快速医学教程
CRASH COURSE

肌肉、骨骼与皮肤 第二版

Muscles, Bones & Skin

SECOND EDITION

Knight, Biswas, Iqbal 著

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Muscles, Bones and Skin

SECOND EDITION

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Preface

Medical school can be stressful at the best of times, so learning the huge amount of material necessary to pass exams can sometimes seem like an impossible task. In *Crash Course: Muscles, Bones and Skin* we've broken the topics down into manageable chunks whilst still comprehensively covering both the pre-clinical and clinical aspects of rheumatology, orthopaedics and dermatology. A new section on communication skills gives practical advice on taking an effective history and a hefty Self-assessment section will help identify weak areas of knowledge.

As medical students, the authors of the *Crash Course* books have already been there, done it, and most importantly, passed the exams. This means the books focus on the stuff you need to know, rather than the stuff that other textbooks think you should know—you've probably realised the difference by now! I hope you find *Crash Course Muscles, Bones and Skin* a useful revision tool, and that all your exams go well.

Sîan Knight

Traditionally I would advise preclinical students to read big books to get a full understanding of anatomical details and physiological mechanisms. However, with recent changes to the medical curriculum and the advent of integrated medical courses there is a need for books with comprehensive but concise coverage of many medical topics. *Crash Course: Muscles, Bones and Skin* meets this requirement.

The text is presented in a pithy, digestible form for easy comprehension. The anatomy, physiology, pathology and pharmacology of muscles, bones and skin have been fully integrated and are supplemented with many illustrations. This user-friendly book will help students master the basic sciences of the musculoskeletal system and skin and to appreciate their relevance to medical practice.

Dr Sam Jacob
Faculty Advisor

In the six years since the first editions were published, there have been many changes in medicine, and in the way it is taught. These second editions have been largely rewritten to take these changes into account, and keep *Crash Course* up to date for the twenty-first century. New material has been added to include recent research and all pharmacological and disease management information has been updated in line with current best practice. We've listened to feedback from hundreds of students who have been using *Crash Course* and have improved the structure and

layout of the books accordingly: pathology material has been closely integrated with the relevant basic medical science; there are more MCQs and the clarity of text and figures is better than ever.

The principles on which we developed the series remain the same, however. Medicine is a huge subject, and the last thing a student needs when exams are looming is to waste time assembling information from different sources, and wading through pages of irrelevant detail. As before, *Crash Course* brings you all the information you need, in compact, manageable volumes that integrate basic medical science with clinical practice. We still tread the fine line between producing clear, concise text and providing enough detail for those aiming at distinction. The series is still written by medical students with recent exam experience, and checked for accuracy by senior faculty members from across the UK.

I wish you the best of luck in your future careers!

Dr Dan Horton-Szar
Series Editor (Basic Medical Sciences)

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Thanks also to the wonderful people at Mosby for their patience and support.

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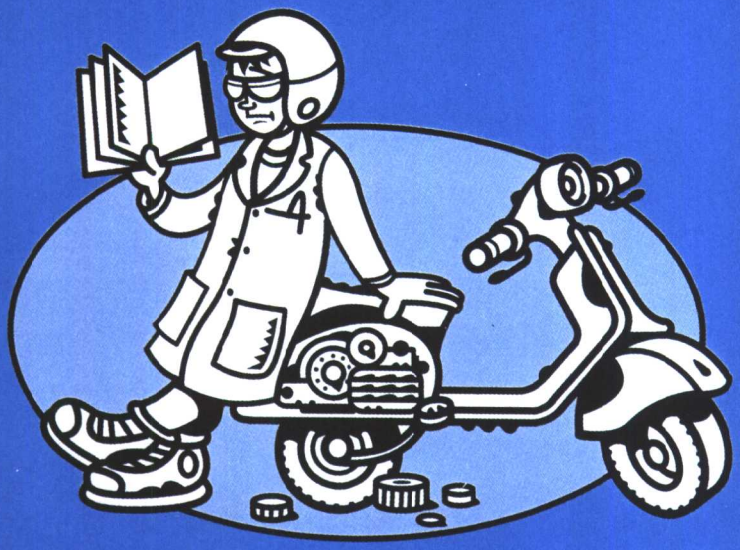

BASIC MEDICAL SCIENCE OF MUSCLES, BONES AND SKIN

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1. Musculoskeletal System —an overview

Overview of the musculoskeletal system

Introduction

The musculoskeletal system comprises muscles, bones and joints. It makes up most of the body's mass and performs several essential functions, including:

- The maintenance of body shape.
- The support and protection of soft tissue structures.
- Movement.
- Breathing.
- The storage of calcium and phosphate in bone.

Connective tissue

Most of the musculoskeletal system is made up of connective tissue such as bone and cartilage. Connective tissue comprises specialized cells embedded in an extracellular matrix of collagen, elastin and structural proteoglycans. In bone, this matrix is mineralized and rigid.

Muscle

There are three types of muscle: skeletal, cardiac and smooth muscle (Fig. 1.1).

- Skeletal muscle—striated muscle controlled by the nervous system. Most muscle in the body is of this type.
- Cardiac muscle—striated muscle of the heart.
- Smooth muscle—non-striated muscle controlled by a variety of chemical mediators. Smooth muscle is important in the function of most tissues, e.g. blood vessels, the gastrointestinal and reproductive tracts.

Energy stored in tissues as ATP is converted by muscle tissue into mechanical energy. This produces movement or tension.

The contraction of muscle requires stimulation. The type of stimulation varies: for example, skeletal muscle is activated by motor neurons, cardiac muscle initiates its own contractions and smooth muscle is activated by a variety of chemical mediators. Stimulation of muscle causes protein filaments within its cells, called actin and myosin, to interact and thus produce a contractile force.

The skeleton

The skeleton consists of bone, cartilage and fibrous ligaments (p. 59). A joint is the site at which bones are attached to each other. The range of movement at the joint, and whether a joint is rigid or flexible, depends on how the bones meet.

Bone

Bone is rigid and forms most of the skeleton. It functions as a supportive framework for the musculoskeletal system, and the bony sites for muscle attachment provide the mechanical basis for locomotion. Other functions of bone include mineral storage in its matrix and formation of blood cells (haemopoiesis) within the marrow.

Cartilage

Cartilage is a resilient tissue that provides semi-rigid support in some parts of the skeleton. Cartilage is also a component of some types of joint. Most bone is formed within a cartilaginous template during development.

Ligaments, tendons and aponeuroses

Ligaments, tendons and aponeuroses are fibrous tissues that connect the various components of the musculoskeletal system.

- Ligaments are flexible bands that connect bones or cartilage together, strengthening and stabilizing joints.
- Tendons are connections between muscle and bone.
- An aponeurosis may be considered as a broad, sheet-like tendon.

Joints

Joints are composite structures between bones. They may also include cartilage and fibrous connective tissue. There are several types of joint (p. 91). The strength of a joint and the range of movement it allows depend upon its position and function.

Properties of the three different muscle types

	Skeletal	Cardiac	Smooth
histological appearance	cross-striated, multinucleated muscle fibres	cross-striated, single nucleated muscle fibres containing intracellular discs	non-striated, spindle cells with a single nucleus
site	skeletal covering	muscular component of the heart	found in wall of blood vessel, airways and walls of hollow organs
cell size	50–60 μm in diameter, up to 10 cm long	15 μm in diameter, 100 μm long	2–10 μm in diameter, 20–400 μm long
control	voluntary/reflex; controlled by somatic nervous system	self-regulated by pacemaker cells; heart rate can be altered by autonomic nervous system	involuntary control or regulation by inherent contraction initiation (visceral smooth muscle)
nature of contraction	rapid contraction and relaxation	spontaneous and rhythmical contraction	slow and sustained contraction
function	voluntary movement of skeleton and posture maintenance	contractions pump blood around the body	related to the structure, e.g. regulation of blood vessel diameter, hair erection, etc.

Fig. 1.1 Properties of the three different types of muscle.

Control of the musculoskeletal system

The musculoskeletal system is controlled by the nervous system to produce coordinated movements and locomotion. There are a number of elements to this control. These include:

- Efferent motor neurons, which activate groups of muscle fibres to produce contraction.
- Afferent feedback from stretch receptors in muscles and tendons, and sensory nerve endings in joints and skin, allowing coordination of movement.
- Neural pathways within the spinal cord, which coordinate the action of related muscle groups (agonist–antagonist pairs, for example) and also initiate repetitive actions, such as walking ('central pattern generator').

For further information about central control of movement and locomotion, refer to *Crash Course: Nervous System, 2nd edn.*

Skin

Structure

The skin is composed of three layers: an outer protective epidermis, an inner connective tissue dermis, and a fatty subcutaneous layer (Fig. 1.2). It is characterized by a tough keratinized surface which protects underlying tissues from the external environment.

The thickness of skin varies depending on its location on the body. The epidermis is usually around 0.1 mm thick, though this increases to between 0.8 and 1.4 mm in places such as the soles of the feet and the palms of the hands where it undergoes repeated trauma. The dermis follows this pattern, ranging from 0.6 mm thickness on the eyelids to 3 mm on the palms and soles. The subcutaneous layer (subcutis) of the skin is much thicker than the above layers and has a different thickness distribution: it is

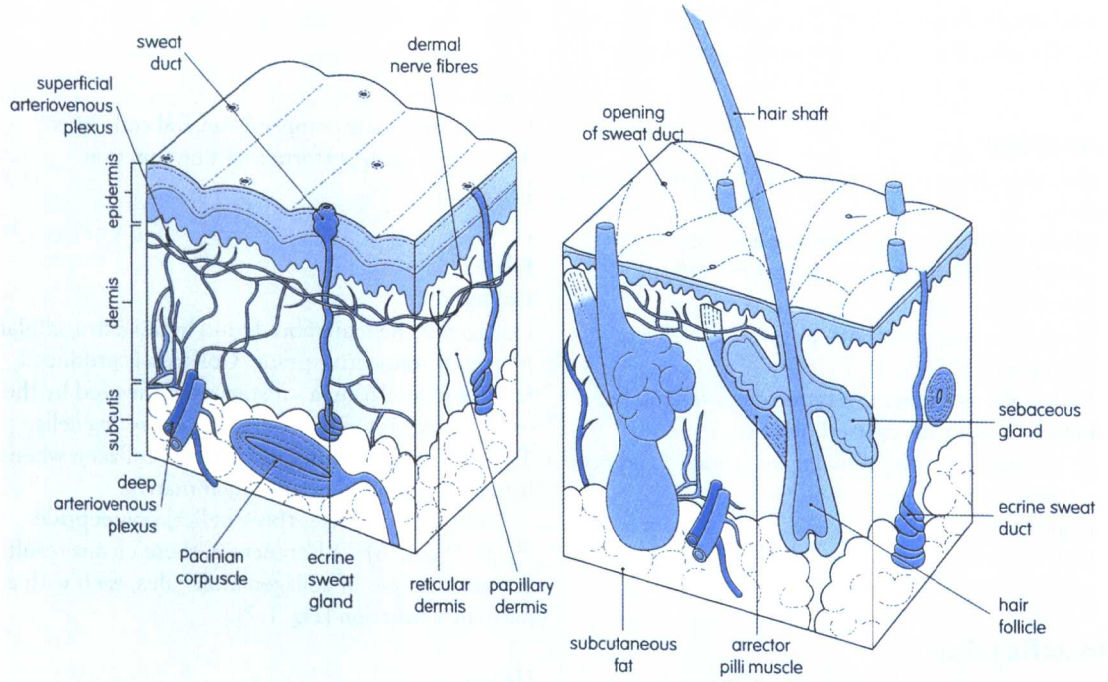

Fig. 1.2 The structure of the skin. (Adapted with permission from *Dermatology: an Illustrated Colour Text*, 2nd edn, by D.J. Gawkrodger, Churchill Livingstone, 1997.)

thickest on the abdomen, where it reaches depths of 3 cm.

Functions

The skin performs many functions on top of its main protective role, including thermoregulation, synthesis of vitamin D and various hormones, and the perception of sensation, temperature and pain.

Skin derivatives

There are many derivatives of skin, including hair, nails, sebaceous glands and sweat glands, which will also be discussed within this book. These structures are so named because they have developed from cells derived from the epidermis. They perform important functions in both the protection and homeostasis of the skin.

Pathology

Because of the skin's exposure to the external environment, it is open to insults caused by infection and infestation. These will be covered later in the book (Chapter 8), as will the clinical manifestations caused by the usual gamut of pathology: inflammation, tunours, genetic disorders, systemic disease and drug-induced disorders.

Connective tissue

Definition

Connective tissue is a basic type of tissue. It comprises cells embedded in an extracellular matrix of ground substance and fibres. Connective tissue is characterized by a high matrix:cell ratio.

Origins

Connective tissue is derived from the embryonic mesoderm and neural crest. These differentiate into the embryonic connective tissue or mesenchyme (Fig. 1.3).

Functions

Connective tissue performs several functions. These include:

- Mediating the exchange of nutrients and metabolic products between tissues and the circulatory system.
- Mechanical support, both physical as well as allowing for muscle attachment.
- Packaging, as connective tissue encloses and lies between other specialized tissues.
  - A metabolic role, allowing fat storage in adipose tissue.
- Insulation.
- Defence and repair; some cells are involved in the immune response.

Classification

Connective tissue is classified according to its function, location, structure and properties (Fig 1.4).

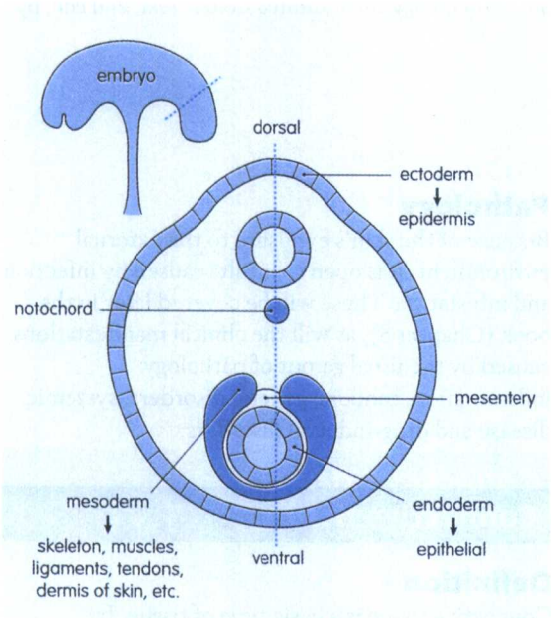

Fig. 1.3 The three primitive embryonic layers and their derivative structures.

Components

The three main components of connective tissue are cells, fibres and ground substance.

Cells

Connective tissue comprises several cell types. These cells each perform a certain function (Fig. 1.5).

Fibres

Collagen

Collagen is the main fibre found in the extracellular matrix of connective tissue. Collagen is produced from tropocollagen, a substance synthesized by the endoplasmic reticulum of matrix-secreting cells. Tropocollagen becomes modified to collagen when it is released into the extracellular matrix.

Collagen comprises three helical polypeptide chains (Fig. 1.6). Differences in these chains result in at least 15 types of collagen molecules, each with a particular function (Fig. 1.7).

Elastin

Elastin is a component of elastic fibres. Elastic fibres are found in the skin, lung and blood vessels. They are thinner than collagen and are arranged in random sheets.

Elastin is produced from proelastin, a substance synthesized by matrix-secreting cells. Proelastin becomes modified to elastin by the cell's Golgi apparatus, when it is released into the extracellular matrix.

Structural proteoglycans

Structural proteoglycans provide a ground substance surrounding the cells and fibres of connective tissue. They comprise protein chains bound to branched polysaccharides and form fibres such as fibronectin and laminin. Some structural proteoglycans are found on the surface of cells, where their functions include cell–cell recognition, adhesion and migration.

Communication between cells and their environment is facilitated by the stuctural proteoglycans which function as cell adhesion molecules. In doing so, they regulate a large number of cell functions, including proliferation, gene expression, apoptosis and differentiation. In future, modifying the actions of adhesion molecules may well be the key to treating illnesses such as cancer.

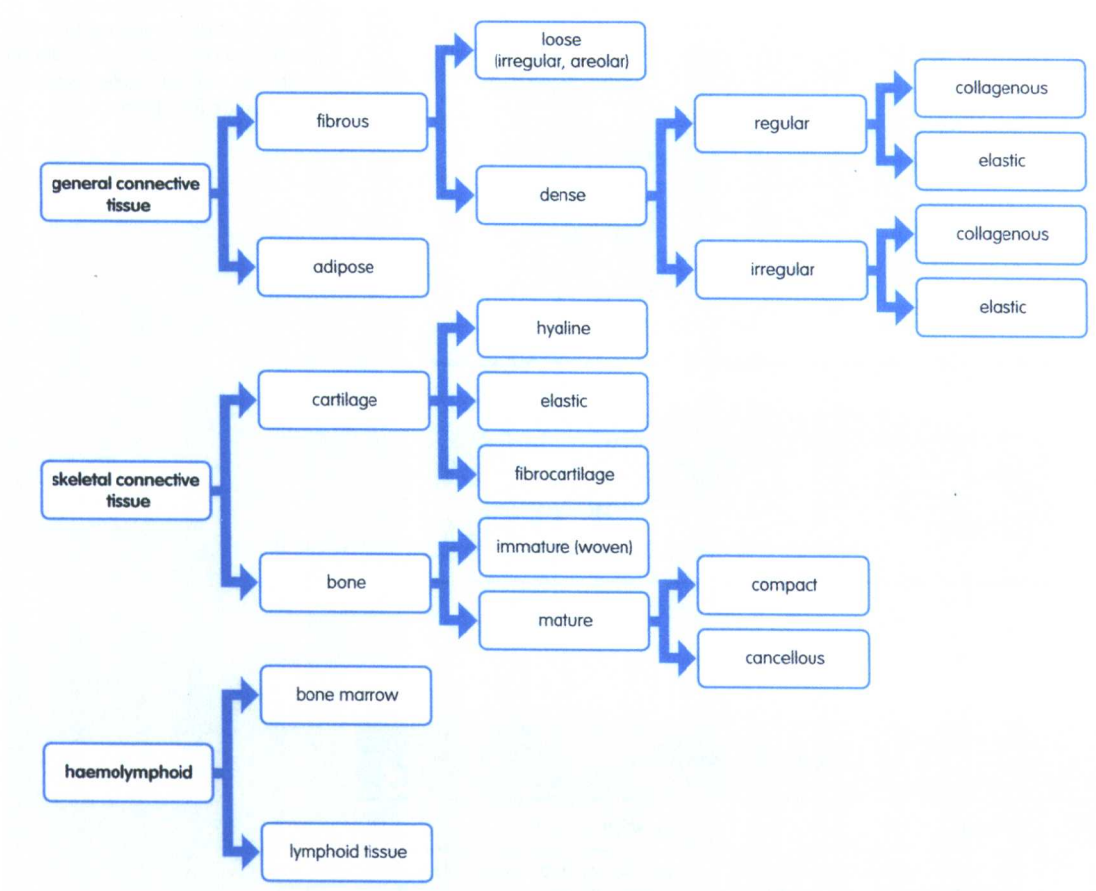

Fig. 1.4 Classification of connective tissue.

Connective tissue cell types and functions

	Cell type	Functions
fixed cells	fibroblasts, chondroblasts, osteoblasts, osteoclasts	synthesis and maintenance of matrix
	adipocytes	fat metabolism
	mast cells	release of histamine
	mesenchymal cells	mature cell precursors
transient cells	white blood cells	immune response
	melanocytes	pigmentation

Fig. 1.5 Connective tissue cell types and their functions.

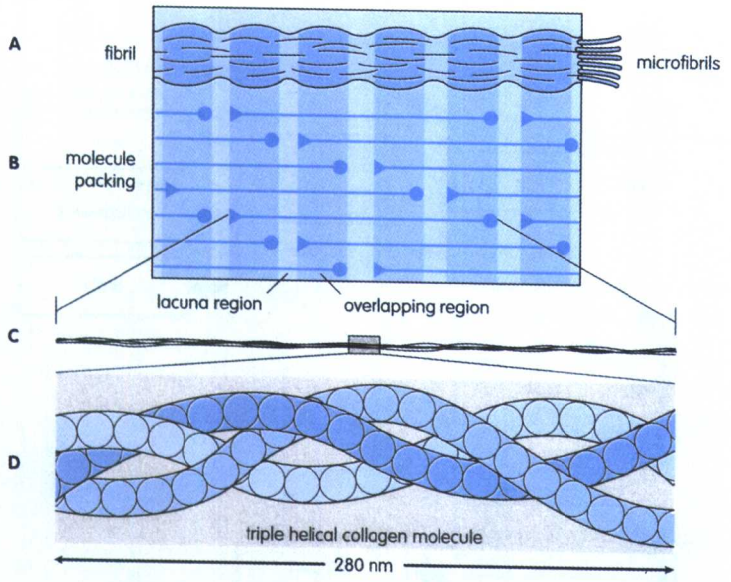

Fig. 1.6 Microstructure of the collagen fibril. (A) Microfibril; (B) packing of molecules; (C) collagen molecule; and (D) triple helix of polypeptide (α) chains.

Functions of collagen types

Type	Location	Function
I	skin, tendon, ligaments, bone, fascia and organ capsules (accounts for 90% of body collagen)	provides variable mechanical support (loose or dense)
II	hyaline and elastic cartilage, notochord, and intervertebral discs	provides shape and resistance to pressure
III	connective tissue of organs (liver, lymphoid organs, etc.), blood vessels, and fetal skin	forms reticular networks
IV	basement membrane of epithelial and endothelial cells	provides support and a filtration barrier
V	basement membrane of smooth and skeletal muscle cells	provides support (other functions poorly understood)

Fig. 1.7 Functions of the different types of collagen.

- List the components of the musculoskeletal system.
- What are the general functions of the musculoskeletal system?
- Describe the stimulation of skeletal, cardiac and smooth muscle.
- List the general functions of the skin.
- Name the three layers of the skin.
- Define connective tissue.
- List the functions of connective tissue.
- Give a simple classification of connective tissue.
- Describe the components of connective tissue.