Nerve Structure
Muscle Structure
Response to Injury

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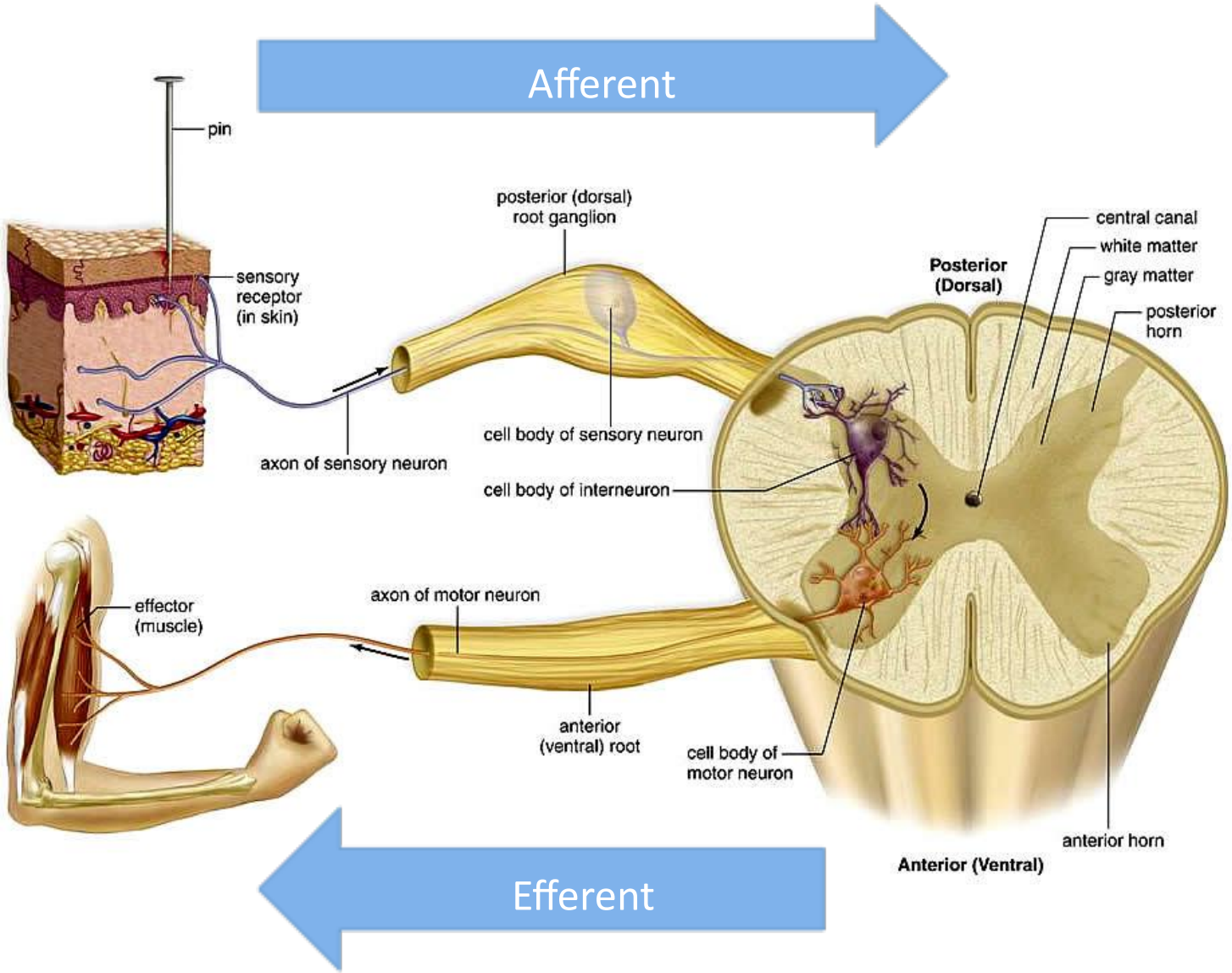
Session Plan

- FRCS T&O – questions and ideas
- You do some of the work!
- Nerve Structure
- (Nerve Physiology)
- Nerve Injury
- Muscle Structure
- Muscle Injury

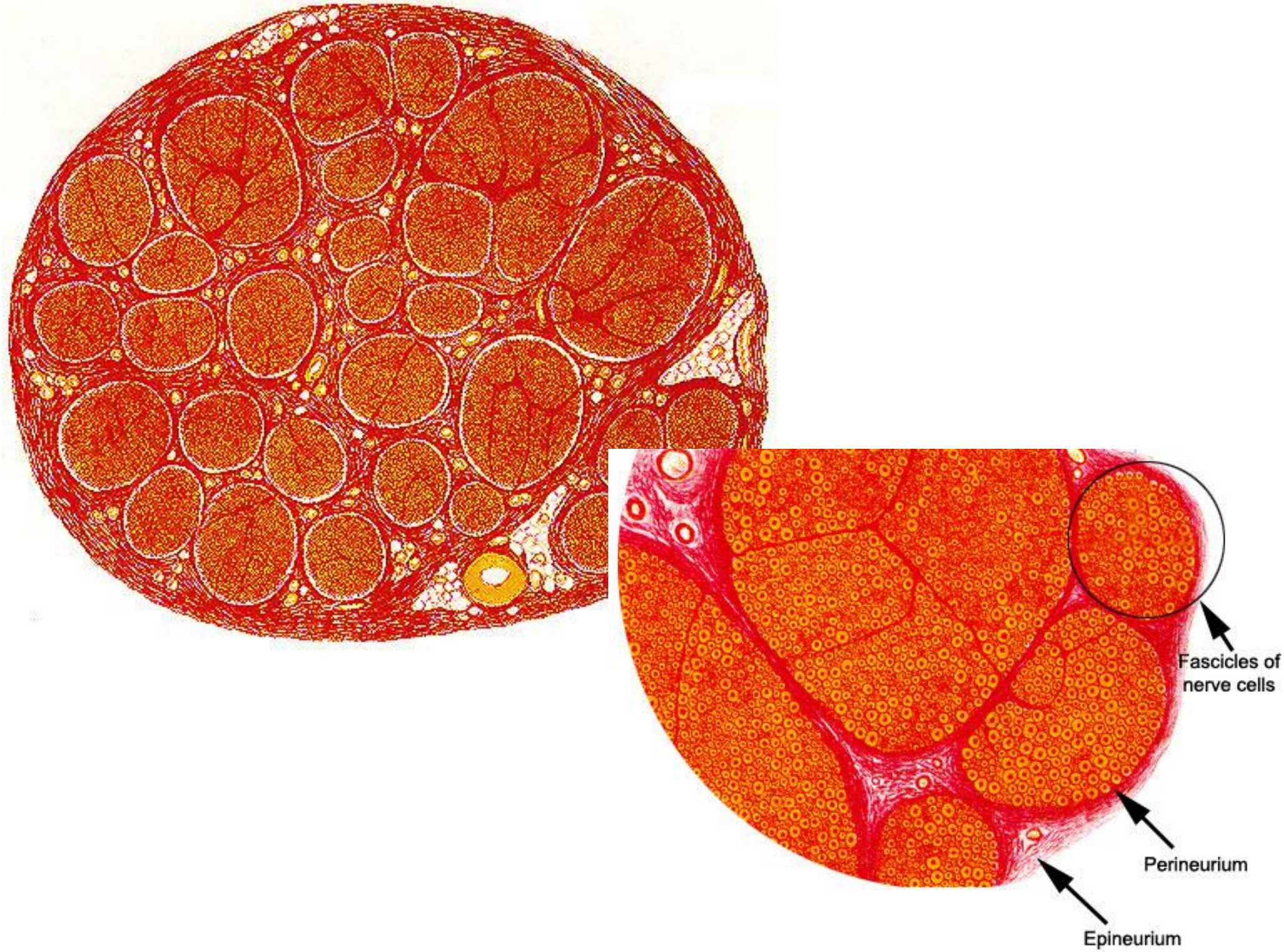
Organisation of Peripheral Nervous system

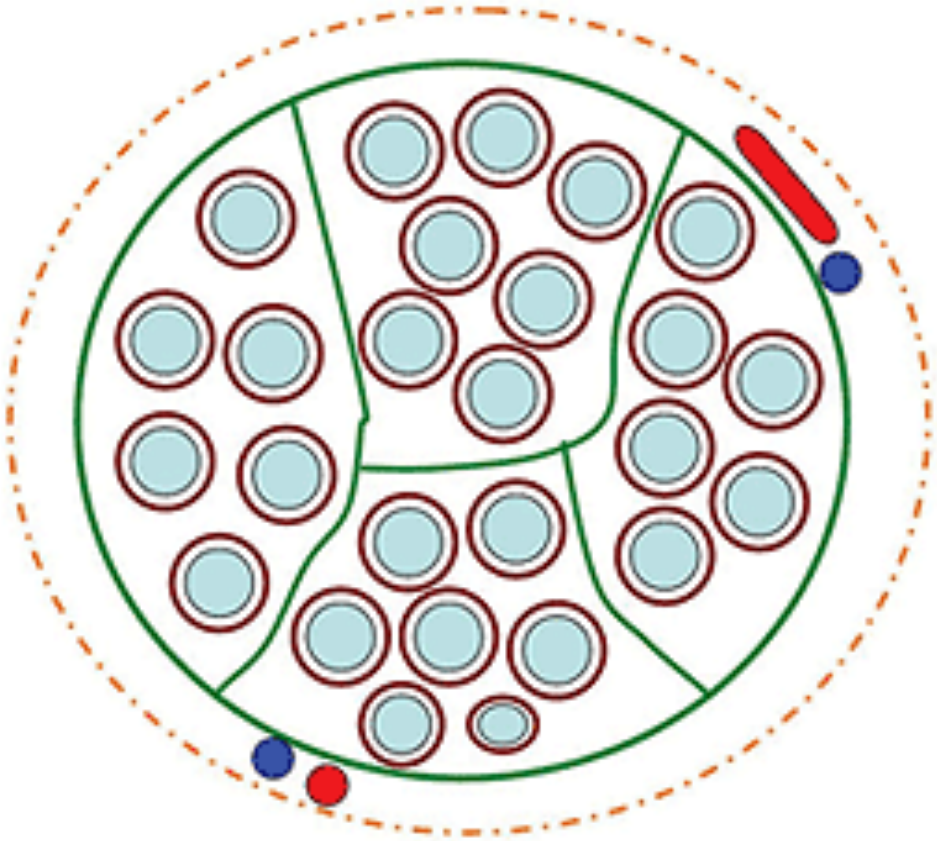


Tell me about the structure of a Nerve?

Task.

1 minute draw and label the cross sectional anatomy of a nerve


Fascicles of
nerve cells
Perineurium
Epineurium



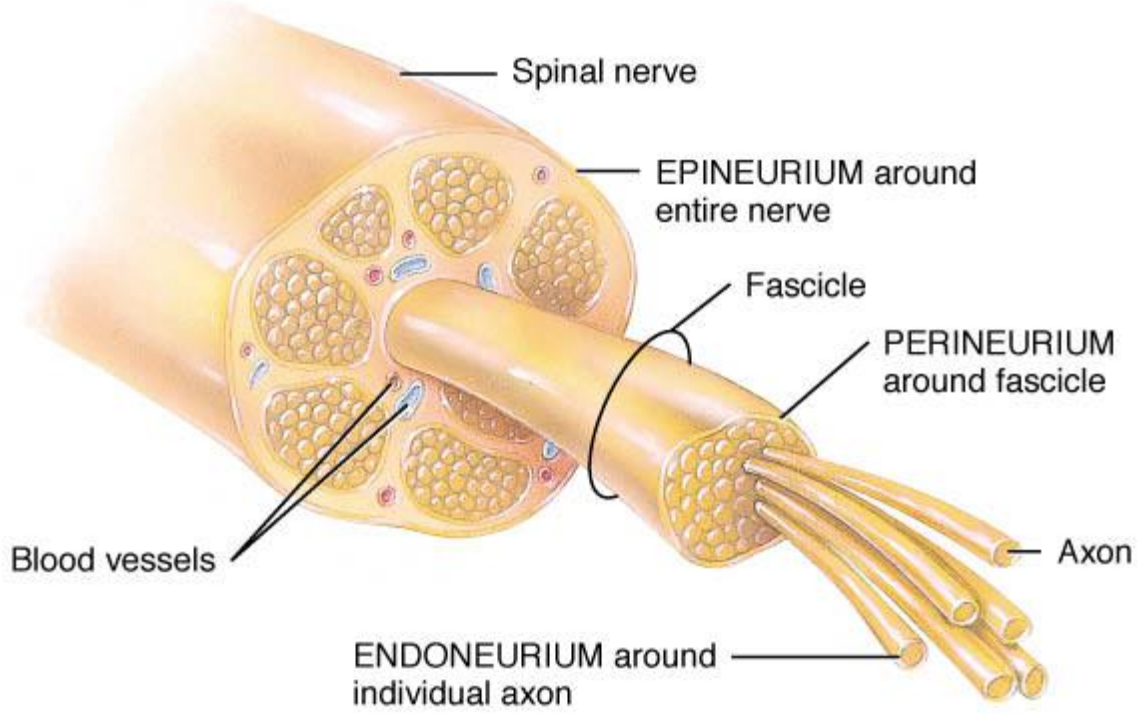
Endoneurium

Nerve fiber

Perineurium

Epineurium

Vasa nervorum



Blood Supply – Anastamotic network

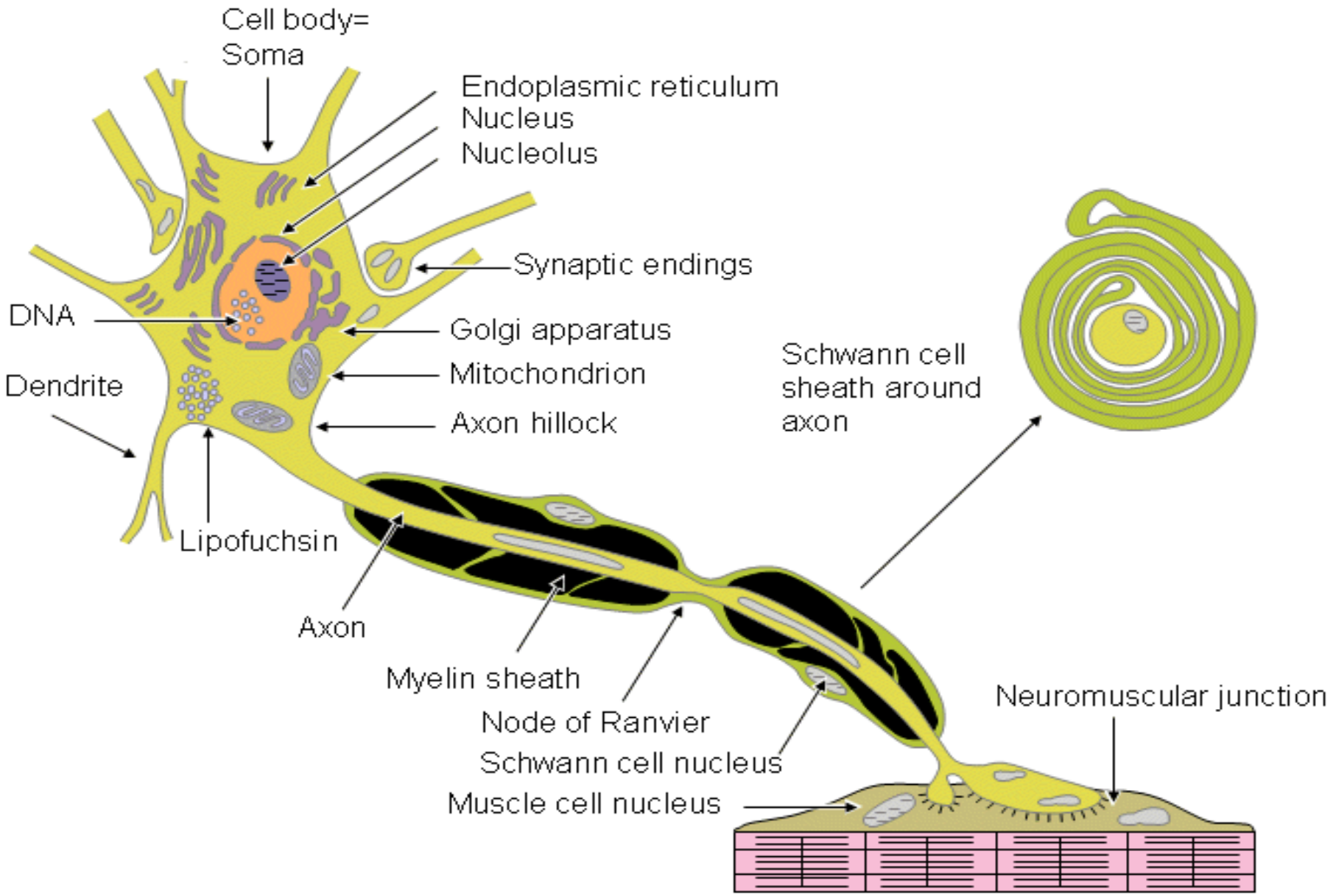
- Major System
  - Superficial (epineurium)
  - Constant position on surface of nerve
- Minor Longitudinal System
  - Deeper (perineurium/endoneurium)
  - Endoneurial Capillaries
    - Act like Blood Brain Barrier
    - Impaired by trauma/ischaemia/toxins/histamine

OK – tell me about axons?

Task 2.

1 minute – draw an axon.

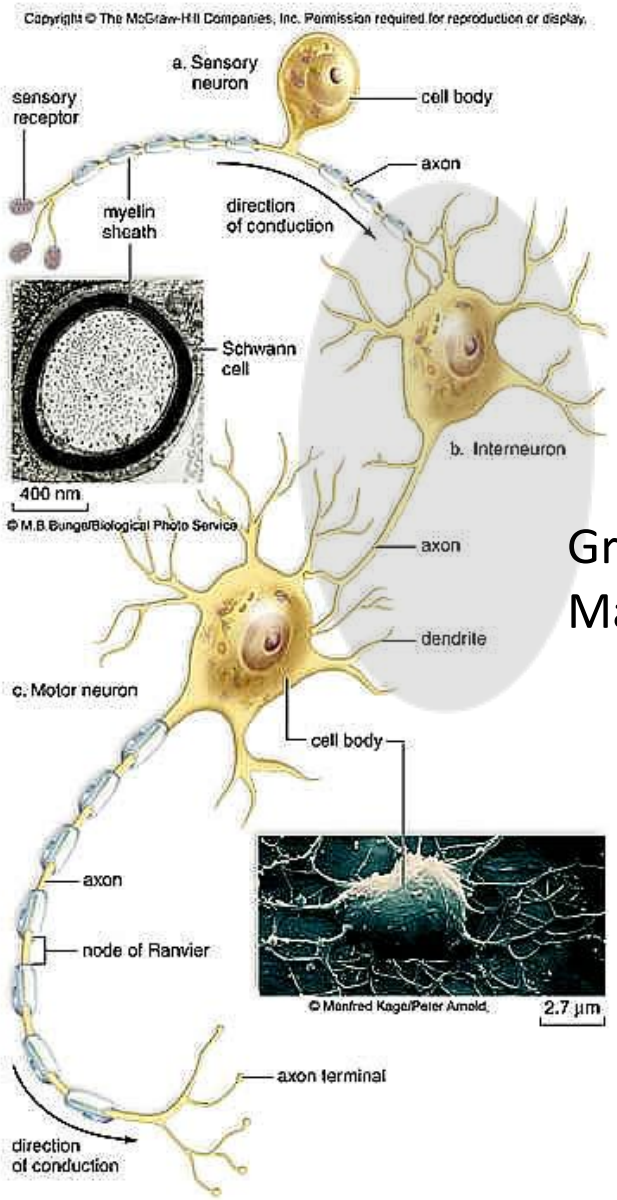
A Motor Axon


Cell body=
Soma
Endoplasmic reticulum
Nucleus
Nucleolus
Synaptic endings
DNA
Golgi apparatus
Mitochondrion
Dendrite
Axon hillock
Schwann cell
sheath around
axon
Lipofuchsin
Axon
Myelin sheath
Node of Ranvier
Schwann cell nucleus
Muscle cell nucleus
Neuromuscular junction

Types of Axon

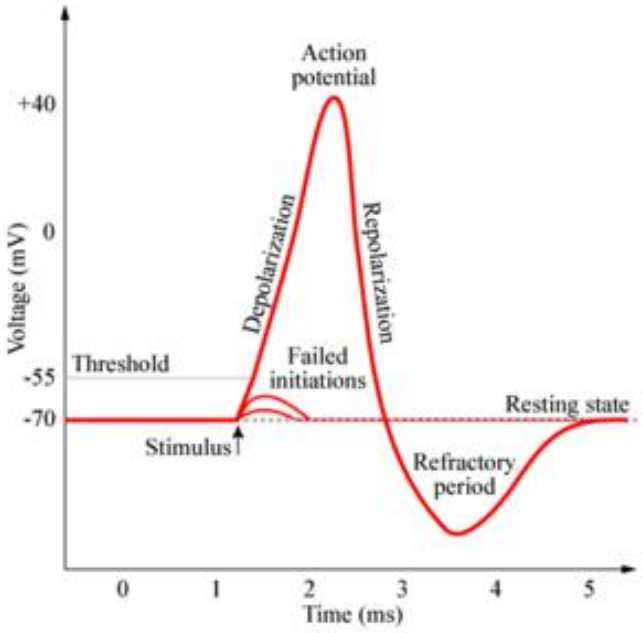
- Sensory (Afferent)
  - Dorsal Root Ganglia
  - Dorsal

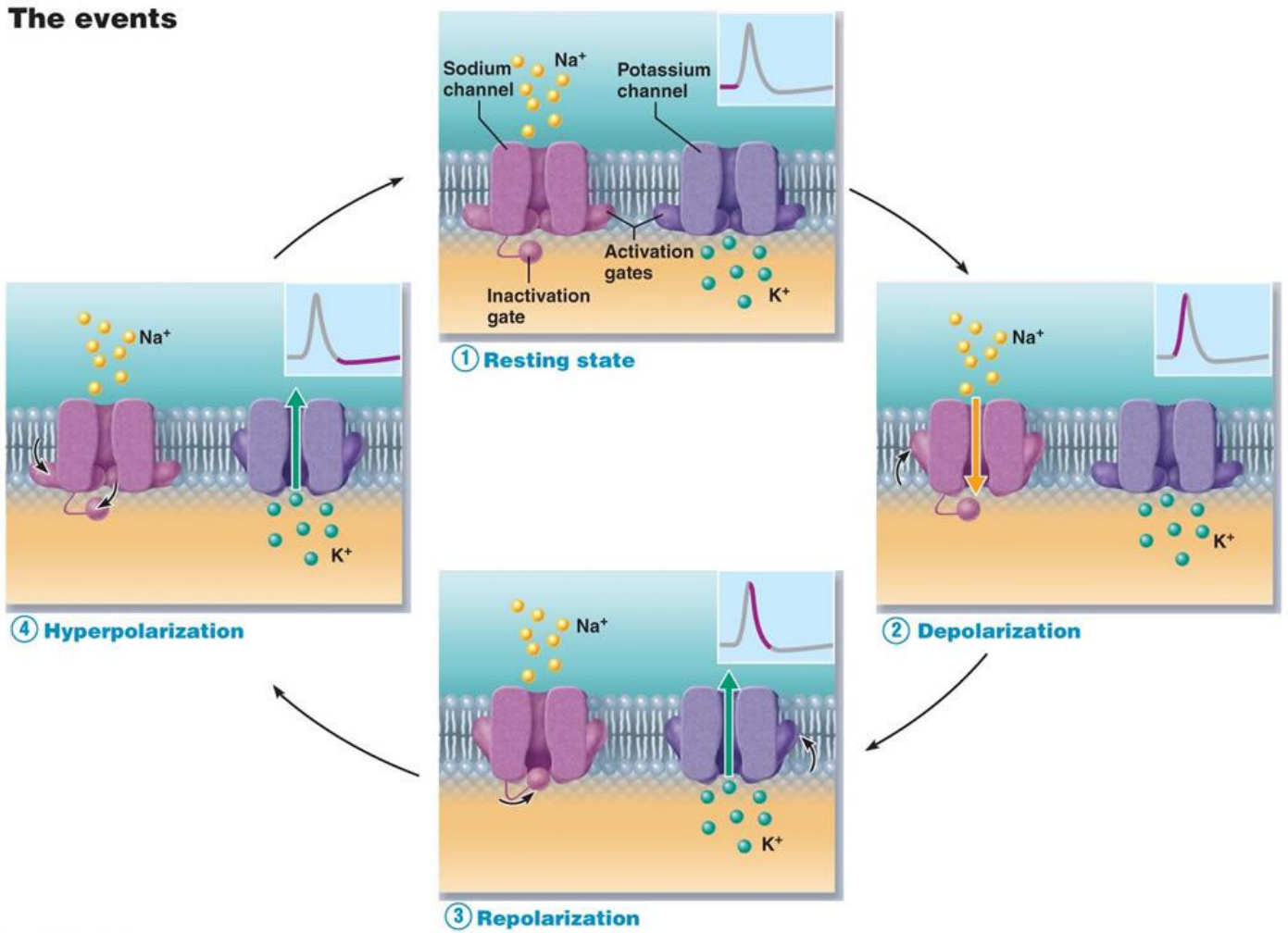
- Motor (Efferent)
  - Anterior



Grey Matter

Action Potential





We are going to talk about Nerve Injury

Question:

What Classification System do you know?

Seddon Classification (1942)

- Neuropraxia
  - Localise myelin damage (compression)
  - Axon continuity preserved
  - No Distal Degeneration
- Axonotmesis
  - Loss of axon continuity
  - Variable preservation of connective tissues structures
- Neurotmesis
  - Disruption of entire nerve

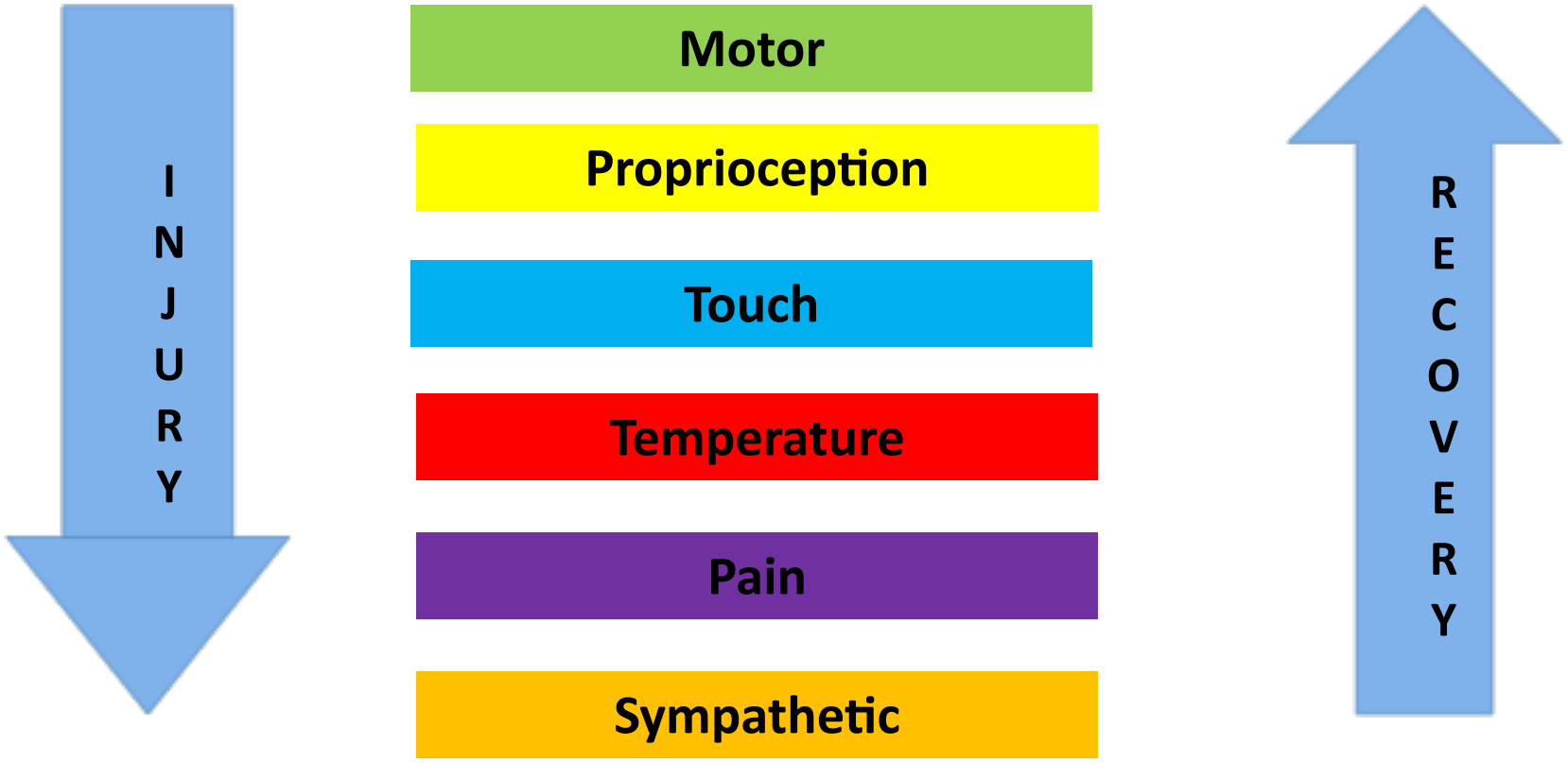
Injury to Nerve

Nerve injuries occur on a continuum of severity

Birch & Bonney	Non-degenerative			Degenerative			
Lundborg 1988	Physiological conduction block		Myelin damage	Axonal damage	Axon + Endoneurium damage	Axon + Endoneurium + Perineurium damage	Axon + Endoneurium + Perineurium + Epineurium damage
	Type A	Type B					
Sunderland 1951	I			II	III	IV	V
Seddon 1942	Neurapraxia *(Transient Block)*			Axonotmesis *(Lesion in Continuity)*	Neurotmesis *(Division of a Nerve)*		

Increasing cross-innervation leading to poorer outcome

After Injury Function Fails sequentially



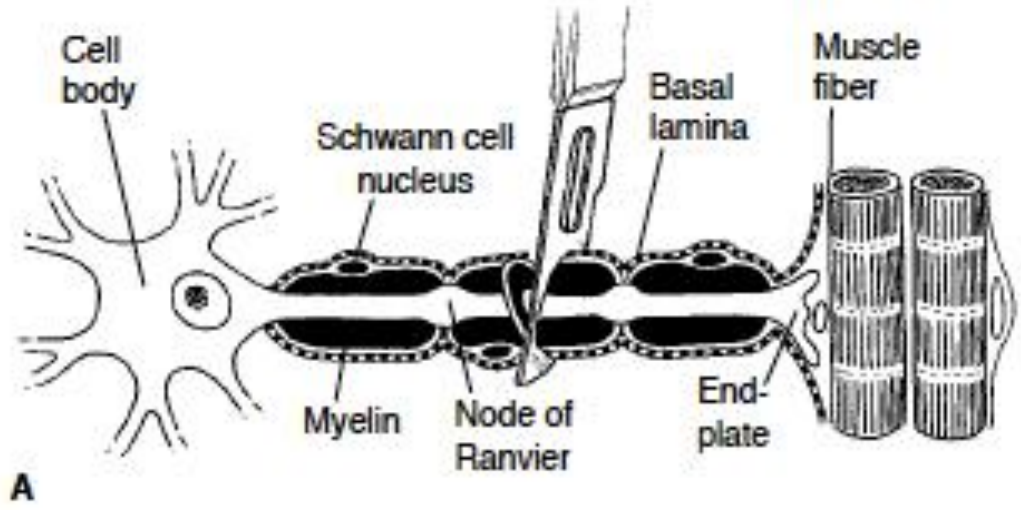
Ok – let's talk about nerve changes after injury...

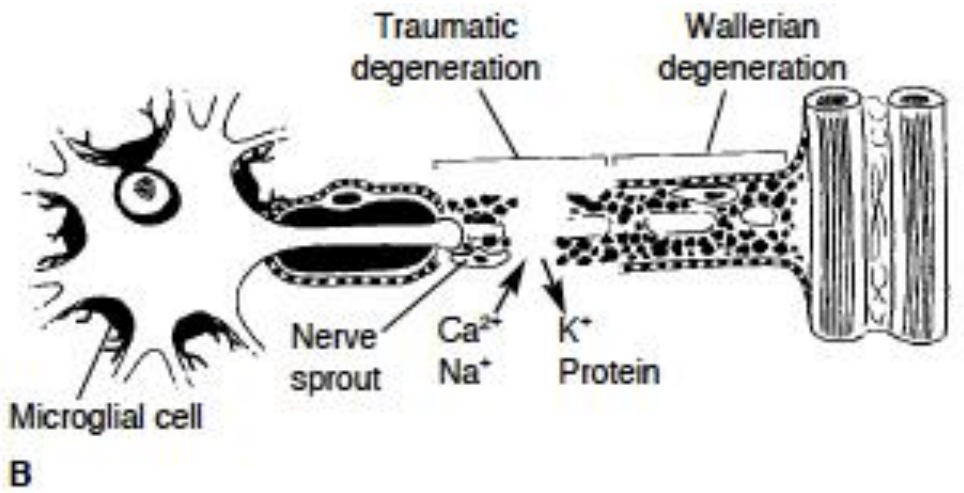
Question:

What happens when you transects a nerve?

What Happens When Transect a Nerve?

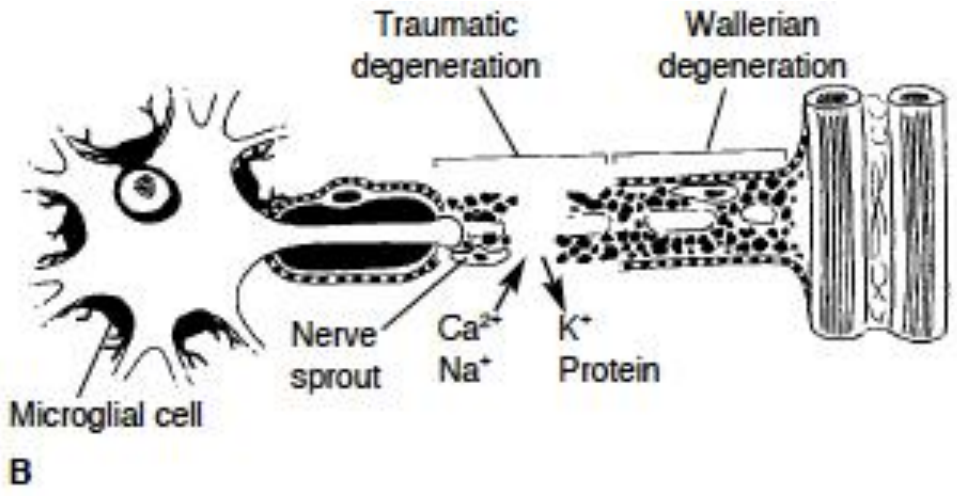
- Transection
- Cell body Swells
- Chromatolysis
  - Neurotransmitter synthesis stops
  - Change in metabolic activity
  - Production of structural material for repair starts





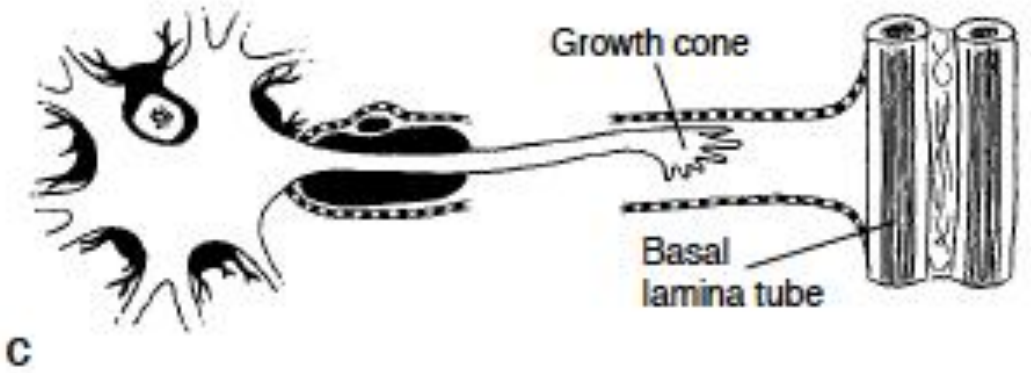
Changes to Axon

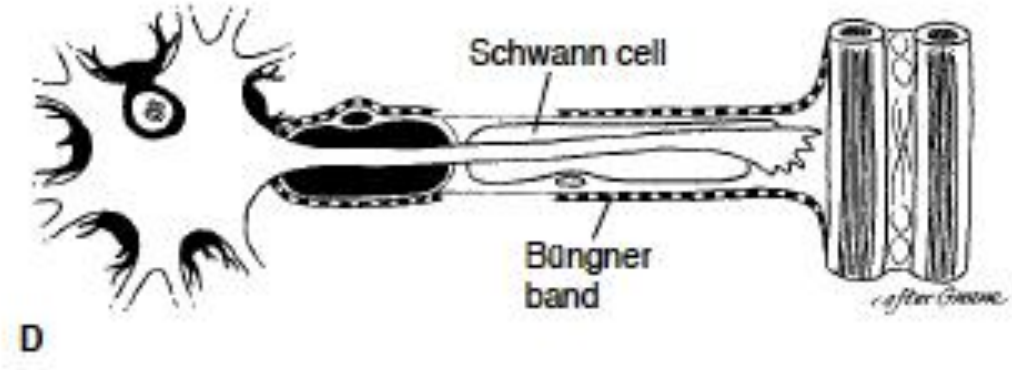
- Proximal to zone of injury
  - Traumatic Degeneration
    - Extends proximally from injury site to next node of Ranvier
- Distal to zone of injury
  - Wallerian Degeneration
    - 48-96 hours later
    - Myelin deteriorates
    - Axon disorganised
    - Schwann cells proliforate
    - Phagocytosis of myelin and axonal debris



Regeneration

- Basal Lamina persists
- Bungner Bands
  - Columns of longitudinally aligned Schwann cells
- Growth Cone
  - Tip of regenerating axon
    - Lamellipodia / Filopodedia
      - Explore environment
  - Axonal elongation
    - In response to 4 factors
    - Neurotrophic, neurite promoting, matrix forming precursors, metabolic (+ others)





Distal Reinnervation – early better!

- Motor
  - Muscle remains viable for 2 years
  - Up to 80% loss of mass by 4 months
    - Increase motor end plate number
    - Muscle hypersensitive and fasiculates
  - Chances of functional reinnervation poor after 12 months if axon not at endplate
- Sensory
  - Nerve seeks Organs (Meissner Corpuscles/Raffini Corpuscles)
  - Degenerate over time – 1-3 years?

So tell me about how you would repair a nerve?

Question:

When, how would you repair a nerve?

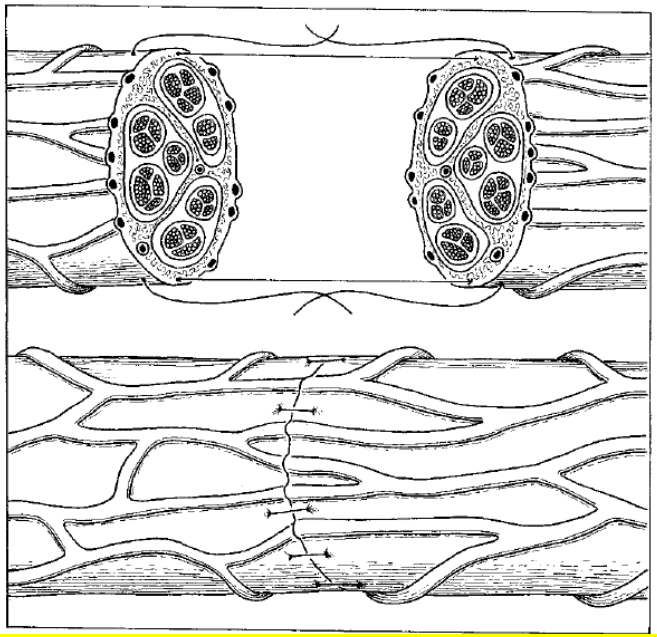
What conditions are ideal?

Nerve Repair

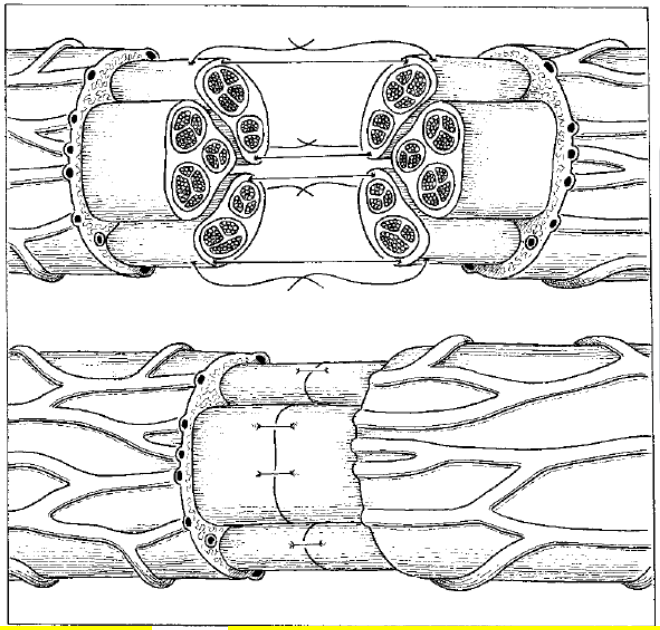
- When?
  - Immediate primary repair better results
- Conditions for repair?
  - Clean wound, good vascular supply, no crush component, good soft tissue coverage
  - skeletal stability, minimal tension repair
- How?
  - Microsurgical
  - 9.0 nylon (withstands greatest distractive force before gapping)

Techniques

Epineurial Repair



Group Fasciular Repair



No Difference in outcome clinically!!

How to Align Ends?

Blood Vessels in epineurium

Match Fasicular bundles

Other Methods Available?

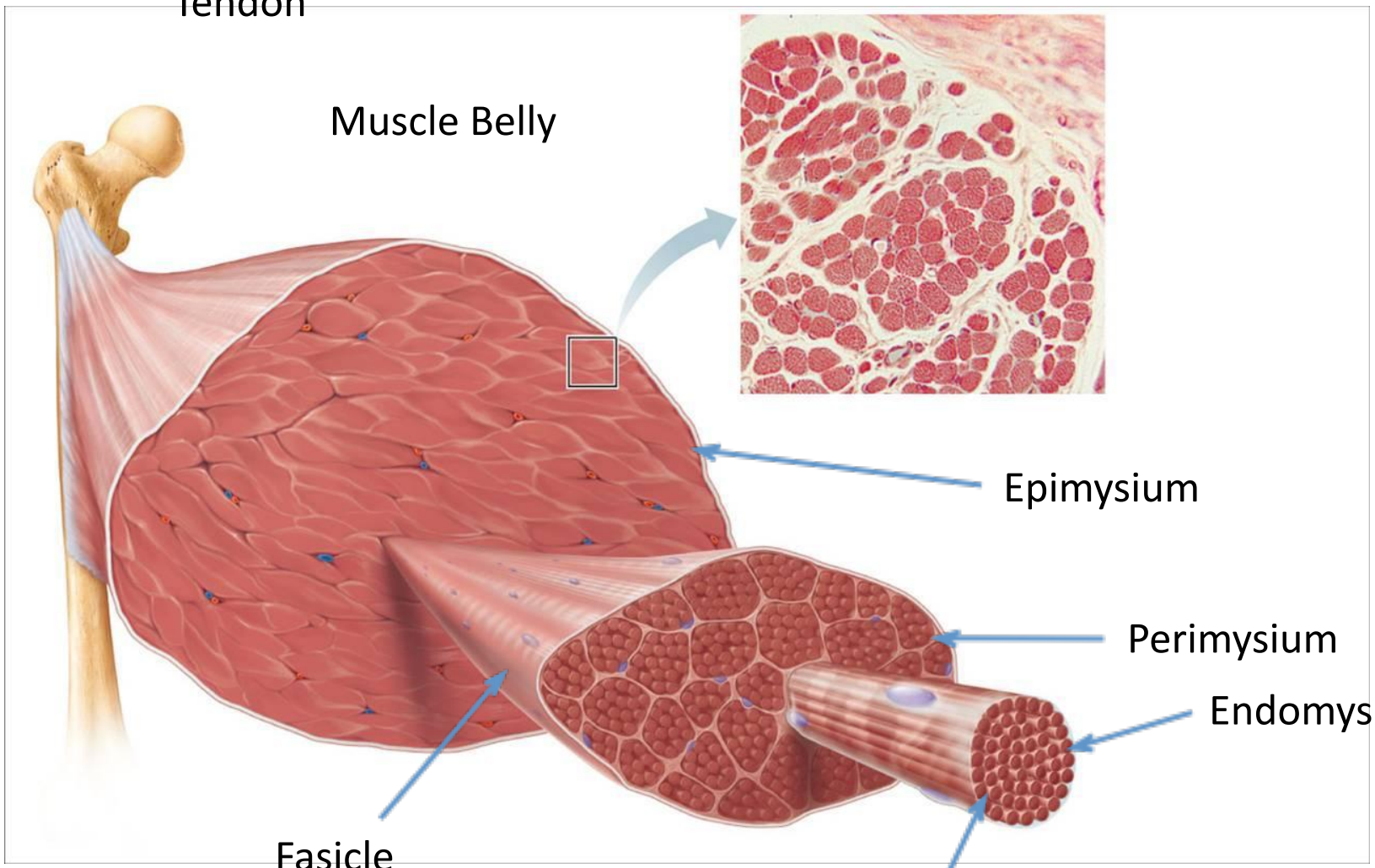
Autograft

Allograft

Collagen Tubes

Muscle Structure

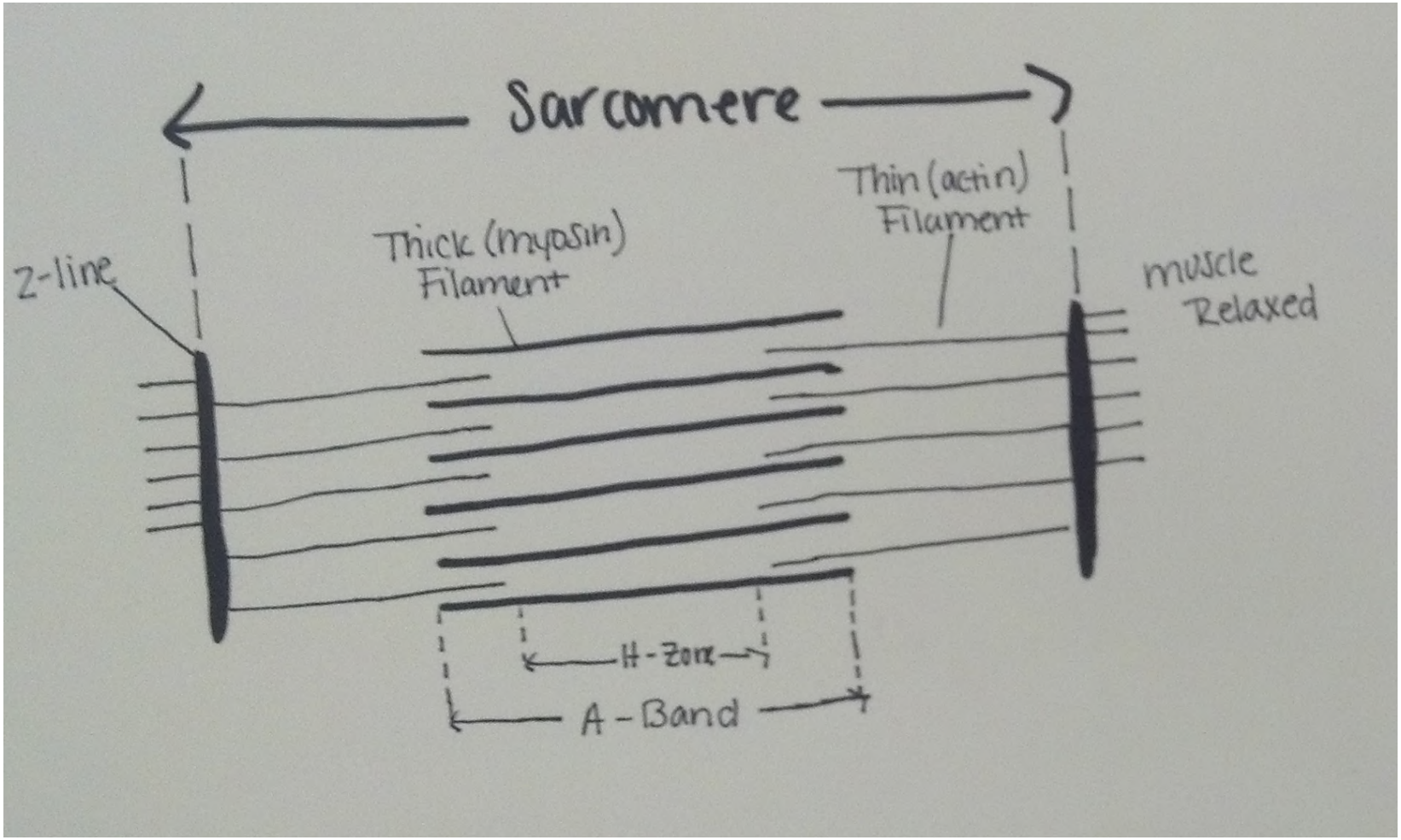
Talk me through this Diagram



Right – what are the contractile units of the myofiber?

Task:

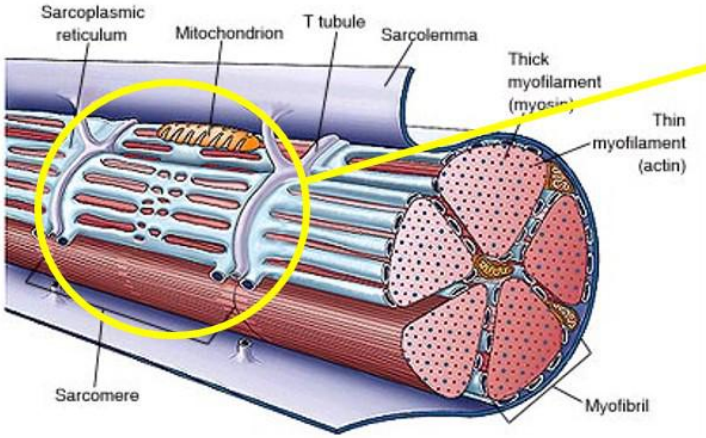
1 minute - Draw a sarcomere schematically.

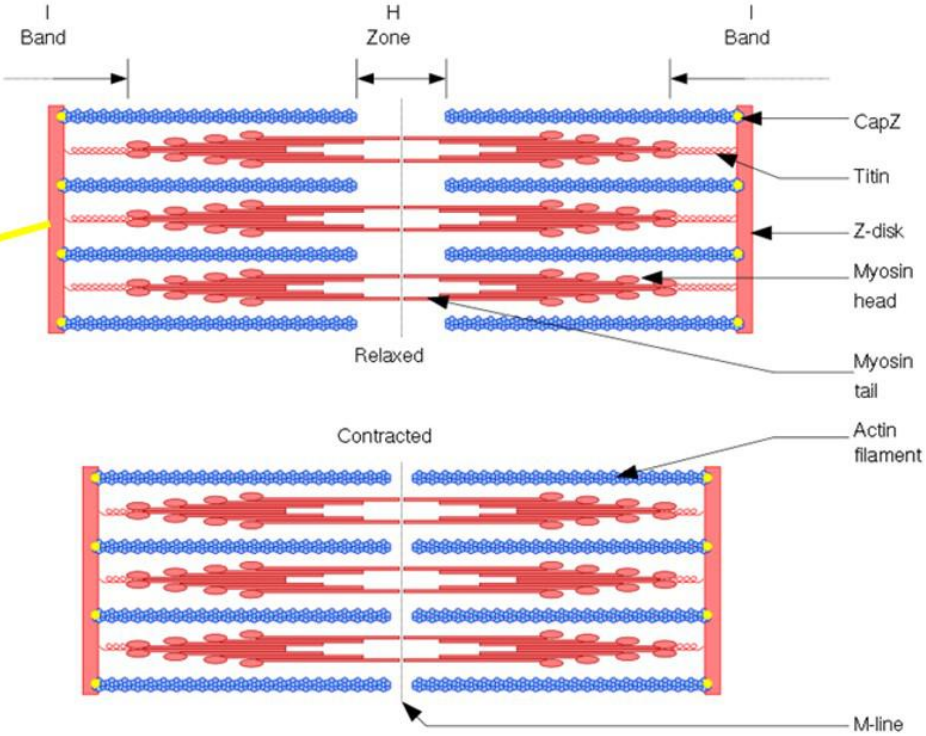


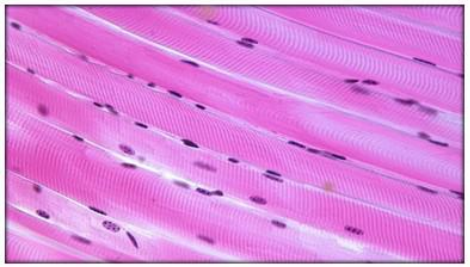
A- band – Actin and Myosin
M-line – central interconnecting Myosin filaments
H-band – only Myosin
I band – Actin filaments only
Z-line - interconnecting Actin fillaments

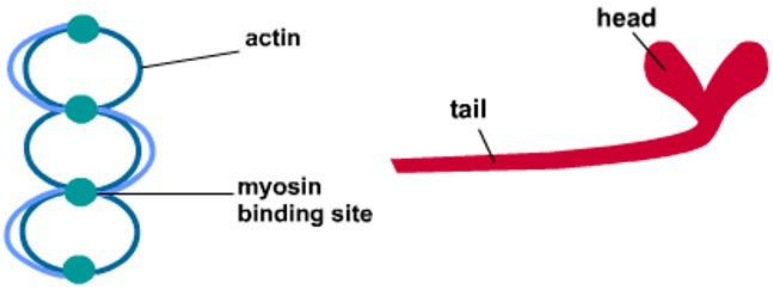
Possible questions?
Changes with contraction
Types of contraction
Eccentric
Concentric

Sarcomere


Sarcoplasmic reticulum
Mitochondrion
T tubule
Sarcolemma
Thick myofilament (myosin)
Thin myofilament (actin)
Sarcomere
Myofibril


I Band
H Zone
I Band
CapZ
Titin
Z-disk
Myosin head
Myosin tail
Relaxed
Contracted
Actin filament
M-line




actin
myosin binding site
head
tail