muscle 662
- bulbourethral glands 659
- bulbus glandis 660
- bumetanide 183
- bursa of Fabricius 120, 534
- Butyrivibrio* spp. 523
- C-16 unsaturated androgens 666
- C-cells 628, 631-2
- Ca²⁺ 568-72
 absorption 509-10
 blood 134
 deficiency 571
 dietary sources 571
 propagation 310-11, 310
 distribution 14
 extracellular 569
 function 568-9
 homeostasis 569-71, 570, 631-2
 hypocalcemia 269
 intracellular 569
 reabsorption 185, 186
 toxicity 571-2
- Ca²⁺ channel 308
- Ca²⁺ current 311
- Ca²⁺-ATPase pump 571
- cadmium toxicity 590
- caged avian vitamin A deficiency 553
- caged layer fatigue 571
- calcitonin 571, 607
- calcitonin gene-related peptide 405, 407
- calcitriol 185, 186
- calcium *see* Ca²⁺
- calcium channel blockers 434
- calcium channel protein 571
- calcium-binding protein 555, 558, 571
- callus 605
- calmodulin 276, 569
- caloric expenditure 110
- calves
 hereditary osteopetrosis 610
 pulmonary circulation 388
see also cattle
- camelids
 adaptation to water lack 112-13
 gastrointestinal system 529, 529
 maximum speed 444
 milk composition 711
 rectal temperature 150
- canaliculi 570, 596
- canary, arterial blood pressure 353
- capacitation 686
- capillaries 373-8
 autoregulation 376-8, 377, 378
 blood flow 375
 blood pressure 374-5
 structure 373, 374
 tone 375-6
- capillary transmural pressure 454
- carbohydrates
 digestion/absorption 512-13, 513, 542
 metabolism 627, 644-5, 645
 milk 705
- carbon dioxide
 in erythrocytes 228-9, 229
 in plasma 227-8
 total/partial pressures 215
 transport 227-30, 228-30
 transport curves 229-30, 230
- carbonic anhydrase 228, 589
- carbonic anhydrase inhibitors 183
- carbonmonoxyhemoglobin 121
- γ -carboxyglutamic acid 558
- cardia stomach 485
- cardiac accelerator stimuli 453
- cardiac action potential 304, 305
 depolarization 304, 305, 306-8
 fast 305, 305, 309-10, 309
 generation of polarized state 306, 306
 propagation 310-11, 310
 redistribution of ions 309
 repolarization 305, 306, 308-9, 308
 slow 305, 305, 309-10
 spontaneous initiation 311-13, 312, 313
- cardiac arrhythmias 319-25
 abnormalities of impulse
 formation 319-22
 abnormal automaticity 320, 321
 altered normal automaticity 319-20, 320, 321
 triggered activity 321-2, 321
- abnormalities of impulse
 propagation 322-4
 conduction block 322, 323
 reentry 322-4, 323, 324
- tachycardia 394, 438
see also specific arrhythmias
- cardiac baroreceptors 181
- cardiac contractility 328, 338
 and blood flow 402
- cardiac cycle 332-6, 333-5, 334
 Wiggers diagram 333-6, 334, 335
- cardiac dilatation 300-1
- cardiac hypertrophy 301-2, 302
 concentric 301, 302
 eccentric 301, 302
- cardiac index, exercise response 447
- cardiac murmurs 421-8, 422

- continuous 426
- diastolic 425-6
 aortic insufficiency 426
 innocent 426
 mitral/tricuspid stenosis 425-6
 pulmonic insufficiency 426
- systolic 422-5, 423
 aortic stenosis 422-3, 423
 functional 424-5, 425
 interatrial septal defect 424
 interventricular septal defect 424
 mitral insufficiency 423-4, 425
 pulmonic stenosis 423, 424
 tetralogy of Fallot 425, 426
 tricuspid insufficiency 424
- cardiac muscle 279-80, 280
see also myocardial cells
- cardiac output 164, 287, 331, 429
 exercise response 446-7, 446, 446, 447
 measurement 339
 regional distribution 399
- cardiac reflexes 348-9
- cardiac valves 295, 296
- cardiopulmonary receptors 362
- cardiopulmonary reflexes 366
- cardiovascular system 288-91
 blood volume distribution 290, 291
 blood volume vs. body weight 289-90
 circulation *see* circulatory system
 dynamic parameters 291-4
 laminar vs. turbulent flow 293-4, 294
 pressure 291-3, 291, 292, 292
 velocity and flow 293, 293
- exercise response 445-51, 446
 physical conditioning 449-51
see also specific parameters
- heart *see* heart
- hypertension effects 433
- vascular compliance 294-5, 295
- vascular resistance 294
- vascular tone 290-1
- carotenoids 552
- carotid bodies 235, 362
- chemoreceptors 362
- carotid sinus 362
 baroreceptors 362
 baroreflex 364, 364
- carotid sinus nerve 362
- carrier-mediated diffusion 14, 504, 504
- cartilage
 anatomy 593-4, 594
 growth 594-5
 syndromes affecting 607-9, 608
- casein 510, 705
- castration 666
- catecholamines 444, 619
see also epinephrine; norepinephrine
- cats
 arterial blood pressure 292, 353
 cardiac arrhythmias 324
 feline urolithiasis syndrome 575
 feline urologic syndrome 189
 female reproduction 685
 heart rate 343
 heat intolerance 152

- hepatic lipidosis 547
- hypertension 431
 hyperthyroidism 431, 631
- kidneys
 nephrons 159
 renal concentrating capacity 177
- leukocyte count 118
- mammary gland 695
- pulmonary circulation 388
- purring 242-3
- rectal temperature 150
- respiratory frequency 210
- somatotrope pituitary tumor 627
- thiamine requirement 562
- urine specific gravity 190
- vitamin A toxicity 554
- cattle
 abomasal displacement 579
 alkali disease 588
 arterial blood pressure 292, 353
 blood constituents 134
 blood values 118, 122
 brisket disease 224
 gastric mucosa 485
 gastrointestinal system 522-31
 forestomach motility 526-9, 526-8
 forestomachs 522-3, 523
 microbial ecology 519-30
 rumen fermentation 523-5, 525
 volatile fatty acid absorption 525-6, 525, 526
- genetic zinc deficiency 590
- growth hormone administration 627
- heart rate 343
- hyena disease 554, 601
- hypomagnesemic syndrome 575
- kidneys 158
 nephrons 159
- mammary gland 695
- mastitis 557
- milk composition 711
- milk fever 281, 556, 572, 579, 613
- parturient paresis 281
- polioencephalomalacia 562
- pseudohypoparathyroidism 613
- pulmonary circulation 388
- rectal temperature 150
- reproduction
 female 672, 676, 680, 683, 684, 692, 692
 male 661, 661
- respiratory frequency 210
- respiratory system 206
- nostrils 204
- retained placenta 588
- spermatozoa 665
- urine specific gravity 190
- water balance 110
- caudal colliculus 55
- caudal ventrolateral medulla 358
- cecal droppings 535
- cell membrane 104, 503
 particle movement 502-6, 503-6
- cell membrane-bound receptors 619-21, 619-21

- cell-mediated immunity 119-20
- cellulolytic bacteria 523
- central chemoreceptors 235, 235, 367
- central command 369
- central nervous system 3
 cardiovascular control centers 357-9
 extracellular environment 8-11, 8-10
 hypertension effects 432-3
- central pattern generators 76
- cerebellum, cardiovascular control
 centers 359
- cerebral circulation 404-6
 anatomy 404, 404
 blood-brain barrier 9-11, 10, 404-5
 cerebral blood flow 405-6
 local control 405-6
 neural control 405
 cerebrospinal fluid *see* cerebrospinal fluid
- circumventricular organs 405
- cerebral cortex
 cardiovascular control centers 358-9
 voluntary motor control 68-70, 69, 70
- cerebrospinal fluid 7-9, 404
 blood-CSF barrier 8-9, 8
 normal values 7
- ceruloplasmin 581
- cervicothoracic ganglion 92
- cervix 674, 686
- Cestrum diurnum* 556
- cetaceans
 mammary gland 695
 milk composition 711
- channel-mediated diffusion 14
- Charles' law 213
- Chastek paralysis 562
- cheetahs, maximum speed 444
- chelating agents 132
- chemical synapses 23
- chemoreceptor trigger zone 477
- chemoreceptors
 birds 255
 carotid body 362
 central 235, 235, 367
 peripheral 235-6
 renal 163
- chemotaxis 118-19, 118, 120
- chewing the cud 528
- Cheyne-Stokes breathing 237, 237
- chickens (*Gallus* spp.)
 arterial blood pressure 353
 blood constituents 134
 blood values 118, 122
 copper as growth promoter 583
 dyschondroplasia 607-9
 exudative diathesis 588
 fatty liver syndrome 547-8
 gas exchange variables 252
 gastrointestinal system 533
 rectal temperature 150
 reproductive hormones 717
see also birds
- chief cells 485
- chloride ions *see* Cl⁻
- chloride shift 229
- chlorothiazide 183
- choana 532
- cholecalciferol 554
- cholecystokinin 488, 492, 511, 511, 519, 536
- cholesterol 490-1
- choline 559
- cholinergic receptors 25-7, 26, 96
 muscarinic 25-7, 26, 96, 307
 nicotinic 25, 26, 96
- cholinergic vasodilator fibers 355, 356, 357
- cholinesterase 347
- chondrocytes 593
- chorio-vitelline placenta 695
- chorion 687, 687
- choroid 58
- choroid epithelial cells 8
- choroid plexus 7, 9
- chromium 580
- chronic kidney disease (CKD) 178, 430
- chronic obstructive lung disease 395
- chronic renal failure 178
- chronotropic action 345
- chylomicrons 515-16
- chyme 476
- chymotrypsinogen 536
- ciliary muscle 57-8, 58, 59
- circle of Willis 404, 404
- circulatory failure 435
- circulatory shock 435, 439
- circulatory system 352-71
 nervous control 353-9, 354, 354, 355, 356, 357
 neurohumoral regulation 359-62
 endocrine control 359-61
 paracrine control 361
 pulmonary circulation 288, 386-98
 reflex control mechanisms 362-9
 afferent nerves to brainstem 362-3, 362
 arterial chemoreflex 367
 cardiopulmonary reflexes 366
 centrally integrated patterns 369
 exercise pressor reflex 367
 integrated response to hemorrhage 368-9, 368
 reflex control of humoral systems 367
 regulation of blood pressure 370
 arterial baroreflexes 363-6, 363-6
 systemic pressure and flow 352-3, 353
see also blood vessels; microcirculation; and specific circulations
- circumventricular organs 405
- circus movement 323
- citric acid cycle 646
- Cl⁻ 577
 absorption 507-8, 508
 blood 134
 distribution 14
- Cl⁻/HCO₃⁻ exchange 508
- clitoris 675
- cloaca 193, 194, 197, 534, 534
- cloacal gland 717
- clonidine 626
- Clostridium tetani* 281
- clotting factors 558

- coagulation 129-31, 130
 coagulation cascade 129, 130
 coagulation factors 128
 defects in 132
 prevention of 131-2
 species differences 132-3
 tests for 132-4
- coagulation cascade 129, 130
 coagulation factors 128
- cobalamin 559, 580
- cobalt 580-1
- cochlea 51, 53
- cochlear duct 51
- cochlear nerve 54
- cochlear nuclei 54-5
- coenzyme A 561
- cold, physiologic responses to 152
- collagen 127
 type I 598
 type II 595
- collagenase 118
- collateral coronary arteries 400-1, 400
- collecting ducts 157
- collecting tubules 157, 160
- colloid 628
- colloid osmotic pressure 131, 392
- colloidal osmotic pressure 166
- color vision 60, 61
- colostrum 710-11, 711
- common starling (*Sturnus vulgaris*), gas exchange variables 252
- compact (cortical) bone 596
- complement system 120
- complementary breathing cycles 207, 233
- compliance 294-5, 295
- concentration gradient 14, 104
- conchae 205
- conducted vasodilation 408-9
- conduction 458
- conduction block 322, 323
- cone cells 59, 61
 visual acuity 63
- congestive heart failure 392
- contact activation pathway 130
- contractile elements 329, 329
- contraction of skeletal muscle 269-72, 270-2
- convection 458
- copper 581-3, 582
 deficiency 582-3
 toxicity 583
- copper reductase 581
- copper-zinc superoxide dismutase 589
- coprodeum 534
- cor pulmonale 394
- cornea 57
- corona radiata 680
- coronary circulation 399-404
 coronary blood flow 401-4
 autoregulation 403-4, 403
 basal tone 401
 myocardial metabolism 402-3, 402
 neural regulation 403
 physical factors 401, 402
 reactive hyperemia 404
 functional anatomy 400-1, 400
- coronary flow reserve 403
- coronary sinus 400, 400
- corpus luteum 680-1, 681
- cortical collecting tubule 160
- corticocellular tract 69, 70
- corticopontine tract 69, 70
- corticospinal tracts 69, 70
 lateral 69, 70
 ventral 69
- cortisol 635-6
- costal breathing 208
- costal pleura 203, 219
- countercurrent exchanger 173, 175-6, 175
- countercurrent multiplier 157, 160, 161, 173-5, 174
- countercurrent system
 gas exchange 151, 151, 152
 renal 152, 173-6, 174, 175
- countertransport 169, 169
- cows *see* cattle
- cranial cervical ganglia 92, 93
- creatine phosphate 191, 272, 457
- creatinine
 blood 134
 clearance 191, 191
- crenation 106
- crista ampullaris 79, 80
- critical temperature 152
- crop 533, 533
- cross-bridges 270, 276
- cross-current model of gas exchange 251
- crossed extensor reflex 75, 76
- crypt enterocytes 493-4
 Cl⁻, Na⁺ and water secretion 495-6, 495
- crypt stem cells 493
- crypts of Lieberkuhn 492, 493
- CSF *see* cerebrospinal fluid
- cupula 80
- curare 269
- curled toe paralysis 561
- Cushing reflex 406
- Cushing's disease
 (hyperadrenocorticism) 637
- Cushny, Arthur 188
- cutaneous circulation 406-7
- cyanocobalamin 559
- cyanogenic goitrogens 631
- cyanosis 243
- cyclic AMP 379
- cyclic GMP 379
- cyclooxygenase (COX) pathway 361
- cytochrome oxidase 581
- cytokines 618
- cytotoxic T cells 119
- dark cutting beef 282
- de-inactivation 18
- dead space ventilation 222
- decarboxylation reactions 558
- deer
 female reproduction 684
 maximum speed 444
- defecation 482, 482
- defense response 369

- deglutition (swallowing) 469-70, 470
 birds 534-5
- dehydration 111
- 7-dehydrocholesterol 554
- delayed afterdepolarizations 321, 322
- delayed rectifier 308
- dendrites 4, 4
- denervated heart 348
- denervation atrophy 281
- dense bodies 275
- depolarization
 of cardiac cells 304, 305, 306-8
 of muscle fibers 268-9, 271
- deposition 239
- dermatitis 561
- dermatomes 36-7, 38
- descending motor tracts 70, 72
- desquamation 241
- detrusor muscle 157
- diabetes insipidus 178
- diabetes mellitus 548-9, 642
 glucose transport 171
 polydipsia/polyuria 178
 type I 548
 type II 548-9
- diapedesis 118, 119
- diaphragm 207
- diaphysis 595
- diarrhea
 Cl⁻ loss 577
 malabsorptive 517-18
 Na⁺ loss 576
 oral rehydration therapy 518, 519
 osmotic 518
 secretory 497-500, 499, 578
- diastole 332
- diastolic failure 435
 causes 436, 436
- dicoumarol 132, 558
- dicrotic notch 332
- diestrus 682
- diethylstilbestrol 677, 677
- differential white cell count 120
- diffusion 14, 24, 103-4, 104, 503-4, 504
 carrier-mediated 14, 504, 504
 channel-mediated 14
 concentration gradient 14, 104
 facilitated 104
 nonionic 505, 505
 simple 14, 103
- diffusion limited gas exchange 453
- digestion/absorption 502-21
 nutrients and electrolytes 507-19
see also specific nutrients
 paracellular absorption 506, 507
 particle movement across cell membranes 502-6, 503-6
 transcellular absorption 506, 507
- 1,25-dihydroxyvitamin D 570
- dipeptidases 536
- directly gated ion channels 25
- Dirofilaria immitis* 395, 396
- dissociation constant 138
- distal tubule 160
- disuse atrophy 281

- diuresis 171, 183, 396
 pressure 430
- diuretics 183, 183
- diurnal temperature 149-50, 150
- diving reflex 369
- dogs
 arterial blood pressure 292, 353
 blood constituents 134
 blood values 118, 122
 bone 455
 cardiac arrhythmias 324
 cardiovascular characteristics 447
 erythrocyte fragility 107
 erythrocyte volume 107
 gastric mucosa 485
 heart rate 343
 heartworm disease 395, 396
 hypertension 430-1
 iatrogenic acromegaly 627
 kidneys 158
 nephrons 159
 renal concentrating capacity 177
 mammary gland 695
 maximum speed 444
 milk composition 711
 muscle 455
 panting 241-2
 phonocardiogram 419, 420, 421
 puerperal tetany 282
 pulmonary circulation 388
 rectal temperature 150
 reproduction
 female 672, 680, 684-5
 male 660, 660, 661
 respiratory system 204
 nostrils 204
 oxygen uptake 452
 urine specific gravity 190
 water balance 517
see also specific breeds
 dolphins *see* cetaceans
- dome cells 494
- donkeys
 adaptation to water lack 112-13
 milk composition 711
 rectal temperature 150
see also horses
- dopamine 24, 24
- dorsal respiratory group 232
- dromotropic action 345
- dry period 709
- ductus arteriosus 413, 414
 patent 388, 415, 426, 427
- ductus deferens 657, 659
- ductus venosus 413
- duodenum 492
 electrolyte absorption 508, 508
- dura mater 595
- dust cells 241
- dyschondroplasia of poultry 607-9
- dystocia 692
- dysuria 189
- ear
 external/middle 49-50, 50
 infection 53
 inner 50-3, 51-3
 early afterdepolarizations 321-2
- eccrine sweat glands 151
- Echidna, milk composition 711
- echocardiography 339
- eclampsia 269, 282
- edema 381, 383-4
 brain 576
 peripheral 384
 pulmonary *see* pulmonary edema
- effective osmotic pressure 106, 131
- efferent renal sympathetic nerve activity (ERNSA) 163, 182, 182
- eicosanoids 361, 619
- Einthoven triangle 318, 319
- ejaculation 667
- ejection fraction 331
- elastic cartilage 594
- elasticity 263
- electrical synapses 23
- electrocardiogram (ECG) 315-19, 333
 cellular electrical activity 315, 316
 diastolic heart murmur 427
 functional heart murmur 425
 mid-systolic click 421
 mitral insufficiency 425
 P wave 315, 332
 PR interval 450
 QRS complex 315, 332, 450
 QT interval 450
 summed vectors 318-19, 319
 surface recordings 315-18, 316-18
 T wave 315
 vs. onset of pressure events 336
see also cardiac cycle
- electrochemical gradient 14-15, 169
- electrolytes
 absorption 508, 508
 regulation of 183-6, 184-6
 birds 196-7
see also specific ions
- electron transport chain 647
- electronic transducers 291
- electrostatic forces 14
- elephants
 heart rate 343
 mammary gland 695
 milk composition 711
- embryonic period 687
- emesis (vomition) 477-9, 478
- emphysema (heaves) in horses 395
- enalapril 434
- encapsulated nerve endings 32
- encephalopathy, hypertensive 433
- encometrium 675
- end-diastolic volume 331
- end-systolic volume 331
- endochondral ossification 599-600, 600
- endocrine pancreas 640-3, 640

- endocrine system 617-53
 adenohypophysis gonadotropin-sex steroid axis 637-8, 638
 adrenal cortex 633-6, 633-5
 adrenal medulla 90, 355, 638-9
 endocrine pancreas 640-3, 640
 hypothalamo-hypophyseal (pituitary) axis 623-4, 624
 pineal gland 91, 643, 643
 pituitary gland
 adenohypophysis 624, 624, 638
 neurohypophysis 624, 624, 639-40, 639
 pituitary-adrenal axis 632-7
see also hormones
- endocrines 359
- endocytosis 118, 506
- endolymph 50, 79
- endometrium 674
- endomysium 265
- β -endorphins 24, 638
 exercise response 460
- endosteum 595
- endothelin 378
- endothelium, smooth 131
- endothelium-derived contracting factor 379
- endothelium-derived hyperpolarizing factor 379
- endotoxic shock 393, 440
- endotracheal intubation 207
- energy metabolism 541, 643-4
 absorptive phase *see* absorption
 diabetes mellitus *see* diabetes mellitus
 exercise requirements 461
 ketosis 545-7, 546
 neonatal hypoglycemia 549
 postabsorptive phase 543-4, 651
 pregnancy toxemia 547
 ruminants 544-5
- enkephalins 24, 638
- enophthalmos 92
- Enteque scio 556
- enteric nervous system 470-1, 471
- enteroendocrine (enterochromaffin) cells 486, 494
- enterokinase 536
- enteropeptidase 511
- eosinophils 116, 116
 function 119
- ependymal cells 7-8
- epicardium 296
- epididymis 656, 657
 birds 718
- epiglottis 206, 206
- epimysium 265
- epinephrine 24, 24, 153, 355, 359, 394, 543
 cardiac effects 350
 receptors 27, 27, 96, 98
- epiphyseal plate 595
- epiphyses 595
- epistaxis 454
- equilibrium potential 15
- equine uveitis 561
- erectile tissue 660
- erection 667

- ergocalciferol 554
eructation contractions 488, 527, 527
erythroblasts 117
erythrocyte count 122-3, 122
erythrocytes 116, 121-6
 carbon dioxide in 228-9, 229
 diameter 122
 energy metabolism 650-1
 fate 123-5, 124
 fragility 107
 hemoglobin 121, 121
 indices 122, 123
 lifespan 123
 mass 445
 mobilization 444-5, 444, 445
 morphology 123
 polychromatophilic 117
 volume 106-7, 107, 107, 123
erythropoiesis 121-2, 122
erythropoietin 122
esophageal stomach 485
esophagus in birds 533, 533
estradiol 677
estriol 677
estrogens 676-7, 677, 701, 722
 cardiovascular effects 360
estrone 677
estrous cycle 682-5, 683, 684
estrus 682
ethacrynic acid 183
ethopabate 560
eupnea 208
Eutheria 695
evaporation 458
 impaired 153-4
evaporative heat loss 151, 151, 458
excitability 263
excitation-contraction coupling 269, 276, 280, 327-8, 328
excitatory burse neurons 86, 87
excitatory postsynaptic potentials 15-16, 16, 17, 44
excitatory synapses 15
exercise physiology 443-63
 blood 444-5
 cardiovascular system 445-51, 446
 circulatory response 369
 fluid balance 459
 hormonal responses 459-60, 460
 maximum speeds 444
 muscular system 454-8
 nutrition 461-2
 pressor reflex 367
 respiratory adaptations 451-4, 451-4
 and skeletal muscle blood flow 408-10
 thermoregulation 458-9, 459
 exercise tolerance 461
 exercise training 409
 cardiovascular adaptations 449-51
 and oxygen transport capacity 445
 exercise-induced blood hyperviscosity 454
 exercise-induced pulmonary
 hemorrhage 392, 454, 455
 exercise-induced pulmonary hypertension in
 horses 396-7, 396, 397
exertional rhabdomyolysis 281, 459
exostoses 553
expiration 207
expiratory reserve volume 211
expiratory valving 251
extensibility 263
extensors 264
external ear 49-50, 50
extracellular adhesion molecules 7
extracellular fluid 108-9, 190
 electrolytes 183-6, 184-6
 maintenance of hydration 173-9
 osmolality 180-1, 181
 pH 137
 volume 181-2
 hypervolemia 182
 hypovolemia 112, 170, 182, 182
 normovolemia 182-3
extracellular ions 13-15, 14, 14, 15
extraglomerular mesangial cells 161
extrapyramidal tract 71
eye 57-8, 58, 59
 autonomic innervation 91
 hypertensive retinopathy 432
 see also visual system
facial nerve 95
facilitated diffusion 104
fast twitch fibers see white muscle fibers
fats see lipids
fatty acid synthetase 705
fatty acids
 liver oxidation 547
 volatile see volatile fatty acids
fatty liver 560-1
 in poultry 547-8
feedback control 623, 623
feedforward mechanisms 453
feline urolithiasis syndrome 575
feline urologic syndrome 189
female reproduction 670-93
 birds 719-24
 anatomy 719
 broodiness 725
 follicle growth 720, 720
 follicle selection 723, 723
 ovarian endocrinology 721-3, 722, 724
 oviduct 720-1, 721
 oviposition 724
 ovulatory cycle 723-4
 sperm storage 721
 blood supply 675-6, 676, 677
 estrous cycle 682-5, 683, 684
 external genitalia 675
 functional anatomy 670-6, 671-6
 hormonal control 676-9, 677, 678
 involution of uterus 692
 ovarian follicle activity 679-82, 679, 680, 681
 parturition 689, 690, 691, 691, 692
 pregnancy 685-9, 686-8
 sexual receptivity 682
 uterine tubes 674, 674
 uterus 674, 674
 see also specific parts
ferritin 124, 585

- fertilization 686-7
fetal period 687
fetal/neonatal circulation 413-15, 413, 414
 changes at parturition 414-15
fever 153
fibrin 129
 degradation 131, 131
 formation 130-1
fibrin degradation products 131
fibrinogen 128, 130, 133, 445
fibrinolysis 131, 131
fibrocartilage 594
fibronectin 7, 127
Fick principle 390
fight or flight reflex 90, 369, 471, 639
fila olfactoria 43
filtration fraction 163, 164
fimbria 674
fitness 461
fixed anions 14
flexors 263-4
flow 293, 293, 294
flow receptors 189
flower-spray (secondary) endings 35
fluid balance, exercise response 459
fluid compartments 108
fluorine toxicity 590-1
foal heat 692
folic acid 559-60
follicle-stimulating hormone (FSH) 637, 665, 678, 717
foramen ovale 413, 414
force-velocity curve 330, 330
forestomachs of ruminants 522-3, 523
 motility 526-9, 526-8
 abomasal contraction 528-9
 bloat 527-8, 528
 eructation contractions 488, 527, 527
 regurgitation contractions 516, 528, 528
forward signs of heart failure 438
fractional oxygen extraction 226, 386
fractures 605, 606
Frank, Otto 330
Frank-Starling mechanism 288, 328, 330, 337, 341-2, 430, 436-7, 437, 448
free nerve endings 33, 33
freemartin 688
fremitus 675
functional residual capacity 211
functional sympatholysis 409
functional syncytium 279
fundic stomach 455-6, 485, 486
furosemide 183, 396, 454
Fürstenberg's rosette 696, 713
fusiform muscle fibers 275
G protein-coupled receptors 619-20, 619, 620
GABA 24, 24
gait 76-7
 bipedal locomotion 453
 stance phase 76
 swing phase 76
galactopoiesis 699-700, 702
galactosyltransferase 705
Galen, Claudius 188

- gallop rhythm 421
gallstones 491
gamma loop 74, 74
gamma-globulins see immunoglobulins
gap junctions 274, 277, 279-80
gas exchange 213-16, 386
 birds 251-5, 251, 252, 252, 253
 countercurrent system 251, 251, 252
 cross-current model 251, 251, 252
 diffusion limited 453
 factors affecting 215-16, 216
 partial pressures 213-15, 215
 physics of gases 213
 symbols 213
gases, physics of 213
gastric glands 485
gastric juice 488
gastric pits 485, 485
gastric secretions 484-9, 485-8, 488
 birds 536
 fundic stomach 485-6, 485, 486
 parietal cells and acid secretion 486-8, 487, 488, 488
gastric ulcers 488-9
gastrin 486, 519, 537
gastrin-releasing peptides 536
gastrointestinal secretions 484-501
 large intestine 500, 500
 liver 489-91, 490, 491
 pancreas 491-2, 492
 saliva see saliva
 small intestine 492-500
 stomach 484-9, 485-8, 488
gastrointestinal system 467-83
 autonomic innervation 91, 471-4, 472
 birds 532-40, 533, 533
 absorption 537
 esophagus and crop 533
 food and water balance 538-9
 large intestine 534
 liver and pancreas 534
 motility 535, 537
 ontogeny 538
 oropharynx 532-3
 prehension and deglutition 534-5
 rectum and cloaca 534, 534
 secretions and digestion 535-7
 small intestine 534
 stomach 533-4, 534
 yolk utilization 537-8
defecation 482, 482
deglutition (swallowing) 469-70, 470
digestion/absorption see digestion/
 absorption
enteric nervous system 470-1, 471
hormones 519
motility 476-7
 birds 535, 537
 eructation contractions 477, 488, 527, 527
 large intestine 479-82, 480, 481
 oesophagus 476
 small intestine 479, 479
 stomach 476-7
oral cavity 467-8, 468
ruminants 522-31
 camelids 529, 529
 forestomach motility 526-9, 526-8
 forestomachs of cow 522-3, 523
 microbial ecology 519-30
 rumen fermentation 523-5, 525
 volatile fatty acid absorption 525-6, 525, 526
 salivary secretion 468-9, 469
 smooth muscle of 474-6
 vomition (emesis) 477-9, 478
gestation period 685
gingival hemorrhage 563
giraffes, arterial blood pressure 292, 353
gizzard 533, 533
glands
 adrenal 460, 460, 633
 apocrine 90, 91, 151, 151
 autonomic innervation 91, 92, 93
 Brunner's 493
 bulbourethral 659
 cloacal 717
 eccrine 151
 gastric 485
 mammary see mammary gland
 merocrine 90, 91
 nasal in birds 197
 parathyroid 631-2
 pineal 91, 643, 643
 pituitary 624, 624, 638, 639-40, 639
 prostate 659
 salivary 91, 533
 salt gland in birds 197-8, 198
 sebaceous 150, 151, 696
 shell gland of birds 721
 thyroid 628, 628, 716, 717
globulins 133
glomerular filtration 163, 166-8, 167
glomerular filtration rate 164, 167-8
 autoregulation 167-8
 birds 194
glomerulotubular balance 171
glomerulus 160, 161, 188
glossopharyngeal nerve 95
glottis 205-6, 206, 533
glucagon 543, 642
 cardiac effects 350
 control of secretion 642
 exercise response 460
glucocorticoids 633, 635-6, 635
 exercise response 460
gluconeogenesis 581, 646-8, 649
glucose
 blood 134
 mobilization 543
 reabsorption 170, 170
 glucose sparing activities 543-4
 glucose tolerance factor 580
 glucose transporters see GLUT
 glucose-alanine cycle 648
 GLUT-1 11
 GLUT-4 641
 glutamate 24, 24, 25
 receptors 28
 glutathione peroxidase 587
 glycerol 648
glycine 24, 24
glycogen storage 461-2
glycogenolysis 544
 exercise response 460
glycoproteins 678
glycosaminoglycans 595
goal-directed movements 71-2
goats
 erythrocyte fragility 107
 heart rate 343
 leukocyte count 118
 mammary gland 695
 milk composition 711
 pulmonary circulation 388
 rectal temperature 150
 urine specific gravity 190
goblet cells 494
goiter 631
goitrens 584
goitrogens 584, 631
 cyanogenic 631
 thiouracils 631
golden eagle, blood values 253
Golgi tendon organs 33, 34-5
gonadotropin-releasing hormone
 (GnRH) 623, 678, 716-17, 716
gonadotropins 678-9
Graafian follicles 673
graded potentials 15-17, 16, 17
 summation 16-17, 17
 see also specific potentials
granular cells of birds 256
granulocytes 116
grass staggers 575
grass tetany 575, 579
Graves' disease 631
gravitational settling 239
gray matter 5
greater thoracic splanchnic nerve 92, 94
grey squirrels, milk composition 711
greyhound
 bone 455
 cardiovascular characteristics 447
 exercise training 449
 muscle 455
grouped breathing 236-7, 237
growth differentiation factor-9 723
growth hormone 543, 624-7
 and bone metabolism 613, 626-7
 and cartilage metabolism 626-7
 regulation of secretion 625-6, 626
growth hormone release inhibitory hormone
 (GH-IH) 625
growth hormone-releasing hormone
 (GH-RH) 625
growth plate, closure of 601
gubernaculum testis 657
guinea pigs
 arterial blood pressure 353
 heart rate 343
 milk composition 711
gustation 46-8, 46
 central pathways 47-8, 47
 taste buds 46-7, 46
 transduction of stimulus 46, 47

hair follicles 33
 Haldane effect 229
 haptoglobin 124, 167
 hard palate 205
 hares, heart rate 343
 Haversian canals 596
 head
 autonomic innervation 92, 93
 movement, detection of 83-4, 83, 84
 hearing
 central pathways 53-5, 54
 see also ear
 heart 287-303
 autonomic innervation 91, 97
 circulation see coronary circulation
 denervated 348
 electrophysiology 304-14
 cardiac action potential 305-9
 fast- and slow-response action potentials 309-10
 principles 304-5, 305
 propagation of action potentials 310-11, 310
 spontaneous initiation of action potentials 311-13, 312, 313
 structural basis 304
 extrinsic regulation 343-50, 343-6, 349, 350
 autonomic innervation 343-9, 344-6, 349
 hormonal control 349-50, 350
 resting heart rate 343, 343
 fetal to adult changes 415
 gross structure 287, 295-6
 atria 295, 295
 cardiac valves 295, 296
 pericardium 296
 ventricles 295-6, 295
 intrinsic regulation 341-3
 Frank-Starling mechanism 288, 328, 330, 337, 341-2
 homeometric autoregulation 337, 337, 342-3, 342
 myocardial cells 296-301
 glycogen granules and lipid droplets 297
 intercalated disks 297
 mitochondria 297, 297
 properties of 298-302
 sarcolemmal reticulum 267, 268, 287
 T tubules 268, 298
 as pump 327-32
 definitions 331, 331
 excitation-contraction coupling 327, 328
 muscle mechanics 328, 329, 330
 ventricular emptying 332, 332
 see also cardiovascular system; and entries under cardiac
 heart failure 435-9
 classification 435
 compensatory responses 436-8
 Frank-Starling mechanism see Frank-Starling mechanism
 neurohumoral 437, 437
 renal 437-8

consequences 438
 definitions 435
 diastolic 435
 causes 436, 436
 high-output 435
 low-output 435
 management 438-9
 systolic 435
 causes 435-6, 436
 heart rate 338-9, 343, 343, 429
 cardiac accelerator stimuli 453
 exercise response 446, 447-8, 447
 exercise training 449
 intrinsic 348
 heart sounds 332-3, 417-21, 422
 auscultation 210-11, 417
 classification 417-18, 418
 prolonged see cardiac murmurs
 transient 418-21
 first 418-19, 419
 second 419-20, 420
 third 420, 420
 fourth 420-1, 421, 450
 gallop rhythm 421
 heartworm disease in dogs 395, 396
 heat
 loss 151-2
 physiologic responses to 150-2
 circulatory adjustments 150-1
 evaporative heat loss 151, 151
 extremes of heat 152
 production 152
 heat stroke 153-4, 459
 hedgehogs, milk composition 711
 Heidenhain, Rudolph 188
Helicobacter pylori 489
 helper T cells 119
 hematocrit 114-15, 115, 122, 444
 hematopoietic stem cells 119
 heme 124, 224
 hemoglobin 121, 121, 122, 224-5
 birds 253-4
 buffering role 139-40, 139, 140
 degradation 124
 exercise response 446
 MCH 122, 123
 MCHC 122, 123
 oxygen buffer function 226, 228
 oxygen-hemoglobin dissociation curve 225-7, 226, 227
 structure 224
 hemoglobinemia 107
 hemoglobinuria 107, 125, 167
 hemolysis 106-7, 124
 hemolytic crisis 579
 hemorrhage
 integrated response to 368-9, 368
 pulmonary, exercise-induced 392, 454, 455
 hemorrhagic shock 393
 hemosiderin 124
 hemostasis 126-31
 components of 127-8, 127, 128
 Henderson-Hasselbalch equation 138, 144
 Henry's law 213, 214
 heparin 132

hepatic arterial buffer response 412
 hepatic circulation 412
 hepatic lipidosis in cats 547
 hepatitis, copper-associated 583
 hepatosis dietetica 588
 hepcidin 585
 hephaestin 585
 Hering-Breuer reflexes 233
 hernia
 inguinal 659
 scrotal 659
 heterometric autoregulation 337, 337, 341
 see also Frank-Starling mechanism
 heterophils 119
 hibernation 152-3
 high altitude pulmonary hypertension 394-5, 395
 His-Purkinje system 304
 histaminase 119
 histamine 24, 24, 393, 519
 histidine 139
 histotoxic hypoxia 243
 homeometric autoregulation 337, 337, 341, 342-3, 342
 homeostasis 287
 homeotherms 149
 homunculus 39
 hormones 617-18
 autocrine actions 618
 cardiac regulation 349-50, 350
 exercise response 459-60, 460
 feedback control of secretion 623, 623
 female reproduction 676-9, 677, 678
 gastrointestinal system 519
 mammary gland function 700
 paracrine actions 618
 peptides 618-21, 619-21
 pregnancy 688-9
 receptors 618
 steroid 622
 see also endocrine system; and individual hormones
 Horner's syndrome 53, 92
 horses
 alkali disease 588
 arterial blood pressure 292, 353
 blood constituents 134
 blood values 118, 122
 bone 455
 bracken-fern poisoning 562
 cecum and colon 480-2, 481
 coumarins in 558
 emphysema (heaves) 395
 exercise training 449
 exercise-induced pulmonary hypertension 396-7, 396, 397
 female reproduction 672, 676, 680, 683-4, 692, 692
 gastric mucosa 485
 heart mass 447
 heart rate 343
 hyperkalemic periodic paralysis 579
 kidneys 158
 mammary gland 695
 maximum speed 444
 milk composition 711
 muscle 455
 phonocardiogram 418
 pulmonary circulation 388
 rectal temperature 150
 respiratory frequency 210
 respiratory system 204
 nasal cavities 205
 nostrils 204
 oxygen uptake 452
 pleura 219
 skeletal muscle 455
 spermatozoa 665
 thoroughbreds
 bone 455
 ECG 449-51, 450
 exercise response 451
 exercise training 449
 heart mass 447
 maximum speed 444
 muscle 455
 splenic response to exercise 445, 445
 urine specific gravity 190
 uveitis 561
 vitamin D in 556
 water balance 517
 human chorionic gonadotropin (HCG) 689
 humans (primates)
 arterial blood pressure 353
 bone 455
 gastric mucosa 485
 heart mass 447
 heart rate 343
 kidneys
 nephrons 159
 renal concentrating capacity 177
 mammary gland 695
 maximum speed 444
 milk composition 711
 muscle 455
 oxygen uptake 452
 pulmonary circulation 388
 urine specific gravity 190
 humoral control of respiration 234-6, 235, 236
 humoral immunity 120
 hyaline cartilage 594
 hyaluronic acid 109, 607
 hyaluronidase 686
 hydration reaction 138, 140, 222
 hydrogen ion concentration 115
 hydrogen peroxide 118, 587
 hydrostatic pressure 166, 516
 pulmonary circulation 390-1, 392
 hydroxyapatite 569
 hydroxyl radical 587
 25-hydroxyvitamin D 554, 570
 hyena disease of cattle 554, 601
 hyperadrenocorticism (Cushing's disease) 637
 hyperaldosteronism 431
 hyperbaric oxygenation 243
 hyperbasemia 145
 hypercalcitoninism, nutritional 610
 hypercapnia 145, 243
 and cerebral vasodilatation 405-6
 hypercapnic acidosis 394

hyperemia
 postprandial 410
 reactive 376, 377, 404
 hyperkalemia 143
 hyperkalemic periodic paralysis of Quarter Horses 579
 hypermetria 73
 hyperosmolality 180, 181
 hyperoxia 243
 hyperparathyroidism
 primary 609
 secondary 609-10
 hyperpnea 210
 hyperpolarization 16, 19, 306
 hyperreflexia 74
 hypertension 366, 429-35
 etiology 430-1, 430
 idiopathic 429
 management 433-5, 433, 434
 persistent 433
 pulmonary 388, 394-7
 secondary 429
 systemic 429
 hypertensive encephalopathy 433
 hypertensive retinopathy 432
 hyperthermia 153
 hyperthyroidism 431, 631
 hypertonia 74
 hypertonic solutions 106, 107
 hyperventilation 222
 hypervolemia 182
 hypoadrenocorticism (Addison's disease) 579, 636-7
 hypobasemia 145
 hypocalcemia 269
 and lactation 709
 hypocapnia 146, 243
 hypochromic microcytic anemia 586
 hypogastric nerve 98
 hypoglycemia 626
 neonatal 549
 hypokalemia 20, 143, 578
 hypokinesia 71
 hypomagnesemic syndromes of cattle and ewes 575
 hypoparathyroidism 610
 hypophosphatemia in ruminants 573-4
 hypophysis 623-4, 624
 hypothalamo-hypophyseal (pituitary) axis 623-4, 624
 hypothalamo-hypophyseal portal system 624, 625, 678
 hypothalamus 623
 cardiovascular control centers 358
 hypothermia 153
 hypothyroidism 630-1
 hypotonic solutions 106, 107
 hypoventilation 222
 hypovolemia 112, 170, 182, 182
 hypovolemic shock 440
 hypoxemia 146, 223, 243
 arterial 453
 tolerance in diving birds 255
 hypoxia 243
 and cerebral vasodilatation 405
 and coronary flow 402
 inspired 387
 hypoxic ascites 224
 hypoxic vasoconstriction 224
 hypodont teeth 468
 I bands 265
 icterus see jaundice
 idiopathic hypertension 429
 ileocolic junction 534
 ileum, electrolyte absorption 508, 508
 imidazole groups 139
 immune system
 B cells 120
 cell-mediated immunity 119-20
 humoral immunity 120
 mammary gland immune defenses 698-9, 711-13, 712, 712
 T cells 119
 immunoglobulins 120, 131
 in colostrum/milk 712
 in serum 712
 immunosuppression 636
 inactivated state 18
 inadequate perfusion 438
 indicator dilution technique 339
 indirectly gated ion channels 25
 inertial forces 239-40
 inflammation 381
 infundibular cleft 532
 infundibulum 674
 inguinal canal 657
 inguinal hernia 659
 inguinal rings 657
 inhibin 665
 inhibitory postsynaptic potentials 15-16, 16, 17
 inhibitory synapses 16, 16
 inner ear 50-3, 51-3
 auditory sensory organ 50-1, 51
 frequency of tone 52-3, 53
 transduction of auditory stimulus 51-2, 52
 inotropic action 345
 inotropic agents 435
 inotropic state 328, 338
 insensible water loss 110, 151
 inspiration 207, 209
 inspiratory capacity 211
 inspiratory reserve volume 211
 inspiratory valving 250
 inspired hypoxia 387
 insulin 640-2
 control of secretion 642
 effects 641-2
 cardiac 350
 exercise response 460
 function 641
 Somogyi overswing 549
 see also diabetes mellitus
 insulin-like growth factor (IGF)-1 625
 insulin-like growth factor (IGF)-2 625
 intention tremor 73
 interatrial septal defect 424
 intercalated disks 279, 297

- intercellular space 109
intercellular substances 109
intercostal muscles 207
intermediolateral cell column of spinal cord 358
interneurons 69, 75
internodes 5
interstitial cells of Cajal 474
interstitial fluid 108, 392
interstitial growth 594
interventricular septal defect 424
intervertebral disks 594
intestinal circulation 410-12
 anatomy 410
 autoregulation 410
 metabolic effects 410-11
 neural control 411-12
intracellular fluid 108-9
intracellular ions 13-15, 14, 14, 15
intracellular messengers 129
intracranial pressure 406
intramembranous ossification 599
intrapleural pressure 217, 389
intrapleural space 203
intrapulmonary bronchus 247
intrapulmonary chemoreceptors in birds 255
intrapulmonic pressure 217, 217
intravascular fluid 108
intrinsic factor 559
intrinsic heart rate 348
intromission 667
involution 700, 702, 702
inward rectifier 306
iodine 583-4
iodine-deficiency goiter 631
iodopsin 60, 553
iodothyronine 5'-deiodinase 587
ion channels 13, 14
 directly gated 25
 indirectly gated 25
 see also individual ions
ion transport 13, 14
ionotropic receptors 25
iris 57, 58
iron 584-6
 deficiency 586
 function 584
 homeostasis 584-5, 585
 metabolism 125-6, 125
 oxidation states 125
 toxicity 586
iron-deficiency anemia 125, 586
ischemic hypoxia 243
ischioavernosus muscle 662
islets of Langerhans 640, 640
isohydric principle 140
isomaltase 536
isometric contraction 329
isoproterenol 394
isotonic contraction 329
isotonic solutions 106, 107
jaundice 124
jejunum, electrolyte absorption 508, 508
jerboas, renal concentrating capacity 177
joints 607, 608
juxtaglomerular apparatus 161-3, 162, 576
juxtaglomerular granular cells 181
K⁺ 142-4, 143, 144, 577-9
 absorption 508-9, 508
 blood 134
 distribution 14
 function 577-8
 hyperkalemia 143
 hypokalemia 20, 143, 578
 metabolism and homeostasis 578
 normokalemia 143
 reabsorption 184-5, 185
 syndromes 578-9
 toxicity 578
K_{ATP} channels 402
kallidin 361
kallikrein-kinin system 361
kangaroo rats, renal concentrating capacity 177
keratin 696
keratomalacia 553
ketoacids 645
ketosis 145, 545-7, 546, 560-1
 classical 545-6
 and lactation 709
 periparturient 546-7
kidney function variables 164
kidneys 157-65
 in acid-base balance 140-3, 143
 anatomy 157, 158, 159
 autonomic innervation 91
 birds 193-4, 194
 in heart failure 437-8
 hypertension effects 432
 innervation 163
 juxtaglomerular apparatus 161-3, 162
 nephron 159-61, 159, 160, 161
 renal concentrating capacity 177
 urine formation 163-4, 164, 164
kinins 361
kinocilium 81, 82
koilin 533
Korotkoff sounds 292
Krogh, August and Marie 207
Kupffer cells 490
labia 675
lacrimal glands, autonomic innervation 91
α-lactalbumin 705
lactase 513
lactate 648
 blood 134
lactation 694-714
 factors affecting 707-10
 genetics/heritability 708
 metabolic disturbances 709
 nutrition and environmental factors 708-9
 feedback-inhibition 706
 milk secretion 702-3, 703, 704-5

- milk synthesis 702-3, 703, 705-6
performance 702
see also mammary gland; milk
lactation tetany 575
lactational osteoporosis 571, 611, 613
lactic acid *see lactate*
lactiferous ducts 696
lactoferrin 118, 713
lactogenesis 699, 701-2
lactogenic complex 702
lactose 705
lactose synthase 705
lactotropes 627
lacunae 596
lamellar flow 293-4, 294
laminin 7
Laplace's law 219, 256-7, 300, 301, 301
large intestine
 birds 534
 motility 479-82, 480, 481
 secretions 500, 500
laryngeal hemiplegia 396, 454
laryngeal mound 533
larynx 205
lateral geniculate nucleus 63
lead poisoning 591
left ventricular contractility 435
left ventricular end-diastolic pressure 448
left ventricular hypertrophy 433
length-tension diagram 329-30, 341
leptin 643
leukemia 120
leukocyte count 118
 absolute number 120
 differential white cell count 120
leukocytes 115-21
 classification and appearance 116-17, 116
 diagnostic procedures 120
 function 118-20
 see also specific types
leukocytosis 120
leukopenia 120
leukotrienes 361
Leydig cells 637, 654, 656
libido 666
lidocaine 20
linear acceleration/deceleration 84
lipids
 digestion/absorption 514-16, 514, 515, 542
 metabolism 627, 645, 647
 milk 705-6
 percentage by weight 455
 synthesis 648-9
lipolysis, exercise response 460
lipoprotein lipase 705-6
lipotropic hormones 460
lipoxygenase pathway 361
liquor folliculi 679
liver
 autonomic innervation 91
 birds 534
 energy metabolism 649-50, 651
 fatty acid oxidation 547

- insulin effects 641
microscopic anatomy 489-90, 490
secretions 489-91, 490, 491
sinusoids 412, 490
llamas, gastric mucosa 485
loop diuretics 183
loop of Henle 157, 160, 161, 173-5, 174
 birds 196
losartan 434
lower motor neurons 71, 71
lubricin 607
lumbar splanchnic nerve 94
lung sounds 210-11
lungs 203, 204
 autonomic innervation 91, 97
 compliance 220
 recoil tendency 218-20, 219
 resistance to airflow 220
 subdivisions 208
 volumes/capacities 211, 211
 see also respiratory system
lusitropy 339
luteinizing hormone (LH) 637, 665, 678, 717
 preovulatory surge 679
luteolysis 676
lymph nodes 241, 697, 698
 satellite 241
lymph vessels 241
lymphatic system 381-3, 383
lymphoblasts 119
lymphocytes 116, 116
 function 119-20, 120
lysozyme 581
M-cells 494
macaw, blood values 253
macrocytic hypochromic anemia 560
macrophages 119, 241
macula 80, 81, 82, 84
macula densa 160, 161, 168
magnesium ions *see Mg²⁺*
malabsorptive diarrhea 517-18
male reproduction 654-69
 accessory sex glands and semen 659-60, 659
 birds 717-19, 718
 blood and nerve supply to genitalia 662-3, 663
 descent of testes 657-9, 658
 emission and ejaculation 667
 mounting and intromission 667
 muscles of genitalia 662, 662
 penis and prepuce 660-2, 660, 661
 spermatogenesis 663-6, 664-6
 testes and associated structures 654-7, 655-7
 testicular function 667-8
 see also specific organs
Malpighian body *see glomerulus*
maltase 513, 536
maltose 536
maltotriase 513
mammalian-type nephrons 193, 195
mammals 695

- mammary gland
 anatomy 695-8, 695, 696-8
 blood supply 696-7, 697
 energy metabolism 650, 651
 hormones affecting 700
 immune system defenses 698-9, 711-13, 712, 712
 insulin effects 641-2
 involution 700, 702, 702
 lymph supply 697, 698
 metabolism 703-4, 704
 nerve supply 697-8, 699
 mammogenesis 699, 700-1
 birth to puberty 701
 conception to parturition 701
 fetal development 700-1
 puberty to conception 701
manatees
 milk composition 711
 osteopetrosis 610
 manganese 586-7
mannitol 183
margination 119
marsupials 695
mast cells 119
mastitis 709
 treatment 709-10
maximal metabolic efficiency 458
Mayer waves 367, 389
mean corpuscular hemoglobin concentration (MCHC) 122, 123, 445
mean corpuscular hemoglobin (MCH) 122, 123, 445
mean corpuscular volume (MCV) 122, 123, 445
mechanoreceptors 33, 33, 33
 birds 255
 renal 163
Meckel's diverticulum 534, 538
medial geniculate nucleus 55
mediastinal pleura 219
mediastinal space 203
 pressure in 217-18, 218
medroxyprogesterone acetate 626
medulla oblongata, cardiovascular control centers 358
medullary space 595
medullary washout 175, 176
megacolon 480
Meissner's corpuscles 33, 34
Meissner's plexus 470, 493
melanocyte-stimulating hormone (MSH) 638
melatonin 626, 643, 643
memory B cells 120
memory T cells 119
menaquinone 557
menisci 607
mercury 591
Merkel's corpuscles 32, 33, 33
merocrine sweat glands 90, 91
mesangial region of kidney 161, 162
mesobronchus 247
mesometrium 671
mesosalpinx 671
mesovarium 671
metabolic acidosis 144, 145, 453
 respiratory compensation 147, 234, 235
metabolic alkalosis 144, 145
 respiratory compensation 147, 235
metabolic water 110
metabolizable energy 644
metabotropic receptors 25
metallothionein 589
metaphysis 595
metastatic calcification 571
metestrus 682
methacholine 394
Methatharia 695
methemoglobin 121
methionine 559
methylmalonyl-CoA mutase 580
Mg²⁺ 574-5
 blood 134
 deficiency 574-5
 extracellular 574
 homeostasis 574
 intracellular 574
 reabsorption 185
 renal threshold 574
 syndromes 575
 toxicity 575
Mg-ATP 574
mice
 arterial blood pressure 353
 heart rate 343
 lung 209
 mammary gland 695
 microcirculation 372-81
 arterioles 378-80, 379, 380
 blood-interstitial fluid exchange 381, 382
 capillaries 373-8, 373, 374, 377, 378
 microglia 6
 microhematocrit 115
 micturition 98-9, 188-9
 reflexes 189
 middle cervical ganglion 92
 middle ear 49-50, 50
 reflex 55, 55
milk
 letdown 696
 nutritive value 710, 711
 removal 707
 secretion 702-3, 703, 704-5
 Golgi route 704
 membrane route 704
 milk fat route 704-5
 paracellular route 705
 physiological control 706-7
 transcytosis 705
 species differences 711
 synthesis 702-3, 703, 705-6
milk fat 705-6
milk fever 281, 556, 572, 579, 613
milk residues 710
milk tetany 575
mineralocorticoids 633-5, 634
 cardiac effects 350

- minerals 567-92
 exercise requirements 462
 macrominerals 568-80
 toxic 590-1
 trace 580-90
see also specific minerals
 minute respiratory volume 222
 minute ventilation 222
 miosis 66, 92
 mitochondria 297, 297
 mitochondrial volume density 455
 mitral insufficiency 423-4, 425, 449
 mitral stenosis 392, 425-6
 molybdenum 587
 monestrous animals 682
 mongrels, cardiovascular characteristics 447
 monoblasts 116
 monocytes 116, 116
 function 119
 mononuclear phagocytic system 119
 monosynaptic reflex 73
 monotremes 695
 moonblindness 561
 motion sickness 477
 motor end plate 268
 motor neurons 71, 71
 motor system 68-78
 reflex motor control 73-6, 73-6
 rhythmic motor control 76-7
 voluntary motor control 68-73
 basal nuclei 71-2
 brainstem motor nuclei 70-1, 70, 71, 72
 cerebellar modulation 70, 72-3
 cerebral cortex 68-70, 69, 70
 upper and lower motor neurons 71, 71
 motor units 28, 73, 268
 summation 272
 mounting 667
 moving mucous blanket 240, 241
 mucociliary escalator 256
 mucociliary transport in birds 256
 mulberry heart of swine 588
 Müllerian ducts 666
 birds 719
 multipolar neurons 5
 multiunit smooth muscle 274, 275
 muscarinic receptors 25-7, 26, 96, 307, 379
 M₁-type 354
 M₂-type 353, 354
 muscle
 arrangement and location 263
 atrophy 281
 cardiac 279-80, 280
 energy metabolism 650, 651
 hypertrophy/hyperplasia 280
 insulin effects 641
 skeletal *see* skeletal muscle
 smooth *see* smooth muscle
 three-component model 329, 329
 types of movement 263-4
 muscle disorders 281-2
 bovine parturient paresis 281
 dark cutting beef 282
 exertional rhabdomyolysis 281
 tetanus 281
 muscle insertions 263
 muscle pump 408, 409
 muscle relaxants 269
 muscle spindles 33, 34, 35
 muscle tone 74-6, 75, 76
 Muscovy duck (*Calrina moschata*), gas
 exchange variables 252
 myasthenia gravis 29
 myeloblasts 117
 myeloid stem cells 116
 myenteric plexus 470, 493
 myoblasts 116
 myocardial cells 296-301, 297
 glycogen granules and lipid droplets 297
 intercalated disks 297
 mitochondria 297, 297
 properties of 298-302
 conduction 298
 contraction 298-300, 298, 299, 299
 dilatation 300-1, 301
 hypertrophy and atrophy 301-2, 302
 metabolism and energetics 300, 301
 regeneration 300
 spontaneous depolarization 298
 sarcoplasmic reticulum 267, 268, 287
 T tubules 268, 298
 myocardial contractility, exercise
 response 448
 myocardial failure 435
 myocardial infarction 392
 myocardial metabolism 402, 403
 myoepithelial cells 640
 myofibrils 265, 266, 296
 myofilaments 266, 274
 myogenic tone 401
 myoglobin 121
 exercise response 456
 myometrium 674
 myosin 131, 265, 269-70, 270, 271, 274, 297
 myosin kinase 276
 myosin light chain kinase 379
 myosin phosphatase 276
 Na⁺ 576
 absorption 169-70, 170, 507
 blood 134
 deficiency 576
 distribution 14
 homeostasis 576
 reabsorption 183-4, 184
 voltage-gated channels 17-18, 18, 28
 Na⁺ channels 306-7, 306
 conductive 170
 voltage-gated 17-18, 18
 Na⁺ current 306-7, 306
 Na⁺ pump 169, 309
 Na⁺-phosphate cotransporter 185
 Na⁺/amino acid cotransporter 508
 Na⁺/Ca²⁺ exchanger 309
 Na⁺/Cl⁻ cotransporter 508
 Na⁺/hexose cotransporter 508
 Na⁺/K⁺-ATPase 19, 184, 505
 nasal cavities 204-5, 205
 nasal glands in birds 197
 nasal septum 205
 nasal strips 396, 397, 454
 nasopharyngeal glands, autonomic
 innervation 91
 natriuresis 183
 pressure 430
 nausea 478
 neck, autonomic innervation 92, 93
 necrosis 7
 negative feedback 363, 623, 623
 neonatal enzootic ataxic (swayback) of
 lambs 583
 neonatal hypoglycemia 549
 neopulmonic parabronchial tissue 248, 249
 nephrons 159-61, 159, 160, 161
 birds 193, 195
 components of 160-1, 161
 corticomedullary 159
 juxtamedullary 160
 Nernst equation 15
 nerve fibers, classification of 6
 nerve growth factor 7
 nervous system 3-12
 autonomic *see* autonomic nervous system
 cells of 3-8, 4-8, 6, 7
see also specific cell types
 central *see* central nervous system
 energy metabolism 650-1
 neurogenic inflammation 407
 neurogenic shock 440
 neuroglia 3, 4, 5-8, 5-8, 6, 7
 neurohypophysis 624, 624, 639-40, 639
 neuromuscular block 269
 neuromuscular junction 26, 28-9,
 267-8, 268
 neuronal cell body 4, 4
 neuronal function 13-22
 action potential 17-21, 18-21
 graded potentials 15-20, 16-20
 ion distribution 13-15, 14, 14, 15
 resting membrane potential 15
 neurons 3, 4-5, 4
 bipolar 5
 multipolar 5
 unipolar 5
 neuropeptide Y 356
 neurotransmitters 23-4, 24, 24, 25
 amines 24, 24
 autonomic nervous system 96-8, 97, 98
 receptors 25-8, 26, 27
see also individual neurotransmitters
 neurotrophic factors 7
 neurovascular unit 406, 406
 neutralization 120
 neutrophil extracellular traps (NETs) 712
 neutrophils 116, 116
 function 118-19, 118
 niacin 560-1
 nicotinic receptors 25, 26, 96
 ganglionic 353
 night blindness 553
 Nissl substance 4
 nitric oxide 24, 24, 377, 379, 393
 cerebral circulation 405
 coronary circulation 402
 hepatic circulation 412

- nitric oxide synthase 377, 379, 405
 inhibition 397
 nitrogen
 nonprotein 134
 total/partial pressures 215
 nociceptors 32, 33
 nocturnal animals 149
 nodes of Ranvier 5, 5
 saltatory conduction 21
 nonesterified fatty acids (NEFA)
 457, 709
 nonionic diffusion 505, 505
 norepinephrine 24, 24, 153, 277, 345, 353,
 355, 359, 394
 cardiac effects 350
 receptors 27, 27, 96, 98
 normoblasts 117
 normoventilation 222
 normovolemia 182-3
 northern goshawk, blood values 253
 nostrils (nares) 204, 204
 nucleus ambiguus 363
 nucleus tractus solitarius 363
 nutrition
 digestion/absorption 502-21
 and estrus cycle 683
 and exercise 461-2
 and lactation 708-9
 nutritional hypercalcitoninism 610
 nutritional hyperparathyroidism 609
 nyctalopia 553
 nystagmus 86-7, 87
 quick phase 86-7, 87
 slow phase 86, 87
 obligatory anaerobiosis 457
 oculomotor nerve 94-5
 oesophageal motility 476
 eructation contractions 477
 olfaction 43-5, 44
 central pathways 44, 45, 45
 odorant receptors 43-4
 transduction of stimulus 44-5, 45
 olfactory bulb 44, 44, 45, 45
 olfactory epithelium 205
 olfactory knob 43
 olfactory nerve fibers 45
 olfactory-binding protein 43
 oligodendrocytes 5-6, 5
 oligopeptides 536
 oliguria 189
 omasum 522, 523
 oncotic pressure 133, 389
 oocyte 720
 oogenesis 673
 open canalicular system 129
 opossums
 mammary gland 695
 milk composition 711
 opsonization 119, 120
 oral cavity 467-8, 468
 oral rehydration therapy 518, 519
 organ of Corti 50-1, 51
 oropharynx in birds 532-3
 osmoconcentration 111, 180

- osmols 105
 osmolal clearance 192
 osmolality 105-6, 105
 extracellular fluid 180-1, 181
 osmolar concentrations 105
 osmoreceptors 177, 180
 osmoregulation 180-1, 181
 osmosis 105-6, 105, 105, 506, 506
 osmotic diarrhea 518
 osmotic diuresis 171
 osmotic diuretics 183
 osmotic fragility test 107, 107
 osmotic pressure 105-6, 105, 105, 516
 effective 106
 pulmonary circulation 392
 osteoblasts 595-6, 596
 osteocalcin 558, 598
 osteochondrosis 607-9, 608
 osteoclast-activating factor 632
 osteoclasts 570, 596, 596
 osteocytes 596, 596
 osteocytic osteolysis 570, 596, 632
 osteomalacia 555, 571, 573, 610-11
 osteopetrosis 610
 hereditary, of calves 610
 of manatees 610
 osteoporosis 571, 605, 611, 612
 lactational 571, 611, 613
 postmenopausal 611
 senile 611
 osteoprogenitor cells 595
 ostriches, maximum speed 444
 otitis media 53
 otitis media interna 53
 otoconia 80
 ototoxicity 53
 ovarian artery 675
 ovarian follicles 671, 673, 673, 679-82, 679,
 680, 681
 birds 720, 720, 723, 723
 Graafian 673
 growing 673
 growth 679, 679
 primordial 671
 regression 673
 ovaries 670-3, 671-3, 681
 birds 720
 overshoot 16, 19
 oviduct 720-1, 721
 ovulation 679-80
 ovulation fossa 671
 oxen, heart rate 343
 oxidative decarboxylation 646
 oxidative phosphorylation 272, 457, 647
 oxygen
 fractional extraction 226, 386
 total/partial pressures 215
 transport 224-7, 225-7
 oxygen extraction 446
 oxygen uptake, exercise response 446, 447,
 451-3, 452, 453
 oxygen-hemoglobin dissociation curve
 225-7, 226, 227
 Bohr effect 227, 453
 oxythiamine 562

- oxytocin 639, 640
 cardiac effects 350
 P wave 315, 332
 Pacinian corpuscles 33, 33, 34, 36
 packed cell volume (PCV) 444
 PaCO₂(U)2(u) in birds 252, 253
 palate 205
 paleopulmonic parabronchial tissue 248, 249
 pampiniform plexus 663, 663
 pancreas
 autonomic innervation 91
 birds 534
 endocrine 640-3, 640
 enzymes 511, 511
 secretions 491-2, 492
see also glucagon; insulin
 pancreatic fibrosis 588
 Paneth cells 494
 panting 151, 241-2
 pantothenic acid 561
 PaO₂(U)2(u) in birds 252
 paracellular absorption 506, 507
see also specific ions
 paracrines 359
 parafollicular cells 628
 parakeet, blood values 253
 parakeratosis of swine 590
 parasympathetic nervous system 94-5, 95
 boutons en passage 26, 27, 29-30
 cardiac innervation 347, 353, 354
 gastrointestinal system 472-3
 sacral outflow 95
 vasodilator fibers 353
see also autonomic nervous system
 parathyroid gland 631-2
 parathyroid hormone 185, 186, 196, 554, 570,
 607, 631-2
 paraventricular nucleus 358
 parietal cells 485-8, 487, 488, 488
 parietal pericardium 296
 pars intermedia 638
 partial pressures 213-15, 215
 particle movement 502-6, 503-6
see also specific processes
 parturient paresis 281, 569
 hormone changes 690, 690
 signs of 689-90
 stages 690-2, 691, 691
 parturition 689-92, 690, 691, 691, 692
 passive transport 13
 patent ductus arteriosus 388, 415, 426, 427
 Pekin duck (*Anas spp.*), gas exchange
 variables 252
 pellagra (black tongue) 560
 pelvic nerve 95, 98
 lesions of 99
 penis 660-2, 660, 661
 autonomic innervation 91
 birds 256
 erection 667
 pepsin 536
 pepsinogen 510, 536
 peptide hormones 618-21, 619-21
 peptides, reabsorption 170-1

- peptones 536
 peri-parabronchial mantle 248, 248
 pericardium 296
 perichondrium 594
 pericranium 595
 perikaryon 4, 4
 perilymph 50, 79
 perimysium 265
 periodic breathing 236-7, 237
 periodic ophthalmia 561
 periosteum 595
 peripheral nervous system 3
 classification of nerve fibers 6
 peripheral resistance, exercise response 447
 peristalsis 274
 peristaltic waves 274
 peritubular capillaries 160, 168
 perivascular end feet 7
 peroxidase 118
 Peyer's patches 493
 pH
 blood 115, 122
 extracellular fluid 137
 and H⁺ concentration 137
 pH-bicarbonate diagram 146, 147
 phagocytosis 118, 241
 birds 256
 Phalaris staggers 581
 phallus of birds 718
 pharynx 205, 206
 phasic flow 390
 pheromones 618, 662
 phonocardiogram 417, 418
 aortic stenosis 423
 diastolic heart murmur 427
 first heart sound 419
 functional heart murmur 425
 heart block 420
 mitral insufficiency 425
 patent ductus arteriosus 427
 phosphate 572
 absorption 510
 reabsorption 185-6
 phosphate buffer system 139
 phosphorus 572-4
 blood 134
 deficiency 573
 dietary sources 573
 homeostasis 572-3
 syndromes 573-4
 toxicity 573
 utilization in ruminants 573
 photoperiodism 668, 683, 683
 birds 715-17, 716, 717
 photopigments 59
 photoreceptors 58-61, 60, 61, 715-16
 in darkness 62
 light absorption 62, 62
 photorefractoriness 716
 photostimulation 716
 phyloquinone 557
 physical conditioning *see* exercise training
 physiologic contracture 272
 physiologic dead space 223
 physiologic receptors 35
 phytic acid 573
 pica 573
 pigeon (*Columba* spp.)
 blood values 253
 gas exchange variables 252
 pigs
 anemia in piglets 586
 arterial blood pressure 292, 353
 blood constituents 134
 blood values 118, 122
 copper as growth promoter 583
 female reproduction 672, 680, 684, 692, 692
 gastric mucosa 485
 heart rate 343
 heat intolerance 152
 hepatosis dietetica 588
 kidneys
 nephrons 159
 renal concentrating capacity 177
 mammary gland 695
 milk composition 711
 mulberry heart 588
 nostrils 204
 parakeratosis 590
 pulmonary circulation 388
 rectal temperature 150
 respiratory frequency 210
 urine specific gravity 190
 piloerection 152
 pineal gland 643, 643
 autonomic innervation 91
 pinocytic vesicles 10
 pinocytosis 118, 506
 pituitary gland 623-4, 624
 adenohypophysis 624, 624, 638
 neurohypophysis 624, 624, 639-40, 639
 pituitary-adrenal axis 632-7
 placenta 688, 688, 695
 chorio-vitelline 695
 placentation 674, 675, 687-8, 687
 placentome 688
 plasma 133-5, 134, 134
 colloid osmotic pressure 133
 effective osmotic pressure 131
 ultrafiltrate 166
 viscosity 445
 volume 109, 115
 plasma proteins 122, 133-4, 134
 plasminogen 128, 131
 plasticity 123
 platelet plug 129
 platelets 128-9, 128
 activation 129
 adhesion 128-9, 129
 aggregation 129
 release reaction 129, 129
 pleura 203, 204, 208, 219
 plugged tom cats 579
 pneumoconiosis 241
 pneumonia 243
 pneumotaxic center 232
 pneumothorax 217, 218
 poikilotherms 149
 Poiseuille-Hagen equation 293, 293, 294

- Poiseuille's equation 388
 Poiseuille's law 220
 poisoning
 bracken-fern 562
 cadmium 590
 fluorine 590-1
 lead 591
 mercury 591
 rodenticides 556, 558
 sweet clover 132, 558
 polarization 306
 polioencephalomalacia 562, 580
 polychromatophilic erythroblasts 117
 polychromatophilic erythrocytes 117
 polycythemia 125
 polycythemia vera 125
 polydipsia 178, 636
 polyestrous animals 682
 polypnea 210
 polyribosomes (polysomes) 122
 polyspermy 686
 polyuria 178, 189
 pores 104
 portal systems 288
 portal vein 412
 portomicrons 537
 positive feedback 623
 post-extrasystolic potentiation 342, 342
 postganglionic fibers 90
 postprandial hyperemia 410
 posture 74-6, 75, 76
 potassium ions *see* K⁺
 poultry *see* chickens (*Gallus* spp.); turkeys
 PR interval 450
 precapillary arterioles 390
 precipitation 120
 preganglionic fibers 90, 353
 pregnancy 685-9, 686-8
 diagnosis 689
 fertilization 686-7
 hormones 688-9
 implantation and placentation 687-8, 687
 transport of oocyte and spermatozoa 685-6
 pregnancy toxemia 547
 pregnant mare serum gonadotropin (PMSG) 689
 prehension in birds 534-5
 prekallikrein 128
 preload 288, 328, 337, 341
 decreased 435
 increased 433
 premature atrial complexes 321
 premature ventricular complexes 321, 450
 prepuce 660-2, 660, 661
 preputial diverticulum 662
 pressoreceptors 362
 pressure 291-3, 291, 292, 292
 pressure natriuresis/diuresis 430
 pressure overload 436
 pressure-volume loop 336-7, 337, 338
 presyncope 319
 pretectal nucleus 63

- sheet flow concept 390
 transit time 391-2
 pulmonary blood volume 389-90
 pulmonary circulation 288, 386-98
 anatomy 386-7, 387
 bronchial vessels 387
 pulmonary vessels 386-7
 right ventricle 386
 pressures 387-90, 388
 pulmonary artery 388-9, 388, 389
 right ventricular 387-8, 388
 vasomotor tone 393-4
 pulmonary edema 384, 392-3
 interstitial 453
 neurogenic 393
 pulmonary embolism 392
 pulmonary hemorrhage, exercise-induced 392, 454, 455
 pulmonary hypertension 388, 394-7
 emphysema (heaves) in horses 395
 exercise-induced in horses 396-7, 396, 397
 heartworm disease in dogs 395, 396
 high altitude 394-5, 395
 vaso-occlusive 384
 pulmonary vascular resistance 387, 391, 391
 pulmonary veins 207
 pulmonary ventilation 222-4, 223, 224
 hypoxic vasoconstriction 224
 terminology 222-3
 ventilation/perfusion relationships 223-4, 223, 224
 pulmonic insufficiency 426
 pulmonic stenosis 423, 424
 pulse contour 388, 388, 389, 389
 pulse pressure 291
 exercise response 446
 pupillary dilator muscle 57
 pupillary light reflex 63-5, 65, 66
 consensual (indirect) 64
 direct 64
 pupillary sphincter muscle 57, 58
 purinergic receptors 379
 Purkinje cells 304
 Purkinje fibers 320
 purring 242-3
 pus 119
 pyloric stomach 485
 pyramidal tract 71
 pyridoxine 561
 QRS complex 315, 332
 exercise response 450
 QT interval 450
 quadriceps reflex 73
 rabbits
 arterial blood pressure 353
 heart rate 343
 mammary gland 695
 maximum speed 444
 milk composition 711
 rectal temperature 150
 vitamin D in 556
 radiation 458
 radiotelemetry 450
 rapid-onset vasodilation 408
 rats
 arterial blood pressure 353
 gastric mucosa 485
 heart rate 343
 milk composition 711
 renal concentrating capacity 177
 reactive hyperemia 376, 377, 404
 receptive field 37, 39-41, 39, 40, 41
 receptor potential 35, 37
 receptor tyrosine kinases 620-1, 621
 receptors 25-8, 26, 27
 cell membrane-bound 619-21, 619-21
 ion channel-coupled 621
 ionotropic 25
 metabotropic 25
 see also individual types
 rectal temperature 149, 150
 rectum in birds 534, 534
 red blood cells *see* erythrocytes
 red kangaroo
 mammary gland 695
 milk composition 711
 red muscle fibers 264-5, 264
 exercise response 455
 red nucleus 70
 lesions of 71
 reentrant excitation 319
 reentry 322-4, 323, 324
 reflex motor control 73-6, 73-6
 reflexes
 auditory 55, 55
 baroreflexes *see* baroreflexes
 cardiac 348-9
 cardiopulmonary 366
 crossed extensor 75, 76
 diving 369
 exercise pressor 367
 micturition 189
 pupillary 63-5, 65, 66
 quadriceps 73
 respiratory 233-4
 stretch 75, 75
 vestibulo-ocular 86
 vestibulospinal 85-6, 85
 refractory period 19, 19, 476
 absolute 307
 relative 307
 regulatory chains 276
 regurgitation contractions 516, 528, 528
 reindeer, milk composition 711
 relative medullary thickness 176, 177
 renal blood flow 163, 164, 167
 birds 197
 renal clearance 190-2, 191
 renal disease, chronic (CKD) 178, 430
 renal hilus 157
 renal hyperparathyroidism 610
 renal interstitium 163
 renal plasma flow 163, 164
 birds 194
 renal portal system in birds 193-4, 197
 renal portal valve 194
 renal shutdown, acute 167
 renal tubular transport 168-71, 169, 170

- renin 161, 168, 359–60, 634
 renin-angiotensin-aldosterone system 181, 181, 359–60, 430
 birds 196
 rennin 510
 renorenal reflexes 163
 repolarization 16, 305, 306, 308–9, 308
 reproduction
 birds 715–26
 female 670–93
 male 654–69
 reproductive system, autonomic innervation **91**
 reptilian-type nephrons 193, 195
 residual volume 211
 respiration 213–21
 birds 245–59
 anatomy 245–9, 246–9
 applied physiology 257–8
 control of ventilation 255–6
 gas exchange 251–5, 251, 252, **252**, **253**
 muscles of respiration 249–51, 250
 pulmonary defense mechanisms 256–7
 gas exchange 213–16, 214, **214**, **215**, 216
 mechanics of 216–19, 217–19
 and pulmonary artery pressure 389
 regulation of 232–8
 braking effect 236
 exercise response 237
 humoral control 234–6, 235, 236
 neural control 233–4
 periodic breathing 236–7, 237
 voluntary control 234
 respiratory acidosis 144, 145–6, 146, 222, 234, 453
 renal compensation 146, 146
 respiratory alkalosis 144, 146, 222, 234
 renal compensation 146
 respiratory center 232–3, 233
 respiratory clearance 239–41
 alveolar 240–1
 particle size 240, 240
 physical forces 239–40
 upper respiratory tract 240, 240
 respiratory cycles 207–8
 respiratory frequency 210, **210**
 respiratory pattern (waveform) 207
 respiratory pressures 216–18, 217, 218
 respiratory quotient 230
 respiratory sinus arrhythmia 349, 349
 respiratory system 203–12
 in acid-base balance 140, 141, 234–5
 airways 204–6, 204–7
 breathing *see* breathing
 exercise response 451–4
 blood gas tensions and acid-base balance 453–4, 454
 exercise-induced pulmonary hemorrhage 454
 locomotion 453
 oxygen uptake 451–3, 452, 453
 ventilation 451, 451
 lungs and pleura 203, 204, 208
 pulmonary alveoli 206–7, 209
 pulmonary volumes/capacities 211, 211
 see also specific parts
 resting membrane potential 15, 16
 resting potential 307
 retching 478
 rete testis 717
 reticular fibers 277
 reticular formation 70
 reticular groove reflex of ruminants 529
 reticulocytes 122
 reticuloendothelial system 393
 reticulospinal tracts
 medullary 70, **70**
 pontine 70, **70**, 98
 reticulum 522, 523
 retina 58, 60
 retinaldehyde 553
 retinoic acids 552
 all-*trans* retinol 552
 retinol-binding protein 552
 retinopathy, hypertensive 432
 retractor penis muscles 662
 retroperitoneal structures 157
 Reynolds number 294
 rhabdomyolysis, exertional 281, 459
 rhesus monkeys, heart rate **343**
Rhizoctonia leguminicola 474
 rhodopsin 59, 553
 rhythmic motor control 76–7
 riboflavin 561
 rickets 555, 571, 573, 610–11
 right ventricle 386
 right ventricular pressure 387–8, 388
 rigor 272
 rigor mortis 272
 RNA polymerase 589
 rod cells 59, 61
 visual acuity 63
 rodenticides 556, 558
 rostral colliculus 63
 rostral ventrolateral medulla 358
 rubriblasts 122, 122
 rubrospinal tract 70
 Ruffell's griffon, blood values **253**
 Ruffini's corpuscles 33, 33
 rumen 522, 523
 fermentation in 523–5, 525
 fungi and protozoa 524–5, 525
 rumen-degradable protein 524
 ruminants
 energy metabolism 544–5
 gastrointestinal system 522–31
 camelids 529, 529
 forestomach motility 526–9, 526–8
 forestomachs of cow 522–3, 523
 microbial ecology 519–30
 rumen fermentation 523–5, 525
 volatile fatty acid absorption 525–6, 525, 526
 hypophosphatemia 573–4
 Phalaris staggers 581
 phosphorus utilization 573
 reticular groove reflex 529

- Ruminobacter* spp. 524
Ruminococcus spp. 523
 sacculae 79, 82
 saliva **91**, 468–9, 469
 digestive role 484
 salivary glands
 autonomic innervation **91**
 birds 533
 salt gland of birds 197–8, 198
 salt toxicity 576
 saltatory conduction 21
 sarcolemma 265
 sarcomeres 266, 296–7, 327
 sarcoplasmic reticulum 267, 268, 287, 327
 sarcotubular system of skeletal muscle 266–7, 266, 267, 276
 satellite fibers 280
 satellite lymph nodes 241
 scala tympani 51
 scala vestibuli 51
 Schwann cells 5, 5
 sclera 57
 scrotal hernia 659
 scrotum 657
 scurvy 563, 598
 seals, milk composition **711**
 sebaceous glands 150, 151
 specialized 696
 second messengers 569, 619
 secondary (flower-spray) endings 35
 secondary hypertension 429
 secondary sexual characteristics 666
 secretin **519**, 537
 secretory diarrhea 497–500, 499, 578
 sedimentation 239
 sedimentation rate **122**
 selectively permeable membranes 106
 selenium 587–8
 toxicity 588
 selenium accumulators 588
 semen 659–60, 659
 cryopreservation 719
 semicircular ducts 79, 82
 semilunar valve 332
 semilunar valves 295, 296
 seminal glomus 717
 seminal plasma 659, 667
 seminiferous tubules 637, 654, 656, 657, 666
 birds 717
 semipermeable membranes 105
 senile osteoporosis 611
 sensible water loss 110
 sensory hair cells 50, 51, 52, 80, 81
 sensory nerve fibers 6
 sensory pathways, ascending 37, 39, 39–41
 sensory receptors 32–5, 33
 septic shock 440
 sequestration 241
 serotonergic receptors 379
 serotonin 24, **24**, 393
 Sertoli cells 654, 656
 sexual receptivity 682

- sheep
 adaptation to water lack 112–13
 arterial blood pressure **292**, **353**
 blood constituents **134**
 blood values **118**, **122**
 heart rate **343**
 hypomagnesemic syndrome 575
 kidneys 158
 mammary gland **695**
 milk composition **711**
 neonatal enzootic ataxic (swayback) of lambs 583
 nostrils 204
 pulmonary circulation **388**
 rectal temperature **150**
 reproduction
 female **680**, 684, 692, **692**
 male 660, 661
 respiratory frequency **210**
 spermatozoa 665
 urine specific gravity **190**
 sheet flow concept 390
 shell gland of birds 721
 shivering 152
 shock 439–41
 cardiogenic 439–40
 circulatory 435, 439
 hypovolemic 440
 septic 440
 stages of 440–1
 shoulder slip 281
 Siggaard-Andersen alignment nomogram 146
 sighs 207, 233
 signal transduction 619
 silicosis 241
 simple diffusion 14, 103
 single-unit (visceral) smooth muscle 274, 275
 sinoatrial (SA) node 311–12, 312
 sinus arrhythmia 389, 450
 sinus bradycardia 320, 320, 449
 sinus tachycardia 319, 320
 sinus of Valsalva 400, 400
 sinusoids 412, 490
 skeletal muscle 263–73
 circulation 407–10, 408
 anticipation of exercise 408
 at rest 408
 effects of exercise training 409–10
 moderate exercise 409
 transition from rest to exercise 408–9
 very intense exercise 409
 contraction 269–72, 270–2
 actin/myosin in 269–70, 270, 271
 energy changes 270
 source of energy 272
 strength of 272, 272
 vs. contracture 272
 depolarization of muscle fibers 268–9, 271
 exercise response 454–8
 adaptions 455–8, **455**
 biochemical changes 456–7
 capillary density 456
 energy considerations 457–8
 histochemistry, biochemistry and morphology 457
 morphology and speed 458
 muscle fibers 455–6
 myoglobin 456
 fiber types 264, 264
 exercise response 455, 456
 red fibers 264–5, 264
 white fibers 265
 harnessing 265, 265
 microstructure 265–7, 266, 267
 neuromuscular junction 267–8, 268
 percentage by weight **455**
 sarcotubular system 266–7, 266, 267
 staircase phenomenon 272, 272
 vs. smooth muscle 276–7
 skin, autonomic innervation **91**
 slaframine 474
 sloths, milk composition **711**
 slow twitch fibers *see* red muscle fibers
 small intestine
 birds 534
 cells of 493–4
 electrolyte absorption 508, **508**
 motility 479, 479
 secretions 492–500
 as response to inflammation 497, 497, 498
 secretory diarrhea 497–500, 499
 villi 492, 493, 494, 495, 496
 see also specific areas
 smell *see* olfaction
 smooth muscle 274–8
 autonomic innervation 92, 93
 contraction 276
 contraction stimuli 277
 gastrointestinal system 474–6
 microstructure 275–6, 275, 276
 multiunit 274, 275
 single-unit (visceral) 274, 275
 vascular 380, 387
 vs. skeletal muscle 276–7
 see also autonomic nervous system
 sniffing 205
 sodium *see* Na⁺
 soft palate 205
Solanum malacoxylon 556
 solid-state catheter transducer systems 448
 solute-free water clearance 192
 solutions 103–8
 diffusion 14, 24, 103–4, 104
 osmosis 105–6, 105, **105**
 tone of 106–7, 106, 107, **107**
 solvent drag 506
 soma 4, 4
 somatic cell count 709
 somatic pressor reflex 367
 somatomedin A 625
 somatomedin C 625
 somatosensory fibers 40
 somatosensory receptors 32, 33–5, 34, 36
 somatostatin 625, 642–3
 somatotrope pituitary tumor 627
 somatotropin *see* growth hormone

- spasticity 74
 spatial summation 16–17
 spermatoc cord 657, 658
 spermatocytogenesis 663
 spermatogenesis 663–6, 664–6
 birds 718
 epididymal transport 664
 hormonal control 665–6
 spermatogenic wave 664–5
 spermatogonia 663
 spermatozoa 664, 665
 spermatozoa reservoirs 686
 spermiation 664
 spermiogenesis 663
 birds 718
 sphincters 264
 urinary bladder 157, 158, 189
 spina bifida 560
 spinal cord
 cardiovascular control centers 358
 lesions of 99
 spindle-shaped muscle fibers 275
 spinothalamic tract 37, 39, 39–41
 spirinolactone **183**
 splanchnic circulation 410–13, 411
 and cardiovascular homeostasis 412–13
 hepatic circulation 412
 intestinal circulation 410–12
 splenic contraction 444, 444, 445, **445**
 spring tetany 575
 stagnant hypoxia 243
 staircase phenomenon 272, 272, 342, 342
 stapedius muscle 55
 Starling curve 337, 337
 Starling principle 392
 Starling's law of the heart 329–30, 341
 statoconia 80
 steatitis 557
 stellate ganglia 345, 345
 stem cells
 hematopoietic 119
 myeloid 116
 stercobilin 124
 stereocilia 50, 80, 80
 steroid hormones 622
 receptors 622–3, 622
 stethoscope 417
 stimulus transduction 35–7, 36, 37
 intensity/duration of stimulus 36
 modality of stimulus 36
 stimulus location 36–7
 stomach
 birds 533–4
 ruminants 522–3, 523
 see also entries under gastric
 stranguria 189
 streak canal 696
Streptococcus spp. 524
 stretch reflex 75, 75
 striola 80
 stroke volume 291, 331, 429
 exercise response **447**, 448, **448**
 exercise training 449
 struvite crystals 575

- submucosal plexus 470, 493
 substance P 24, 405
 succinylcholine 269
 sucrase 513, 536
 sulfa drugs 558
 sulfonamides 560
 sulfur 579–80
 superoxide anion 587
 superoxide dismutase 581
 supraventricular pacemakers 312–13
 supraventricular tachycardia 324
 surface tension 219, 219
 surfactants 219–20, 256
 swallowing (deglutition) 469–70, 470
 sweat composition 459
 sweat glands 90
 apocrine 90, 91, 151, 151
 eccrine 151
 merocrine 90, 91
 sweency 281
 sweet clover poisoning 132, 558
 sweet taste 47
 swine *see* pigs
 sympathetic nervous system 92–4, 93, 94
 abdominal/pelvic viscera 92–4, 94
 boutons en passage 29
 cardiac innervation 344–6, 344–6
 cardiovascular control 355–6, 356
 cholinergic vasodilator fibers 355, 356, 357
 gastrointestinal system 473
 head and neck 92, 93
 preganglionic cell bodies 353
 smooth muscle and glands 92, 93
 thoracic viscera 92
 see also autonomic nervous system
 sympathoadrenal system 459, 460
 symporters 14
 synapses 3, 24
 chemical 23
 electrical 23
 excitatory 15
 inhibitors 16, 16
 see also neuromuscular junction
 synaptic cleft 268
 synaptic transmission 23–31
 neurotransmitters 23–4, 24, 24, 25
 receptors 25–8, 26, 27
 syncope 319
 synovial joints 607
 syrinx 205
 systemic circulation 288
 systemic hypertension 429
 systemic inflammatory response syndrome (SIRS) 440
 systole 332
 systolic failure 435
 causes 435–6, 436
- T cells 119
 see also specific types
 T tubules 268, 298
 T wave 315
 tachycardia 394, 438
 sinus 319, 320
- tachypnea 210
 tapetum lucidum 58
 taste *see* gustation
 taste buds 46–7, 46
 taste receptor cells 47
 taurine 491
 taurocholic acid 491
 teat sphincter muscle 696
 tectorial membrane 50
 tectospinal tract 70
 teeth
 brachyodont 468
 hypsodont 468
 telmisartan 434
 temperature *see* body temperature
 temporal summation 17
 tenase complex 130
 tensor tympani reflex 55
 testes 654–7, 655–7
 birds 717
 endocrine regulation 718–19
 descent of 657–9, 658
 function 667–8
 testosterone 665, 677
 tetanus 281
 tetany 272, 281, 569, 575
 puerperal 272, 282
 tetrahydrofolate methyltransferase 580
 tetrathiomolybdate 592
 tetrodotoxin 20
 thebesian veins 453
 theca interna/externa 679
 birds 720
 thecal capillaries 679
 Theria 695
 thermoreceptors 32, 33
 birds 255–6
 thermoregulation 369
 exercise response 458–9, 459
 thiaminase 562
 thiamine 561–2
 thiazide diuretics 183
 thiouracils 631
 thirst 180
 antidiuretic hormone-thirst system 184, 185
 relief of 112
 stimulus for 111
 thoracic viscera, autonomic innervation 92
 threshold potential 15, 16, 17
 thrombin 128, 129
 generation of 130, 130
 thrombin receptor 379
 thrombocytes *see* platelets
 thrombomodulin 128, 128, 132
 thromboplastin *see* tissue factor
 thrombosthenin 131
 thromboxane A₂ 129, 361
 thyrocalcitonin 628, 632
 thyroid follicles 628, 628
 thyroid gland 628, 628
 and photoperiodic response in birds 716, 717
- thyroid hormones 153, 622, 628–31
 actions 630
 cardiovascular effects 360
 control of secretion 629–30, 630
 exercise response 459–60
 formation and release 628–9, 629
 receptors 622–3, 622
 structure 629
 thyroid-stimulating hormone (TSH) 628
 thyrotropin releasing hormone (TRH) 629
 thyroxine, cardiac effects 350
 tick paralysis 29
 tidal volume 211
 tight junctions 10, 506
 tissue factor 128, 130
 tissue factor pathway 130
 tissue injury, neutrophils in 118
 tissue-type plasminogen activator 128, 128
 tocopherols 556
 tone 274
 of solutions 106–7, 106, 107, 107
 total body water 108, 109
 total peripheral vascular resistance 429
 total ventilation 222
 trabecular (spongy, cancellous) bone 596
 trachea 206, 207
 birds 246, 246
 transamination 645
 transcellular absorption 506, 507
 see also specific ions
 transcellular fluid 108, 109
 transcytosis 705
 transferrin 124
 transmembrane potential 307
 transmural pressures 389
 transport tetany 575
 trapezoid body 55
 dorsal nucleus 55
 Traube-Hering-Mayer waves 367, 389
 tree shrew, milk composition 711
 trehalose 513
 treppe 272, 272, 342, 342
 triads 267, 267
 tricarallylate 575
 tricuspid insufficiency 424, 449
 tricuspid stenosis 425–6
 trigger zone 15, 20
 triglycerides 705–6
 trilaminar substance of birds 256–7
Trisetum flavescens 556
 tropomyosin 270, 297
 troponin 270, 297
 trypsin 511, 511
 trypsinogen 536
 tubular fluid 163
 tubular reabsorption 168–71, 169, 170
 transport maximum 171
 tubular secretion 171
 tubuloglomerular feedback 168
 tunica albuginea 654, 671
 tunica dartos 657
 tunica mucosa 492
 tunica muscularis 493
 tunica serosa 493
 turbulent flow 293–4, 294
- turkeys
 arterial blood pressure 353
 blood values 253
 gastrointestinal system 533
 turtles, vitamin A deficiency 553
 tyrosinase 581
 tyrosine 24, 24
 tyrosine kinase 620–1, 621
- unipolar neurons 5
 units of measurement, interconversion 107–8, 107
 upper air passage reflexes 233–4
 upper airway obstruction 454
 upper motor neurons 71, 71
 upper respiratory tract clearance 240, 240
- urachus, persistent 688, 688
 urea 190
 recirculation 175
 urea excreting group 196
 ureter 157
 ureterovesicular valve 188
 urethra 157
 flow receptors 189
 urethralis muscle 662
 uric acid 134
 formation in birds 196
 urinary bladder 157, 159
 autonomic innervation 91, 98
 sphincters 157, 158, 189
 transitional epithelium 189
 urine transport to 188–9
 urinary continence 189
 urine
 characteristics 189–90, 190
 birds 197
 color 190
 composition 190
 birds 195–7, 197
 concentration 176–8, 177, 177
 birds 194–5
 consistency 190
 formation 163–4, 164, 164
 birds 194–5, 195
 micturition 98–9, 188–9
 odor 190
 specific gravity 190, 190
 transport to urinary bladder 188–9
 volume 164
 urobilin 124, 190
 urobilinogen 124, 190
 urodeum 534
 urokinase-type plasminogen activator 128
 uroliths 575
 uterine artery 675
 uterine milk 686
 uterine tubes 674, 674
 uterovaginal junction 721
 uterus 674, 674, 675
 autonomic innervation 91
 gravid 674
 involution of 692
 utricle 79, 82
- V150 461
 vagina 674–5
 birds 721
 vestibule 675, 676
 vaginal artery 675
 vaginal cavity 658
 vaginal tunic 657
 vagus nerve 95, 247, 353, 488
 dorsal motor nucleus 363
 Valsalva maneuver 389
 varicosities 277
 vas deferens 657, 659
 vasa recta 173, 175–6, 175
 birds 196
 vascular bed *see* blood vessels
 vascular compliance 294–5, 295
 vascular endothelium in hemostasis 127–8
 vascular resistance 294
 vascular tone 290–1, 375
 basal 375
 capillaries 375–6
 myogenic 375
 pulmonary circulation 393–4
 vasculotoxic agents 394
 vasoactive intestinal peptide 536
 vasoactive substances 393
 vasoconstriction 376
 hypoxic 224
 vasodilation 375
 active 356–7, 357
 cholinergic vasodilator fibers 355, 356, 357
 conducted 377
 vasomotor nerves 393–4
 vasopressin 176–7, 379
 cardiac effects 350
 cardiovascular effects 360
 vasopressinergic receptor 379
 vectors 318–19, 319
 veins
 innervation 91
 see also individual veins
 venous congestion 436, 438
 venous return 288
 ventilation *see* respiration
 ventilation/perfusion mismatch 223–4
 ventilation/perfusion ratio 223, 223
 ventilation/perfusion relationships 223–4, 223, 224
 ventral respiratory group 232
 ventricles 295–6, 295
 innervation 344
 left
 contractility 435
 end-diastolic pressure 448
 hypertrophy 433
 right 386
 wall stress 300, 301
 ventricular emptying 332, 332
 ventricular fibrillation 319, 324
 ventricular function curves 337, 337
 ventricular pacemakers 313
 ventricular performance 337–9, 338
- ventricular preload 448
 ventricular pressure-volume diagram 336–7, 337
 ventricular tachycardia 324
 ventriculus 533, 533
 very low density lipoproteins (VLDL) 720
 vesicular glands 659
 vestibular nerve 84–6, 85
 vestibular nuclei 70, 71, 84
 vestibular organ 79–81, 80, 81
 orientation of sensory cells 80–1, 82
 vestibular system 79–88
 detection of head movement 83–4, 83, 84
 nystagmus 86–7, 87
 transduction of stimulus 80, 81–3, 81
 vestibulo-ocular pathway 86, 87
 vestibulo-ocular reflex 86
 vestibulospinal reflex 85–6, 85
 vestibulospinal tracts 85, 85
 lateral 70
 medial 70
 vibration 34
 villi 492, 493
 blood flow 495, 496
 cells of 494
 villous absorptive enterocytes 494, 520
 carbohydrate absorption 513
 fat absorption 515, 515
 protein absorption 511–12, 512
 visceral pleura 203, 219
 viscerosensory fibers 39, 40
 viscerosensory receptors 32, 35, 36
 visual acuity 62–3, 63
 visual field 63, 64
 visual system 57–67
 pathways of visual signals 63–6, 63–6
 photoreceptor cells 58–61, 60, 61
 structure of eye 57–8, 58, 59
 transduction of visual signals 61–2, 62
 vitamins 551–64
 exercise requirements 462
 see also specific vitamins
 vitamin A 552–4, 552
 deficiency 553
 functions 552–3
 status 553
 syndromes 553–4
 toxicity 553
 vitamin B₁ 561–2
 vitamin B₂ 561
 vitamin B₆ 561
 vitamin B₁₂ 559, 580
 vitamin C 562–3
 vitamin D 185, 186, 554–6, 554, 607
 deficiency 555, 611
 function 554–5
 syndromes 556
 toxicity 555–6
 vitamin E 556–7
 deficiency 557
 syndromes 557
 vitamin K 557–8
 vitellogenin 720

- volatile fatty acids 522
 absorption 525-6, 525, 526, 537
 Volkmann canals 596
 voltage-gated Na⁺ channels 17-18, 18
 volume overload 436
 voluntary motor control 68-73
 basal nuclei 71-2
 brainstem motor nuclei 70-1, 70,
 71, 72
 cerebellar modulation 70, 72-3
 cerebral cortex 68-70, 69, 70
 upper and lower motor neurons 71, 71
 vomiting center 477
 vomition (emesis) 477-9, 478
 von Willebrand disease 132
 von Willebrand factor 128, 129
 vulva 675
- water
 daily requirements 110-11
 gain 110
 intoxication 109
 loss 110
 metabolic 110
 transport 170
 turnover 110
- see also* body water
 water absorption 516-19, 516, 517, 518
 water balance 110-11, 110, 111
 gastrointestinal system 517, 517
 see also diarrhea
 water lack, adaptation to 112
 water vapor, total/partial pressures 215
 wave summation 272
 wedge pressure 389
 Weisberg, H.F. 103
 Wenckebach type I atrioventricular
 block 450
 wet poultry droppings 576
 whales *see* cetaceans
 wheat pasture tetany 575
 whey 705
 white blood cells *see* leukocytes
 white fat 153
 white fat disease 557
 white matter 5
 white muscle disease 557, 588
 white muscle fibers 265
 biochemical properties 300
 exercise response 455
 Wiggers diagram 333-6, 334, 334, 335
 winter tetany 575
- Wolffian ducts 666
 birds 719
- xerophthalmia 553
 xylazine 626
 yaks, milk composition 711
 yellow fat disease 557
 yolk 720
 yolk lipids 538
 yolk stalk 538
 yolk utilization in
 birds 537-8
- Z lines 275
 zabu, milk composition 711
 zinc 588-90, 589
- zona
 fasciculata 633
 glomerulosa 633
 reticularis 633
- zone
 of hypertrophy 600
 of maturation 600
 of proliferation 600
 of provisional calcification 600
 zonula occludens 10, 506

