

Introduction to Surgical Pathophysiology

Introduction to Surgical Pathophysiology

Core concepts, key mechanisms, and clinical relevance for the surgical learner

1. What Is Surgical Pathophysiology?

Term	Definition
Pathophysiology	Study of how normal physiological processes are altered by disease.
Surgical Pathophysiology	Application of pathophysiologic principles to conditions that commonly require operative intervention. It bridges basic science (cellular, molecular, systemic changes) with the surgical decision-making process.

Why it matters:

- Guides pre-operative risk assessment.
- Helps predict intra-operative challenges (e.g., bleeding, tissue fragility).
- Informs postoperative management and complication prevention.

2. General Principles of Tissue Injury & Repair

Phase	Time Frame	Cellular/Molecular Events	Clinical Implications
Hemostasis	Seconds–minutes	Vascular spasm, platelet adhesion/aggregation, fibrin clot formation.	Immediate control of bleeding; importance of coagulation status (e.g., anticoagulants).
Inflammation	Hours–days	Neutrophil migration, cytokine release (IL-1, TNF- α), increased vascular permeability.	Edema, pain, fever; may affect wound healing and infection risk.
Proliferation	Days–weeks	Fibroblast proliferation, collagen deposition (type III $\rightarrow$ type I), angiogenesis, epithelialization.	Granulation tissue formation; basis for wound closure techniques.

Introduction to Surgical Pathophysiology

Phase	Time Frame	Cellular/Molecular Events	Clinical Implications
Maturation (Remodeling)	Weeks–months (up to 2?yr)	Collagen cross?linking, scar contraction, apoptosis of excess cells.	Strength of scar reaches ~80?% of original tissue; relevance for tensile stress on sutures.

Key concepts

- **Ischemia–reperfusion injury:** Reactive oxygen species (ROS) generated when blood flow returns to a previously ischemic area ? cell membrane damage, inflammation, microvascular dysfunction.
- **Oxidative stress:** Imbalance between ROS and antioxidants; contributes to organ dysfunction after major surgery.
- **Systemic inflammatory response syndrome (SIRS):** Widespread cytokine release can lead to multi?organ dysfunction; surgical trauma is a common trigger.

3. Major Organ?Specific Pathophysiologic Themes

3.1 Cardiovascular System

Issue	Pathophysiology	Surgical Relevance
Myocardial ischemia	Reduced coronary perfusion ? ATP depletion ? necrosis/apoptosis.	Pre?op stress testing; intra?op myocardial protection (cardioplegia).
Heart failure	Neuro?hormonal activation (RAAS, SNS) ? remodeling, decreased output.	Volume management, choice of anesthetic agents, postoperative ICU monitoring.
Aortic aneurysm	Degeneration of media (elastin loss, collagen fragmentation).	Timing of repair, need for proximal/distal control, risk of rupture.

3.2 Respiratory System

Issue	Pathophysiology	Surgical Relevance
Acute lung injury (ALI)/ARDS	Alveolar-capillary barrier disruption ? protein?rich edema, reduced compliance.	Protective ventilation strategies, fluid balance, postoperative pulmonary care.

Introduction to Surgical Pathophysiology

Issue

Pathophysiology

Surgical Relevance

**Pulmonary
embolism**

Thrombus obstructs pulmonary artery ?
ventilation?perfusion mismatch, right?
ventricular strain.

Peri?op anticoagulation protocols,
early ambulation.

**Obstructive
sleep apnea