

# Advanced Physiology and Pathophysiology

Essentials for Clinical Practice

**Nancy C. Tkacs PhD, RN**

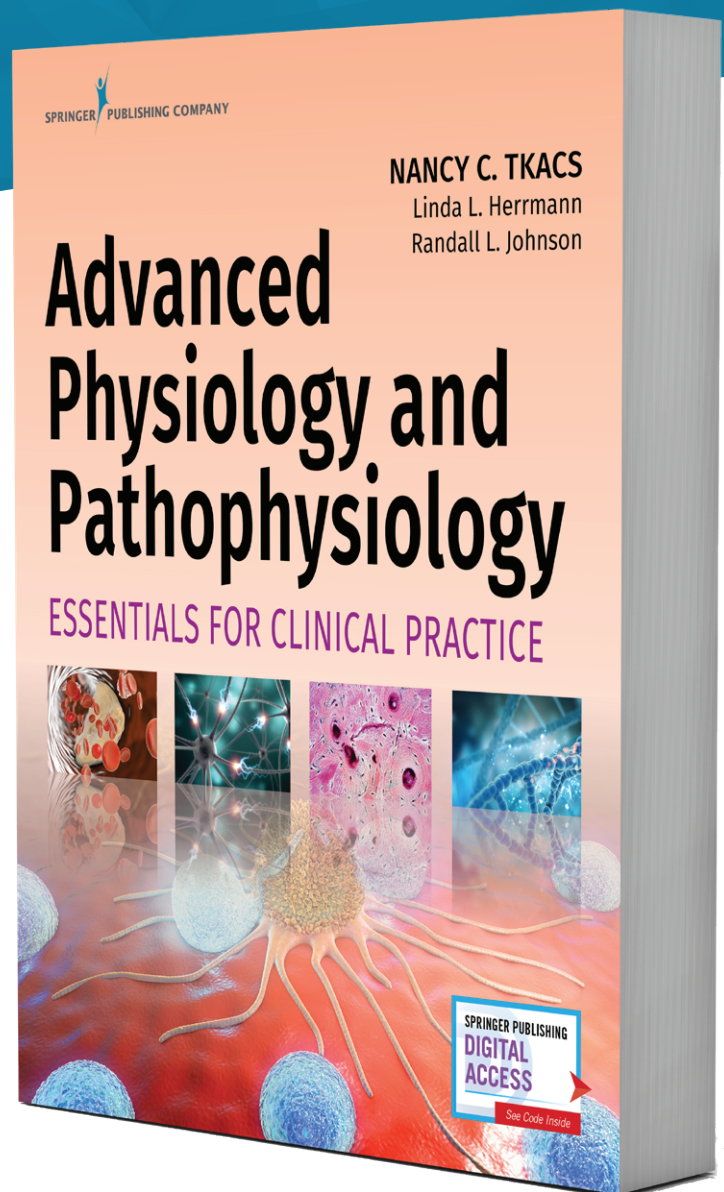
Linda L. Herrmann PhD, RN, ACHPN, AGACNP-BC, GNP-BC, FAANP

Randall L. Johnson PhD, RN

***Specifically designed for future healthcare providers who will diagnose, manage, and prescribe.***

This advanced physiology and pathophysiology text is designed to address the specific learning needs of future nurse practitioners, physician assistants, and other advanced healthcare providers caring for patients across the life span.

Focusing on practical applications of physiology, it facilitates in-depth understanding of important pathophysiological concepts as they relate to major disorders commonly seen in clinical practice and includes comprehensive pediatric and geriatric considerations. This knowledge is crucial to providing the foundation required to be an informed and confident clinical decision maker.



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## MEET THE EDITORS



**Nancy C. Tkacs**  
PhD, RN

Dr. Tkacs has been teaching pathophysiology for advanced nursing practice for over 25 years, drawing on her knowledge of organ systems physiology and pathophysiology to provide a strong basic science foundation for advanced nursing practice. She has taught the course most recently at the University of Pennsylvania and University of Southern California.



**Linda L. Herrmann**  
PhD, RN, ACHPN, AGACNP-BC, GNP-BC, FAANP

Dr. Herrmann is a clinical assistant professor at New York University Rory Meyers College of Nursing and nurse practitioner with expertise in gerontology, neuroscience, and palliative care. She teaches advanced pathophysiology and aging at the graduate level.



**Randall L. Johnson**  
PhD, RN

Dr. Johnson is an associate professor of nursing at the University of Tennessee Health Science Center. He is also a pediatric critical care nurse practitioner and has taught pathophysiology in both undergraduate and graduate degree programs.

*“We dedicate the book to our students who have asked such great questions through the years. You inspire us to do all we can to provide detailed, yet understandable explanations of the pathophysiological phenomena underlying advanced clinical practice.”*

Focuses on core concepts to provide a flexible foundation to adapt for instructor/program needs

Addresses WHY patients present with symptoms

Empowers students to think critically and prepares them for pharmacology and future clinical courses

Bridges science to clinical practice, & includes robust pediatric and gerontological considerations

Prepares students with concepts and vocabulary to learn how to learn about new diseases

# ENHANCED LEARNING FEATURES

**CASE STUDY 13.2: A Teenage Boy With Celiac Disease**  
 Amanda Chaney and Michelle Zappas

**Patient Complaint:** "My stomach has been upset off and on for the past few months. I feel really bloated, especially after I eat, and sometimes my stomach makes really loud noises followed by a lot of gas. I've lost a few pounds and I have been really tired. I never seem to have enough energy. I think I'm just really stressed out about starting college next year."

**History of Present Illness/Review of Systems:** You observe a healthy-appearing, 17-year-old boy, who reports fatigue, some intermittent nausea, and occasional vomiting. He notes that he has had loose, foul-smelling "floating" stools, usually three to four times per day. He denies taking any OTC or herbal supplement medications, with the exception of one iron supplement daily. He does report some intermittent, vague, generalized abdominal pain that comes and goes. He denies fever or any other acute complaints.

**Past Medical/Family/Social History:** The patient's past medical history is notable for iron deficiency anemia. His weight has been fluctuating over the past year, with weight loss of 10 lb in the past 2 months. With the exception of a tonsillectomy at age 7, he has had no surgeries, hospitalizations, or other chronic illnesses. His social history is negative for use of tobacco, alcohol, or other drugs. He indicates that his mother has autoimmune thyroiditis, which is well controlled; his father is alive and well, with a medical history of diabetes. He has a sister with celiac disease.

**Physical Examination:** Findings are as follows: temperature of 98.6°F, blood pressure of 110/72 mm Hg, heart rate of 60 beats/min, and respirations of 20 breaths/min. BMI is 20.9 kg/m<sup>2</sup>; abdominal pain is generalized, 2 out of 10. The patient is alert and oriented, and is a healthy-appearing teenager. Skin is dry and warm, with multiple pruritic papules and vesicles grouped on elbows, knees, and back. Eyes show no scleral icterus. Mouth has moist mucous membranes. S/S heart sounds are present, with regular rate and rhythm. Lungs are clear to auscultation bilaterally. Abdomen is flat, soft, and nontender, with hyperactive bowel sounds in all four quadrants. The liver edge is palpable just below the costal margin, soft and smooth. The spleen is not palpable. No other masses are palpable, and there is no rebound or guarding.

**Laboratory and Diagnostic Findings:** Laboratory data reveal mild anemia (Hb of 12.2 g/dL), AST, ALT, alkaline phosphatase, glucose, cholesterol, and thyroid levels are all normal; IgA tissue transglutaminase is elevated. EGD shows flattened villi, and a small bowel tissue biopsy sample is positive for IgA-tTG. Additional testing shows low levels of iron, folic acid, and vitamins B12 and D.

**CASE STUDY 13.2 QUESTIONS**

- In a patient with celiac disease, what is the effect of exposure to dietary gluten on small intestine structure and function?
- Why is the blood tested for IgA-tTG when testing for celiac disease?
- When should the provider be concerned about malabsorption in this patient?

ALT, alanine aminotransferase; AST, aspartate aminotransferase; BMI, body mass index; EGD, esophagogastroduodenoscopy; Hb, hemoglobin; IgA, immunoglobulin A; OTC, over-the-counter; tTG, tissue transglutaminase.

**PEDIATRIC CONSIDERATIONS**  
 Randall L. Johnson

**EMBRYOLOGICAL DEVELOPMENT OF THE CIRCULATORY SYSTEM**

All structures of the cardiovascular system—heart and blood vessels—are lined with a single layer of endothelial cells. In fact, endothelial cells make up the endothelial structures that will develop into heart and vessels. Cardiac development is described in Chapter 10. Heart vessels must develop simultaneously, to deliver oxygen and nutrients to support embryonic and fetal growth. From the earliest stages of endothelial tubes, the vessels destined to become arteries develop distinctive characteristics first, followed by the vessels destined to become veins. The proportion of pulmonary vessels and the embryonic blood from the placenta to the pulmonary vessels of blood flow to the heart is the final circuit. There is a brief, but the vessels are reduced or to their final size.

**BLOOD PRESSURE**

Hypernatremia is a circulatory system, including type 2 diabetes should be managed as a circulatory system.

**GERONTOLOGICAL CONSIDERATIONS**  
 Flynn/Trice

**AGE-RELATED CHANGES IN THE KIDNEY**

Age-related changes in the kidney include changes in organ size, number of nephrons, GFR, vasculature, and metabolism. Knowledge of age-associated changes in kidney function and biology has been greatly improved by studying diverse populations from healthy and aged persons of different ages (Fitz 13.3).<sup>42</sup>

**CHANGES IN KIDNEY MASS AND VOLUME**

The kidneys start to decrease in both weight and volume starting at about the fourth decade of life.<sup>42,43</sup> Loss of mass occurs mainly in cortical tissue owing to reduction in number and function of nephrons, while medullary mass is generally preserved.

**CHANGES IN RENAL BLOOD FLOW AND GLOMERULAR FILTRATION RATE**

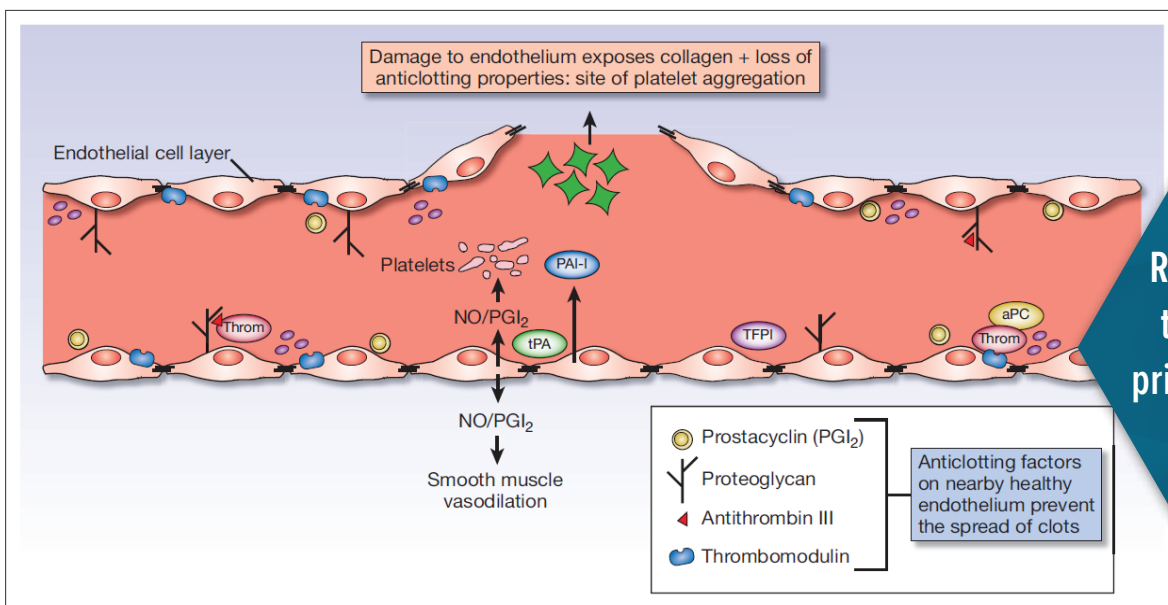
In the adult, RBF is about 1,200 to 1,300 mL/min in the absence of kidney disease, and GFR is about 10% of that. Each decade after age 40, RBF is reduced by about 10% and average GFR decreases by about 0.8 mL/min/1.73 m<sup>2</sup>.<sup>44</sup> The reduction in GFR and RBF are intercorrelated and primarily involve structural changes within the kidney and its vasculature. An animal study, similar to that on the one described in Box 13.3, have shown that many of these processes will occur independently of overt pathological processes. However, metabolic syndrome such as diabetes and hypertension, as well as pathological processes such as atherosclerosis and nephritis, correlate with more pronounced structural changes and decreases in kidney function. Finally, exercise may and oxidative production can decline with aging, so aerobic resistance may remain normal despite reduced GFR.<sup>45</sup>

**CHANGES IN NEPHRON NUMBERS AND FUNCTION**

At approximately age 40, the number of nephrons begins to decrease by more than 1,000 per kidney per year, partially explaining the decreased RBF and GFR described earlier.<sup>46</sup> Disease nephron number at birth

Case Studies throughout provide real-life scenarios to help connect pathophysiological concepts to clinical presentations

Pediatric and Gerontological Considerations provide essential life span coverage.

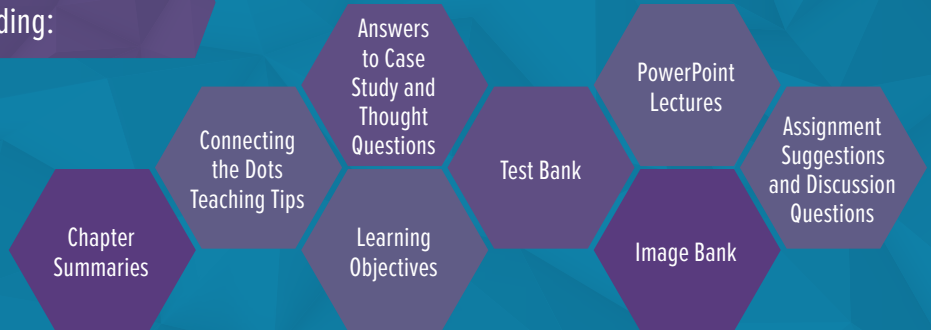


Richly illustrated to demonstrate principles of health and disease



## BONUS FEATURES

This text is accompanied by an Instructor's Manual and comprehensive bonus resources, including:



### Thought Questions

1. What is the “big picture” of the role of the immune system in maintaining homeostasis?
2. What are the general principles involved in protection provided by the innate and adaptive immune systems?

Thought Questions require students to reflect on the section they have just read, recall facts, and use higher-level thinking to apply what they have learned.

Bridge to Clinical Practice sections link pathophysiological concepts to clinical practices of assessment and management.



#### BRIDGE TO CLINICAL PRACTICE: Vascular System

##### PRINCIPLES OF ASSESSMENT

###### History

###### Evaluate:

- Symptoms of peripheral artery disease: Calf pain with walking, toe pain while lying down
- History of blood clots, hyperlipidemia, syncope
- Smoking status (active habit and total pack-years)
- Diet – Salt, sugar, fruits, vegetables, fats, carbohydrates
- Physical activity – Minutes/day, days/week, how well tolerated
- Family history of hypertension, diabetes, kidney disease, varicose veins, coronary artery disease, stroke

###### Physical Examination

- *Vital signs:* Know the proper methods for obtaining an accurate blood pressure measurement

###### Observe:

- Jugular venous pressure
- Cyanosis of lips or extremities
- Clubbing of the fingertips
- Discoloration of the skin
- Varicose veins, especially around the umbilicus
- Nonhealing ulcers or wounds of the lower extremities

###### Auscultate:

- Carotid arteries and abdomen for bruits
- Lung bases for pulmonary edema
- Liver scratch test for hepatomegaly

###### Palpate:

- Blood pressure by palpation
- Pulses
- Capillary refill
- Lower extremities for altered edema

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Nearly 30  
Case Studies

Key Points at  
the End of Each  
Chapter

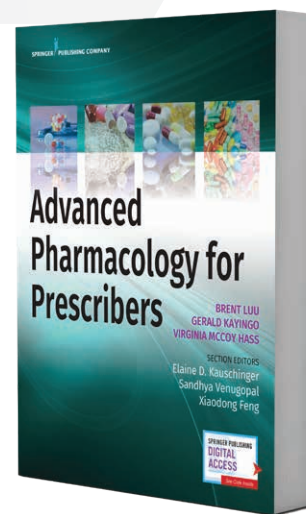
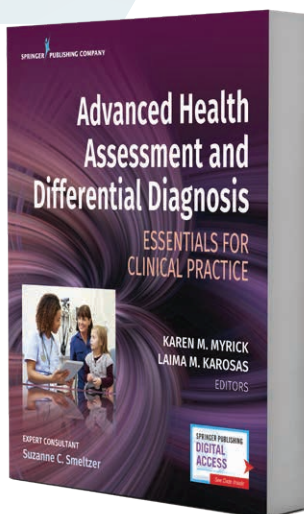
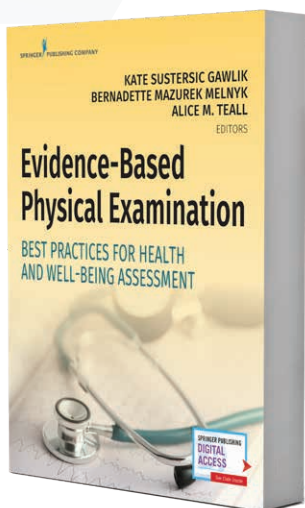
200+ Thought  
Questions

500+ Images

70+ Tables

# POWER THROUGH THE 3PS

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## Evidence-Based Physical Examination

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**The first book to teach physical assessment techniques based on evidence and clinical relevance.**

Grounded in an empirical approach to history-taking and physical assessment techniques, this text for advanced practice clinicians and students focuses on patient well-being and health promotion. It is based on analysis of current evidence and up-to-date guidelines and recommendations and underscores the evidence, acceptability, and clinical relevance behind physical assessment techniques.

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Essentials for Clinical Practice

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**The first textbook to specifically target the scope of practice for advanced practice providers.**

With a focus on promoting sound clinical decision-making and a streamlined and highly accessible approach, this text for advanced practice nurses and physician assistants delivers up-to-date primary care health assessment techniques for individuals throughout the life span. Each chapter offers a concise overview of anatomy and physiology and an in-depth review of normal and abnormal findings.

## Advanced Pharmacology for Prescribers

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Virginia McCoy Hass DNP, MSN, RN, FNP-C, PA-C

**Delivers the critical information clinicians need to be thoroughly informed prescribers.**

This unique resource—an evidence-based pharmacology text and reference for advanced practice students and clinicians—guides users in analyzing the pharmacological foundations of drug therapy and fosters the development of sound clinical judgment in determining the appropriate medication for every patient across the life span.