MSK II MODULE
Comparison Of Three Types Of Muscles

(LGIS PHYSIOLOGY)

Dr. Aneela Yasmeen

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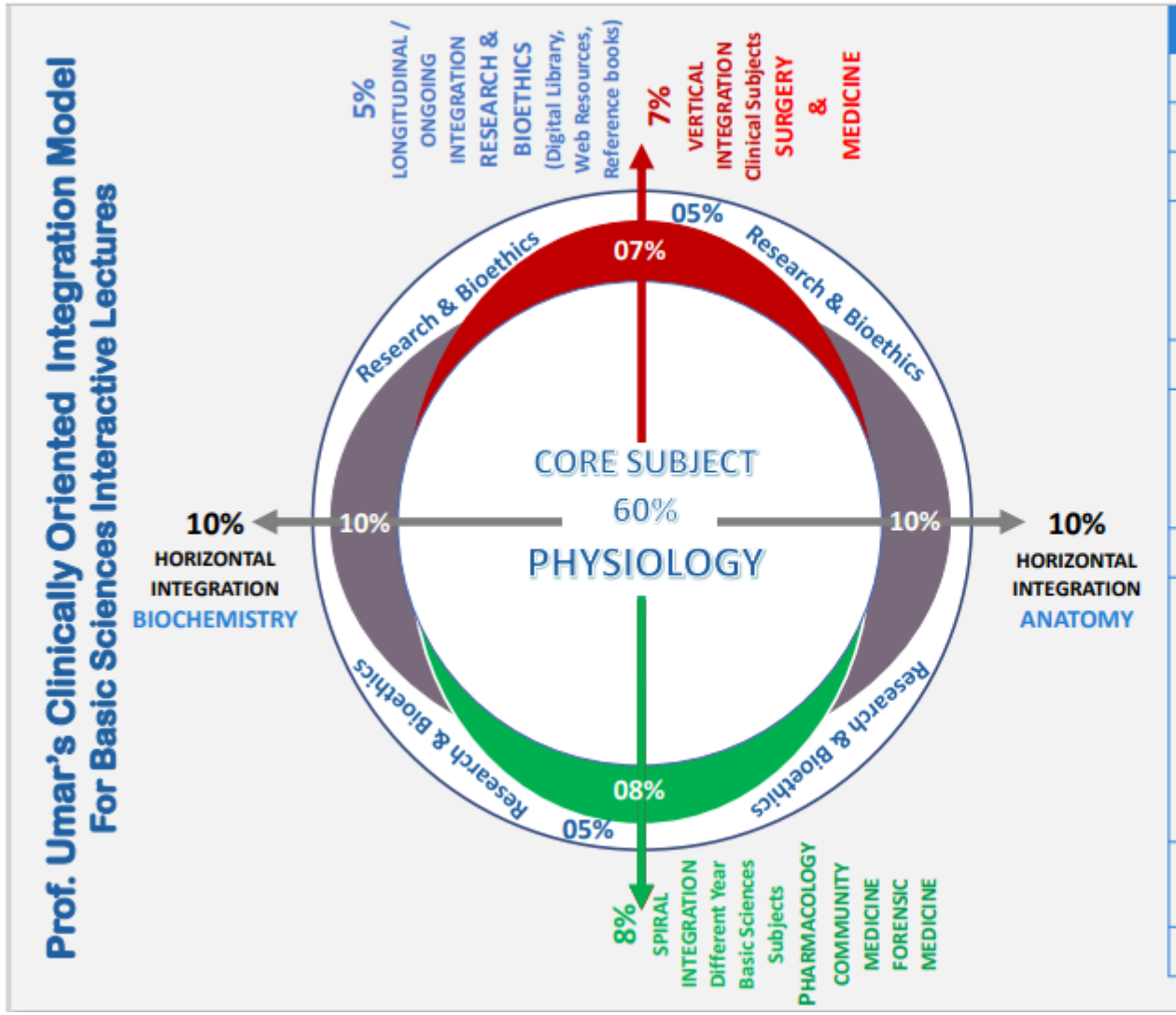
General Format for Large Group Interactive Session of Physiology:

S. No.	Headings	Domains/Type of Integration	Approximate %
1.	Title	• Introduction of GIT • Concept about it's Electrical Activity • Enteric Nervous System & GIT Reflexes	Lecture No.1 out of 10
			slide
3.	Physiologic Anatomy (Histology)	• Brain Storming/ Horizontal Integration • Interactive	15%
4.	Core Concepts of the Topic	Core concepts of Physiology	60%
5.	Concept explained through Animations	Core Concepts of Physiology	10%
	topic with key	• Interactive	
7.	Research article relevant to the topic with reference	• Promotion of research culture • Use of Digital Library • Critical Thinking • Self-directed Learning	5%
8.	PM&DC Code of Ethics/Professionalism/Communication Skills with reference	• Professional Ethics • Self-directed Learning • Interactive	5%



Model 1st Year PHYSIOLOGY LGIS (≈30 slides)	
Core Subject – 60% (≈ 18-20 slides)	
Physiology(≈ 18-20 slides)	
Horizontal Integration – 20% (≈ 5-6 slides)	
Same Year Subjects	• Anatomy (10%) (≈ 2-3 slides) • Biochemistry (10%) (≈ 2-3 slides)
Vertical Integration – 07% (≈ 2-3 slides)	
Clinical Subjects	• Medicine (3-5%) (≈ 1-2 slides) • Surgery (3-5%) (≈ 1-2 slides)
Spiral Integration – 08% (≈ 2-3 slides)	
Different Year Basic Sciences Subjects	• Pharmacology(1-3%) (≈ 1-2 slides) • Community Medicine (1-3%) (≈ 1-2 slides) • Forensic Medicine (1-3%) (≈ 1-2 slides)
Longitudinal / Ongoing Integration – 05% (≈ 1-2 slides)	
Research, Bioethics & AI(≈ 1-2 slides)	

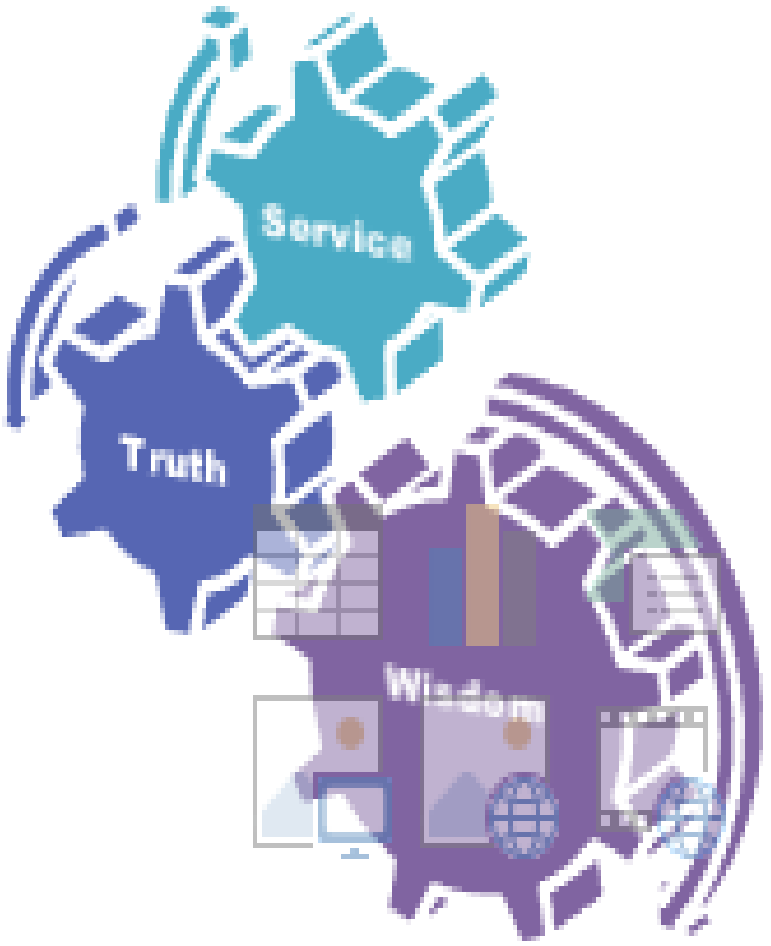
comparison of three types of muscles

Vision; The Dream/Tomorrow

To impart evidence-based research oriented medical education

To provide best possible patient care

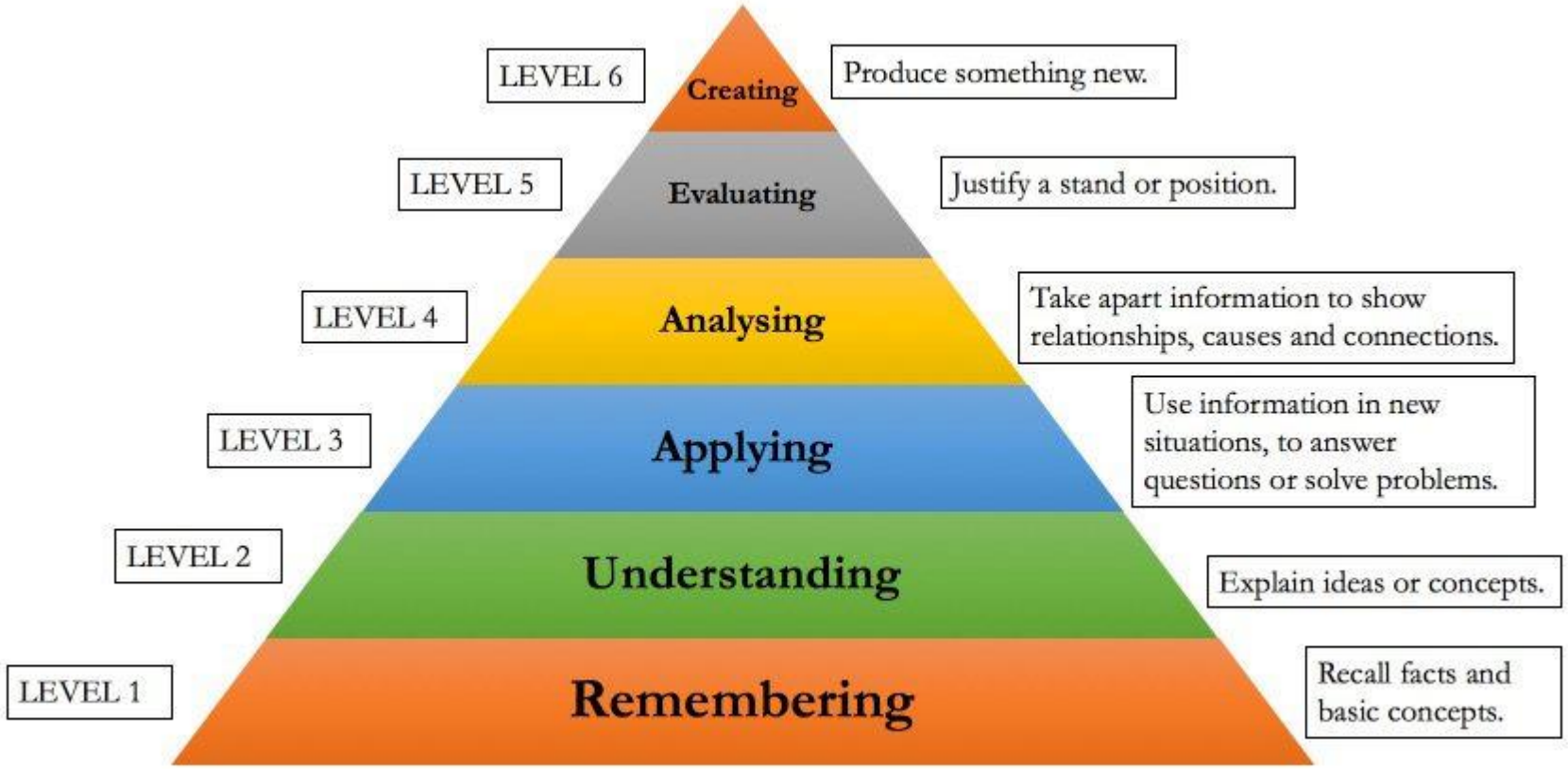
To inculcate the values of mutual respect and ethical practice of medicine



BLOOM'S TAXONOMY : DOMAINS OF LEARNING

Sr. #	Domain of learning	Abbreviation	Levels of the domain	Meaning
1	cognition	C	C1	Recall / Remembering
2			C2	Understanding
3			C3	Applying / Problem solving
4	Psychomotor	P	P1	Imitation / copying
5			P2	Manipulation / Follows instructions
6			P3	Precision / Can perform accurately
7	Attitude	A	A1	Receiving / Learning
8			A2	Respond / Starts responding to the learned attitude
9			A3	Valuing / starts behaving according to the learned attitude

BLOOM'S TAXONOMY OF THE COGNITIVE DOMAIN



Learning objectives

s.no	Learning objectives	Level of cognition
1	Recall physiological anatomy of three types of muscles	C1
2	Understand differences among three types of muscle	C2
3	Differentiate between histological features of three kind of muscles	C2
4	Describe difference in mechanisms of contraction of three types of muscles	C2
5	Enlist locations of three types of muscles.	C1

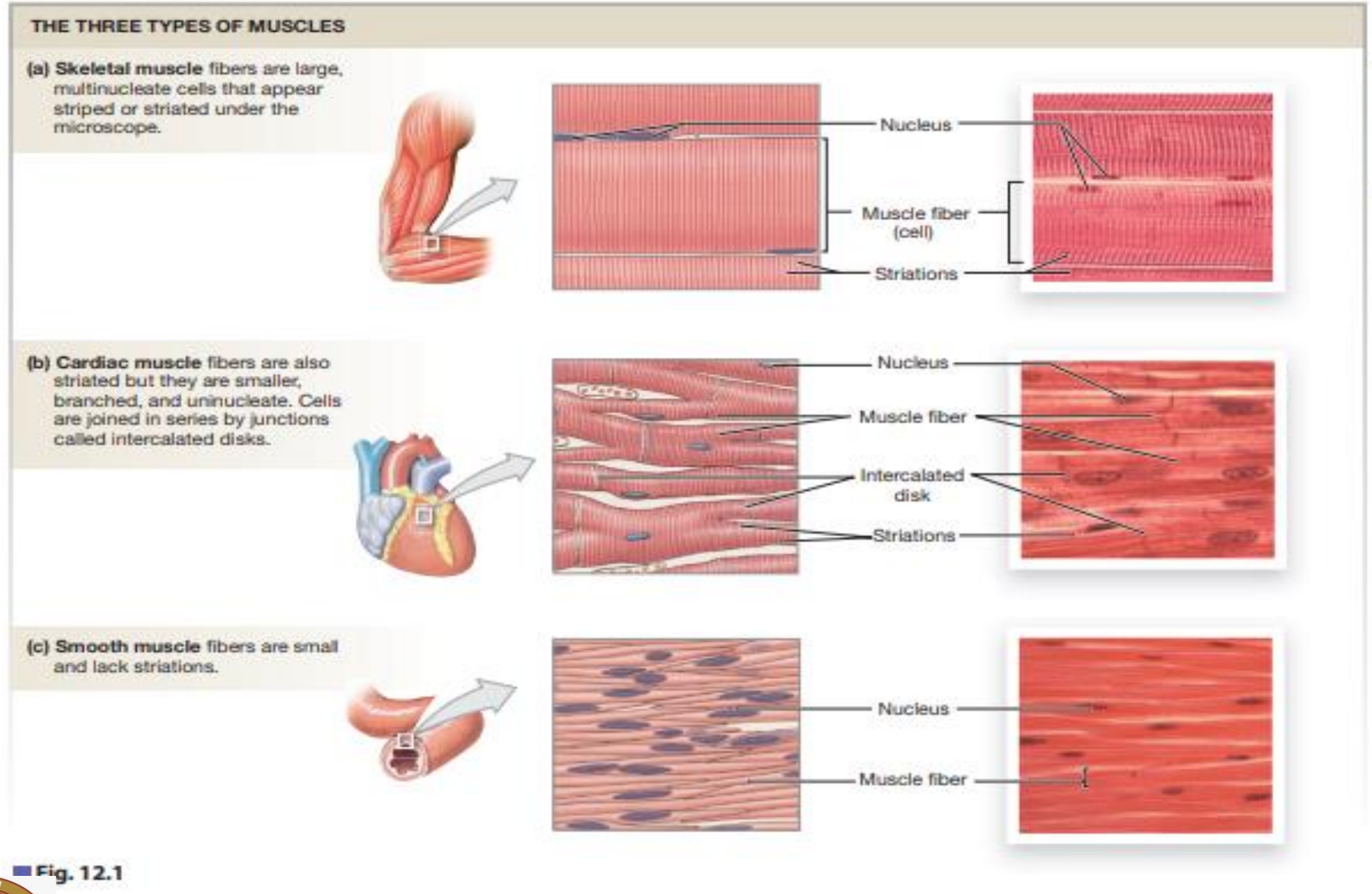


Fig. 12.1

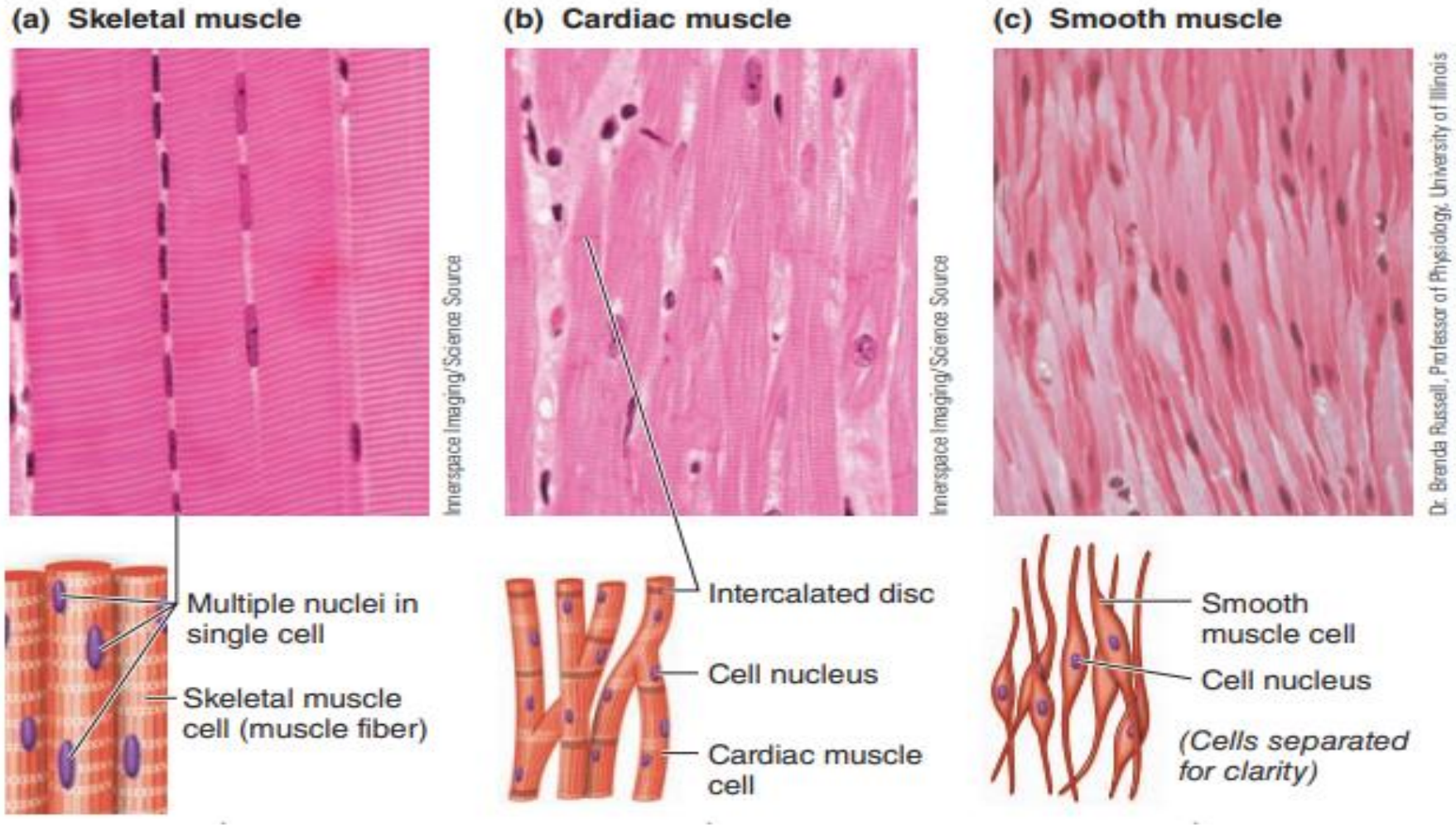
Horizontal Integration with Histology

Three Types of Muscles

Silverthorne physiology 6th edition

Horizontal Integration with Histology

Three Types of Muscles



Sherwood 9th edition page 252

Classification: Striated muscle, voluntary muscle	**Classification:** Striated muscle, involuntary muscle	**Classification:** Unstriated muscle, involuntary muscle
Description: Bundles of long, thick, cylindrical, striated, contractile, multinucleate cells that extend the length of the muscle	**Description:** Interlinked network of short, slender, cylindrical, striated, branched, contractile cells connected cell to cell by intercalated discs	**Description:** Loose network of short, slender, spindle-shaped, unstriated, contractile cells that are arranged in sheets
Typical location: Attached to bones of skeleton	**Location:** Wall of heart	**Typical location:** Walls of hollow organs and tubes, such as stomach and blood vessels
Function: Movement of body in relation to external environment	**Function:** Pumping of blood out of heart	**Function:** Movement of contents within hollow organs

Figure 8-1 Characteristics of three types of muscle. The photos in (a), (b), and (c) are light micrographs of longitudinal sections of skeletal, cardiac, and smooth muscle, respectively.

Sherwood 9th edition page 252

Comparison between the three types of muscle cells:

	Skeletal	Cardiac	Smooth
Location	Attached to bones	The heart	Internal organs and skin
Shape	Elongated and cylindrical 	Branched 	Spindle 
Nucleus	Several peripherally located nuclei	Single centrally located nucleus	Single centrally located nucleus
Striation	Striated	Striated	Non-striated
Function	• Movement of bone • Heat production	Beating of the heart	Movement of the viscera
Control	Voluntary	Involuntary	Involuntary

Three Types of Muscles

https://www.google.com/url?sa=i&url=https%3A%2F%2Fslideplayer.com%2Fslide%2F13670678%2F&psig=AOvVaw0gJ20Rcya8ut42e5PL-b9U&ust=1683743562645000&source=images&cd=vfe&ved=0CBEQjRxqFwoTCPC96Nnv6P4CFQAAAAAdAAAAABAE

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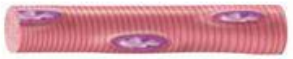
Three Types of Muscular Tissue

	Location	Function	Appearance	Control
Skeletal 	skeleton	movement, heat, posture	**striated**, multi-nucleated (eccentric), fibers parallel	**voluntary**
Cardiac 	heart	pump blood continuously	**striated**, one central nucleus	**involuntary**
Visceral (smooth muscle) 	G.I. tract, uterus, eye, blood vessels	Peristalsis, blood pressure, pupil size, erects hairs	**no striations**, one central nucleus	**involuntary**

Three Types of Muscles

Core Concept

Detailed Comparison of Three Types of Muscles in Their Contractile Process

Core Concept

TABLE 8-4 Comparison of Contractile Process in Different Muscle Types

Characteristic	Skeletal Muscle	Multiunit Smooth Muscle	Single-Unit Smooth Muscle	Cardiac Muscle
Mechanism of contraction	Sliding filament mechanism	Sliding filament mechanism	Sliding filament mechanism	Sliding filament mechanism
Innervation	Somatic nervous system	Autonomic nervous system	Autonomic nervous system	Autonomic nervous system
Level of control	Under voluntary control; also subject to subconscious regulation	Under involuntary control	Under involuntary control	Under involuntary control
Initiation of contraction	Neurogenic	Neurogenic	Myogenic (pacemaker potentials and slow-wave potentials)	Myogenic (pacemaker potentials)
Role of nervous stimulation	Initiates contraction; accomplishes gradation	Initiates contraction; contributes to gradation	Modifies contraction; can excite or inhibit; contributes to gradation	Modifies contraction; can excite or inhibit; contributes to gradation
Modification by hormones	No	Yes	Yes	Yes
Presence of myosin and actin filaments	Yes	Yes	Yes	Yes
Presence of troponin and tropomyosin	Yes	Tropomyosin only	Tropomyosin only	Yes
Presence of T tubules	Yes	No	No	Yes

comparison of three types of muscles

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Core Concept

Development of sarcoplasmic reticulum	Well developed	Poorly developed	Poorly developed	Moderately developed
Source of increased cytosolic Ca^{2+}	Sarcoplasmic reticulum	ECF and sarcoplasmic reticulum	ECF and sarcoplasmic reticulum	ECF and sarcoplasmic reticulum
Mechanism of Ca^{2+} action to permit cross-bridge binding	Physically repositions troponin–tropomyosin complex in thin filaments to uncover actin cross-bridge binding sites	Chemically brings about phosphorylation of myosin cross bridges in thick filaments so that they can bind with actin	Chemically brings about phosphorylation of myosin cross bridges in thick filaments so that they can bind with actin	Physically repositions troponin–tropomyosin complex in thin filaments to uncover actin cross-bridge binding sites
Presence of gap junctions	No	Yes (very few)	Yes	Yes
Speed of contraction	Fast or slow, depending on type of fiber	Very slow	Very slow	Slow
Means by which gradation is accomplished	Varying number of motor units contracting (motor unit recruitment) and frequency at which they are stimulated (twitch summation)	Varying number of muscle fibers contracting and varying cytosolic Ca^{2+} concentration in each fiber by autonomic and hormonal influences	Varying cytosolic Ca^{2+} concentration through myogenic activity and influences of the autonomic nervous system, mechanical stretch, hormones, and local metabolites	Varying length of fibers (extent of filling of heart chambers) and varying cytosolic Ca^{2+} concentration through autonomic, hormonal, and local metabolite influences
Clear-cut length–tension relationship	Yes	No	No	Yes

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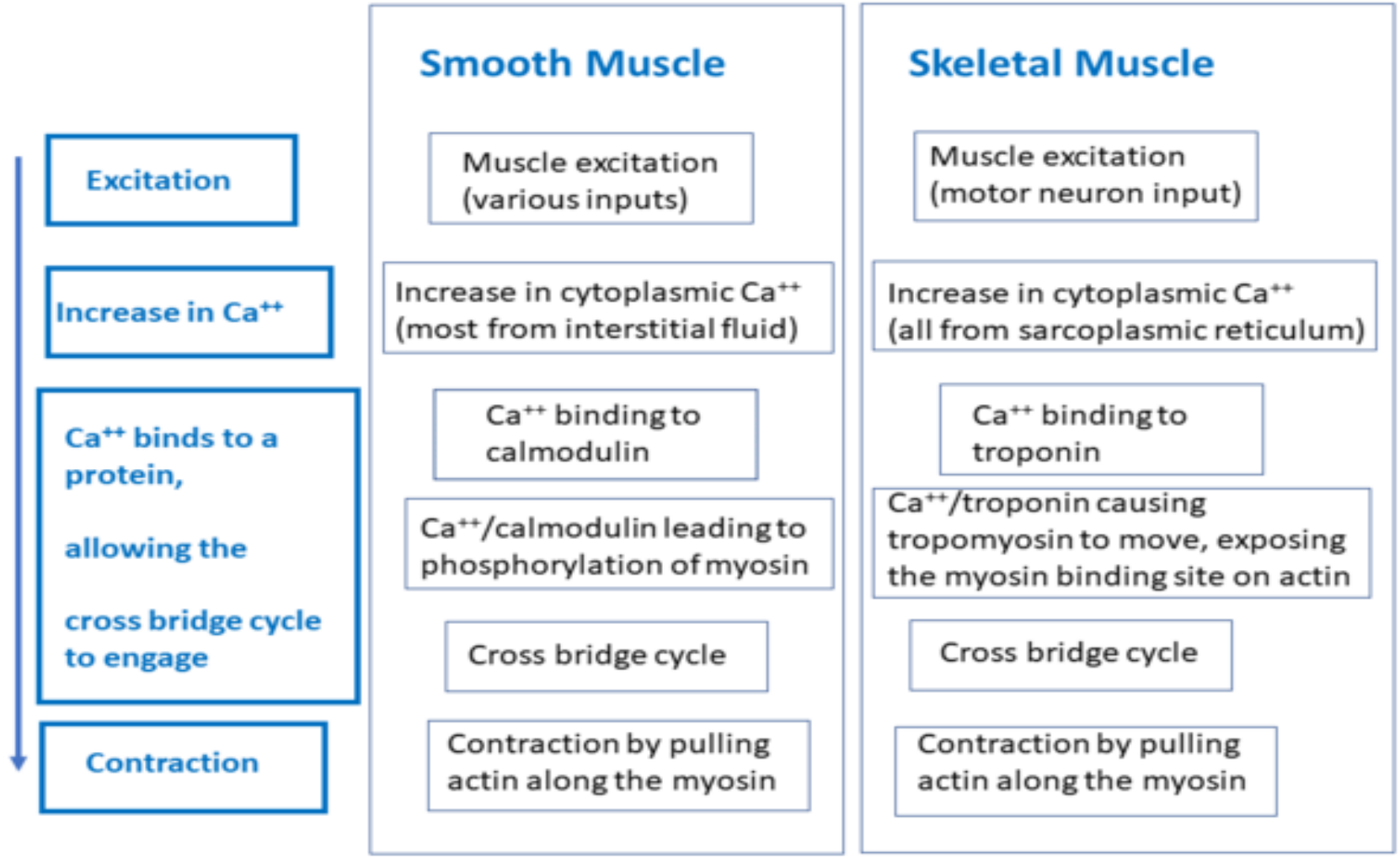


Three Types of Muscles

Core Concept

Core Concept

Comparison of the Three Muscle Types — Table 12.3

	Skeletal	Smooth	Cardiac
Appearance under light microscope	Striated	Smooth	Striated
Fiber arrangement	Sarcomeres	No sarcomeres	Sarcomeres
Location	Attached to bones; a few sphincters close off hollow organs	Forms the walls of hollow organs and tubes; some sphincters	Heart muscle
Tissue morphology	Multinucleate; large, cylindrical fibers	Uninucleate; small spindle-shaped fibers	Uninucleate; shorter branching fibers
Internal structure	T-tubule and sarcoplasmic reticulum	No t-tubules; sarcoplasmic reticulum	T-tubule and sarcoplasmic reticulum
Fiber proteins	Actin, myosin; troponin and tropomyosin	Actin, myosin; tropomyosin	Actin, myosin; troponin and tropomyosin
Control	• Ca^{2+} and troponin • Fibers independent of one another	• Ca^{2+} and calmodulin • Some fibers electrically linked via gap junctions; others independent	• Ca^{2+} and troponin • Fibers electrically linked via gap junctions
Contraction speed	Fastest	Slowest	Intermediate
Contraction force of single fiber twitch	Not graded	Graded	Graded
Initiation of contraction	Requires ACh from motor neuron	Stretch, chemical signals. Can be autorhythmic	Autorhythmic
Neural control of contraction	Somatic motor neuron	Autonomic neurons	Autonomic neurons
Hormonal influence on contraction	None	Multiple hormones	Epinephrine

Silverthorne physiology 6th edition

TABLE 11.4 Comparison of Skeletal, Cardiac, and Smooth Muscle

Feature	Skeletal Muscle	Cardiac Muscle	Smooth Muscle
Location	Associated with skeletal system	Heart	Walls of viscera and blood vessels, iris of eye, arrector muscle of hair follicles
Cell shape	Long threadlike fibers	Short, slightly branched cells	Short fusiform cells
Cell length	100 µm–30 cm	50–120 µm	30–200 µm
Cell width	10–500 µm	10–20 µm	5–10 µm
Striations	Present	Present	Absent
Nuclei	Multiple nuclei, adjacent to sarcolemma	Usually one nucleus, near middle of cell	One nucleus, near middle of cell
Connective tissues	Endomysium, perimysium, epimysium	Endomysium only	Endomysium only
Sarcoplasmic reticulum	Abundant	Present	Scanty
T tubules	Present, narrow	Present, wide	Absent
Gap junctions	Absent	Present in intercalated discs	Present in unitary smooth muscle
Autorhythmicity	Absent	Present	Present in unitary smooth muscle
Thin filament attachment	Z discs	Z discs	Dense bodies
Regulatory proteins	Tropomyosin, troponin	Tropomyosin, troponin	Calmodulin, myosin light-chain kinase
Ca^{2+} source	Sarcoplasmic reticulum	Sarcoplasmic reticulum and extracellular fluid	Mainly extracellular fluid
Ca^{2+} receptor	Troponin of thin filament	Troponin of thin filament	Calmodulin of thick filament
Innervation and control	Somatic motor fibers (voluntary)	Autonomic fibers (involuntary)	Autonomic fibers (involuntary)
Nervous stimulation required?	Yes	No	No
Effect of nervous stimulation	Excitatory only	Excitatory or inhibitory	Excitatory or inhibitory
Mode of tissue repair	Limited regeneration, mostly fibrosis	Limited regeneration, mostly fibrosis	Relatively good capacity for regeneration

Core Concept

Sarcopenia

- Sarcopenia is the age-related progressive loss of muscle mass and strength. The main symptom of the condition is muscle weakness. Sarcopenia is a type of muscle atrophy primarily caused by the natural aging process. Scientists believe being physically inactive and eating an unhealthy diet can contribute to the disease.

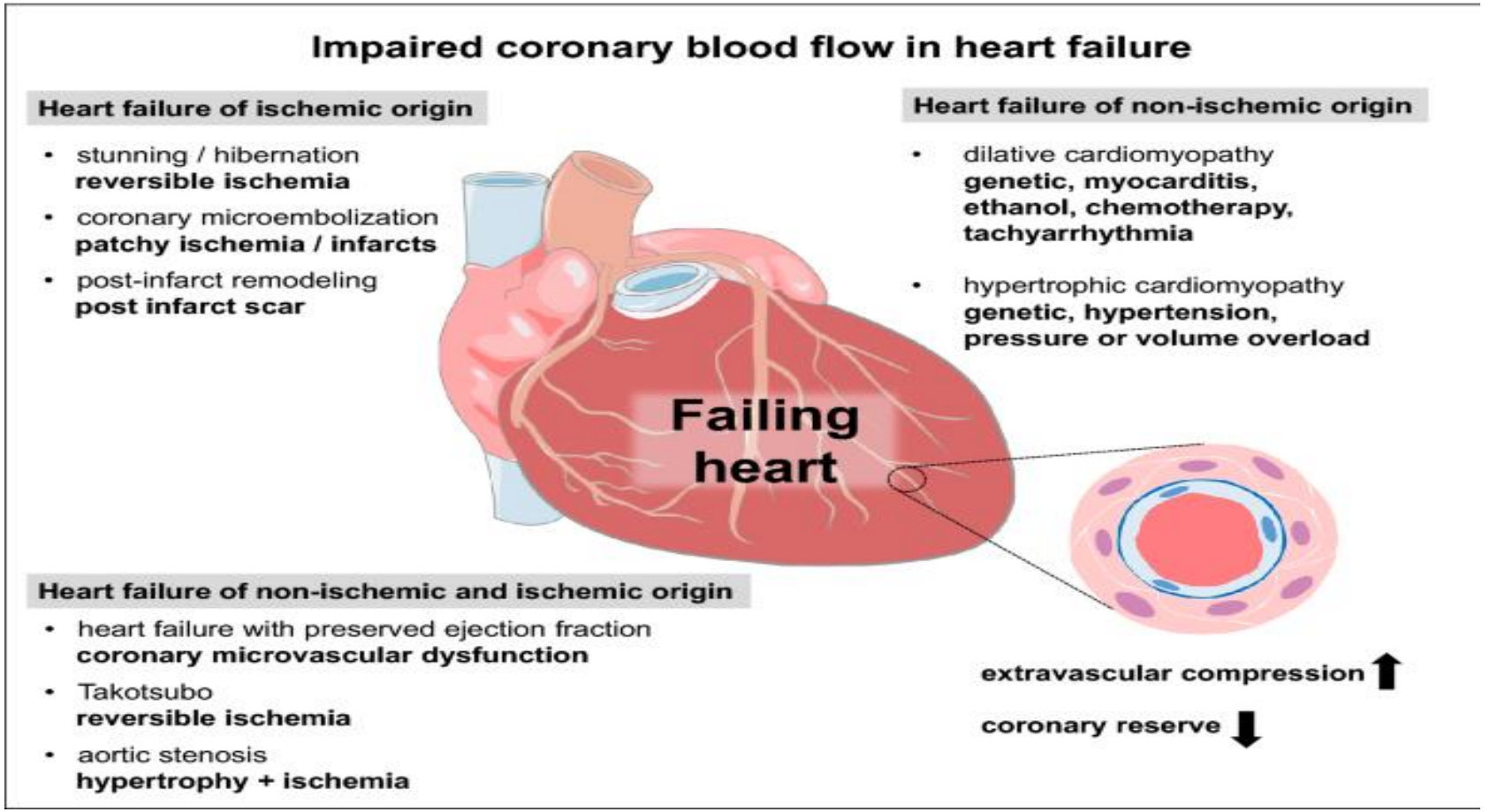
Vertical Integration with Internal Medicine

Rigor mortis

- Rigor mortis is a postmortem change resulting in the stiffening of the body muscles due to chemical changes in their myofibrils. Rigor mortis helps in estimating the time since death as well to ascertain if the body had been moved after death.

Vertical Integration with Forensic Medicine

Impaired Contractility and Heart Failure



Vertical Integration with Internal Medicine

Bioethics

- **Non-maleficence**

The principle of nonmaleficence holds that there is an obligation not to inflict harm on others. It is closely associated with the maxim primum non nocere (first do no harm).

Longitudinal bioethics Curriculum

Research

Journal of *Cardiovascular Development and Disease*

MDPI

Review

Novel Insights into the Sinoatrial Node in Single-Cell RNA Sequencing: From Developmental Biology to Physiological Function

Wei Fan [1,2,3,†], Chao Yang [1,2,3,†], Xiaojie Hou [4], Juyi Wan [1,2,3,*] and Bin Liao [1,2,3,*]

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[2] Metabolic Vascular Diseases Key Laboratory of Sichuan Province, Luzhou 646000, China
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[4] Department of Cardiac Surgery, Beijing Anzhen Hospital, Capital Medical University, Beijing 100069, China
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† These authors contributed equally to this work.

Abstract: Normal cardiac automaticity is dependent on the pacemaker cells of the sinoatrial node (SAN). Insufficient cardiac pacemaking leads to the development of sick sinus syndrome (SSS). Since currently available pharmaceutical drugs and implantable pacemakers are only partially effective in managing SSS, there is a critical need for developing targeted mechanism-based therapies to treat SSS. SAN-like pacemaker cells (SANLPCs) are difficult to regenerate in vivo or in vitro because the genes and signaling pathways that regulate SAN development and function have not been fully elucidated. The development of more effective treatments for SSS, including biological pacemakers, requires further understanding of these genes and signaling pathways. Compared with genetic models and bulk RNA sequencing, single-cell RNA sequencing (scRNA-seq) technology promises to advance our understanding of cellular phenotype heterogeneity and molecular regulation during SAN development. This review outlines the key transcriptional networks that control the structure, development, and function of the SAN, with particular attention to SAN markers and signaling pathways detected via scRNA-seq. This review offers insights into the process and transcriptional network of SAN morphogenesis at a single-cell level and discusses current challenges and potential future directions for generating SANLPCs for biological pacemakers.

Keywords: sinoatrial node; single-cell RNA sequencing; transcription factors; signaling pathways; molecular regulation

check for updates

Citation: Fan, W.; Yang, C.; Hou, X.; Wan, J.; Liao, B. Novel Insights into the Sinoatrial Node in Single-Cell RNA Sequencing: From Developmental Biology to Physiological Function. *J. Cardiovasc. Dev. Dis.* **2022**, *9*, 402. https://doi.org/10.3390/jcdd9110402

Academic Editor: Marina Campione

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https://doi.org/10.3390/jcdd9110402

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References

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- Guyton textbook of physiology
- Share wood textbook of physiology
- Ganong textbook of physiology
- **Research**
- https://doi.org/10.3390/jcdd9110402
- **Video link/youtube**
- **https://www.youtube.com/watch?v=loXOdSmP1tA**