Patho-physiology of Nervous System Talk 5 – Motor and Musculo-Skeletal disorders

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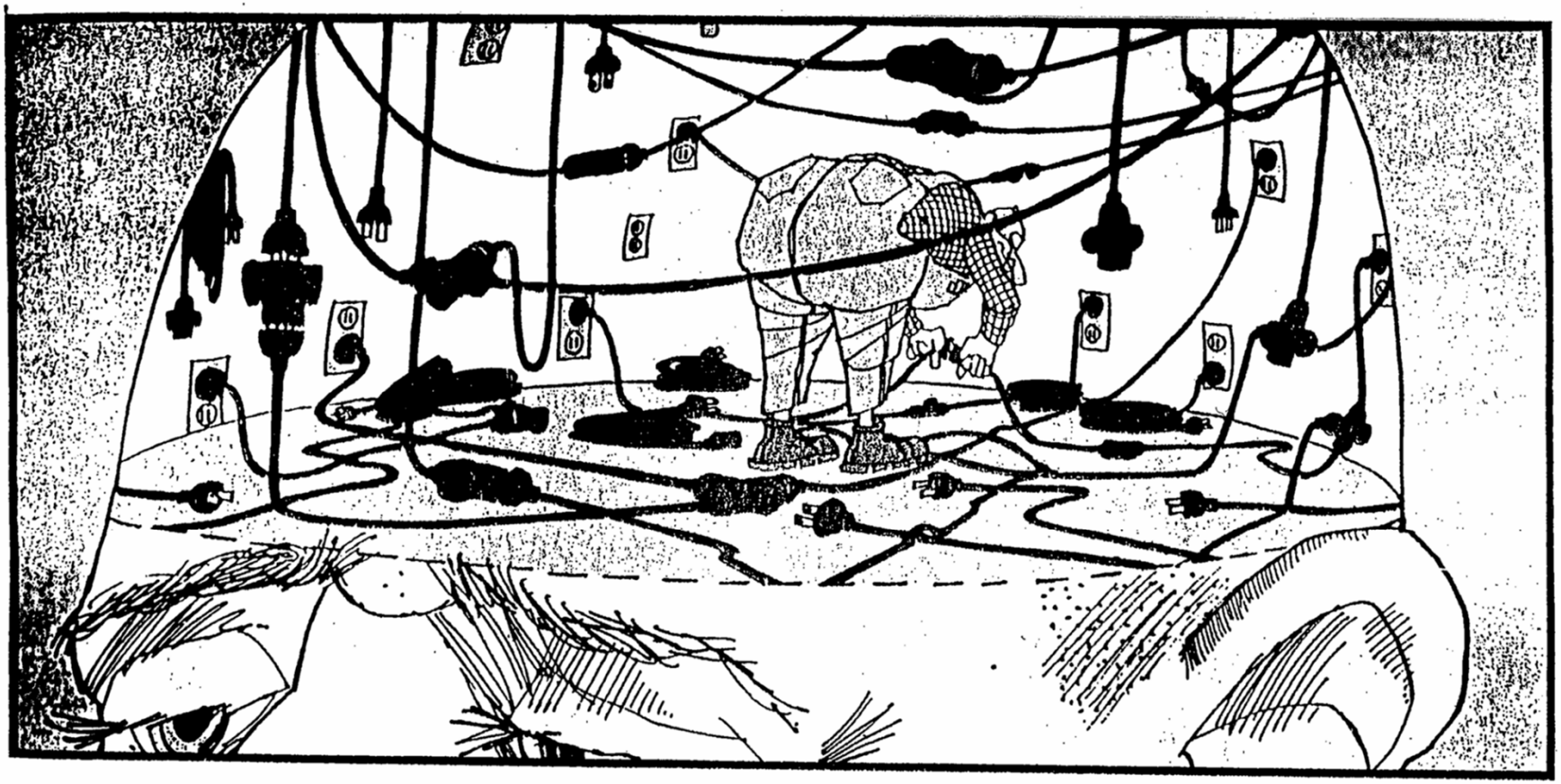


How the brain works.

How is the movement executed and impaired?

Talks on (C)NS

Talk 1 - Pain and Sensory_disorders_1

Talk 2 - Syndromes in neurosciences

Talk 3 - Disorders of tele-metric senses

Talk 4 - Cognitive functions, dementias, etc.

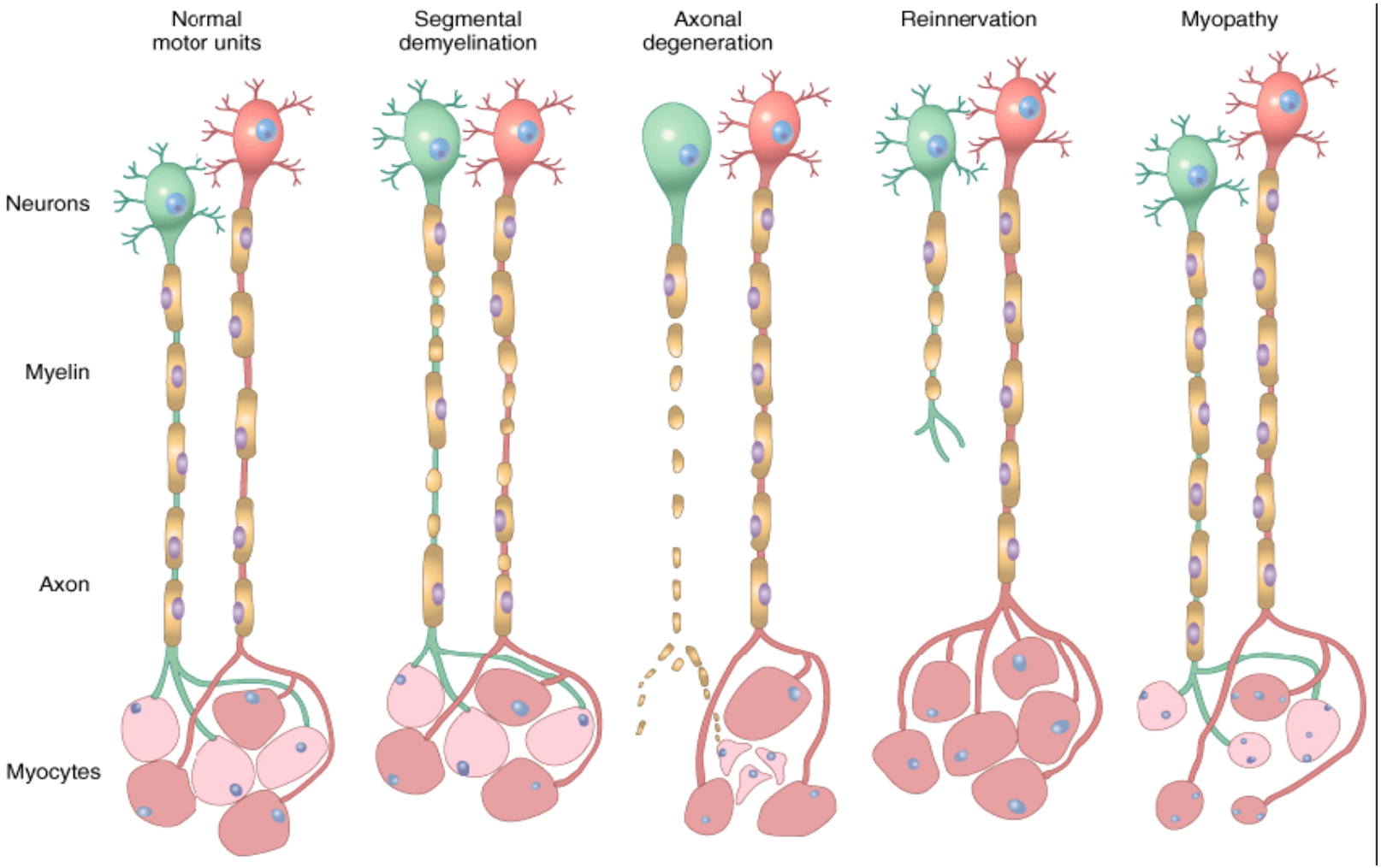
Talk 5 - This – Motor and Musculo-Skeletal disorders

Motor disorders/
Movement disorders

Movement disorders

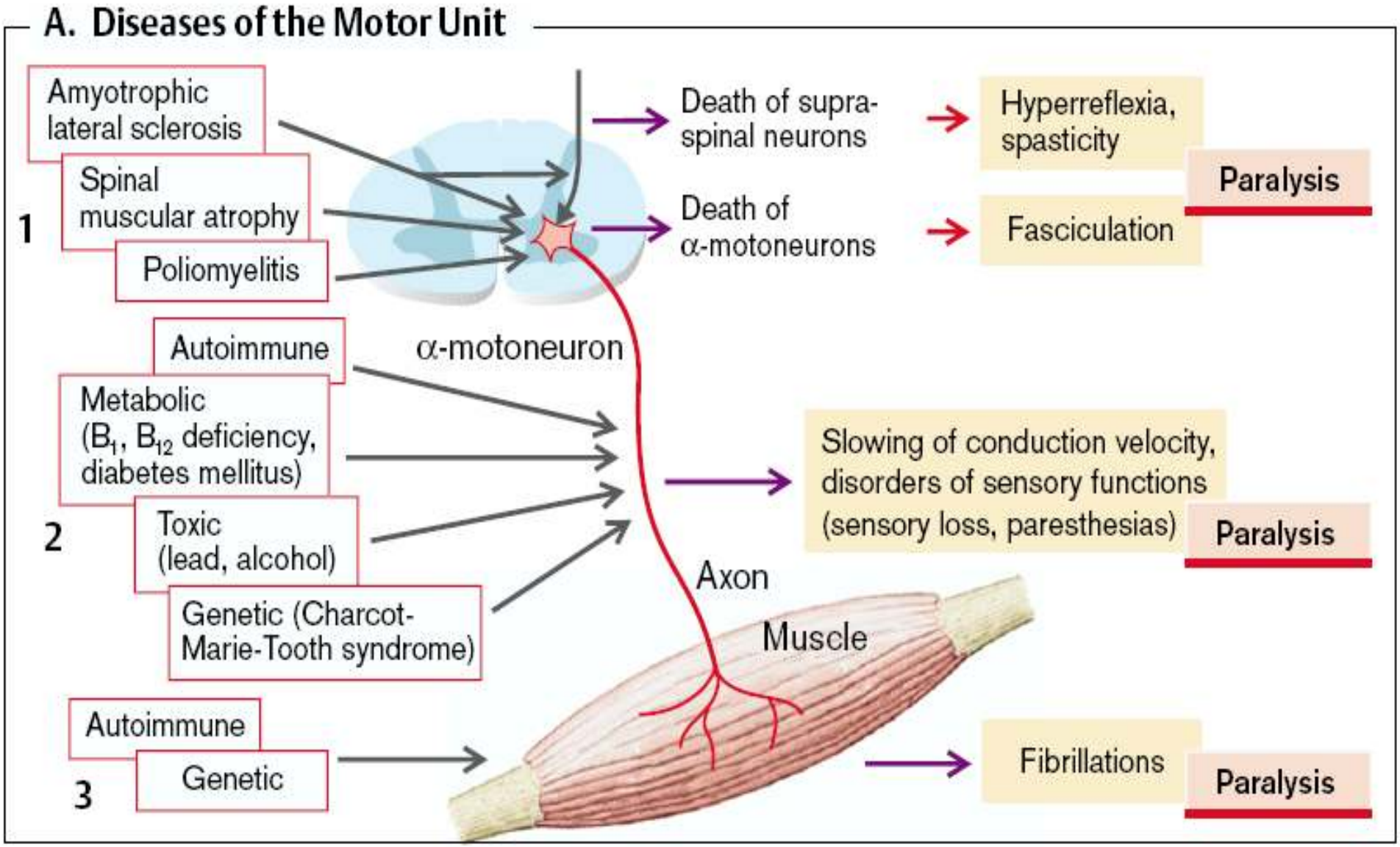
- Muscle disorders
- Lower (alpha-) motoneuron disorders
- Upper (cortico-spinal) motoneuron disorders
- Basal ganglia disorders
- Cerebellum disorders
- Disorders of passive movement apparatus

”Lower” motoneuron - Neuro-muscular unit disorders



norm neuropathy myopathy

Diseases of the motor unit: neuropathies



Vitamin B1, thiamin - energetic and carbohydrate metabolism, diseases: beri-beri, Korsakoff syndrome, ecephalopathy

Vitamin B12, cobalamin –
diseases: pernicious anemia, cell division problems, myelin sheath production deficits

Pb (lead) – neurotoxicity, demyelinization, receptor and inhibition-excitation changes

Poly-radiculo-neuritis/ Gullain-Barre syndrome/ ascending paralysis
(starts after bacterial/ or viral infections, immuno-patho-genesis, axonal demyelinisation)

Neuropathies versus myopathies

Clinical findings	**Neuropathy**	**Myopathy**
Muscle weakness	**++**	**++**
Loss of reflexes	**+**	0
Fasciculations (twitchings)	**+**	0
Sensory deficit	**+**	0
Abnormal reflexes (Babinski)	**+**	0

Lower motoneuron disorders

- Peripheral nerve affected
  - Axonal degeneration; injury $\rightarrow$ Waller degeneration
  - Axonal demyelinization (Guillain-Barre syndrome)

(Both motor and sensory disorder)

- α-motoneuron soma affected
  - Inflammation (example poliomyelitis)

Lower motoneuron disorders

- Phenomenology of sole motor disorders
  - motor unit (fasciculations)
  - atrophia of the whole motor unit
  - when denervated, first comes fibrillation, then atrophia

Upper motoneuron

Is it a

- Pyramidal pathway ?

or

- Extra-pyramidal system ?

Simple answer: it is central neuron, part of cortico-spinal (pyramidal) pathway (and these are also other descendent systems)

Upper motoneuron, signs

- plegia, paralysis, paresis
- spasticity
- cogged wheel sign
- hyperreflexia
- clonus
- abnormal exteroceptive reflexes (Babinski)
- (no atrophy, no fasciculations)

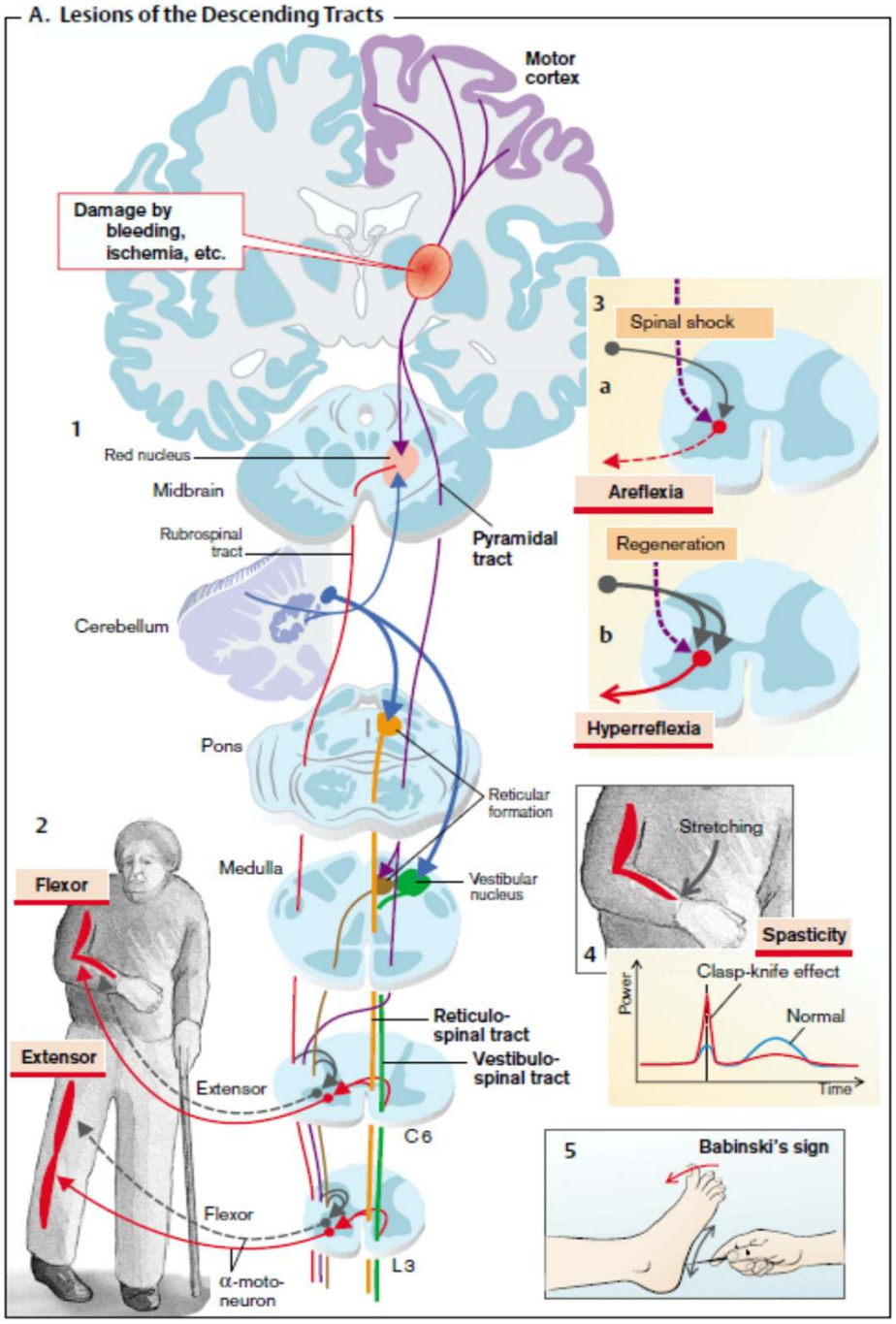
Upper motoneuron, point of view of general practice

"Upper motoneuron" means all descendent motor systems, not only tractus cortico-spinalis

Brain $\rightarrow$ lateral signs, hemiplegia

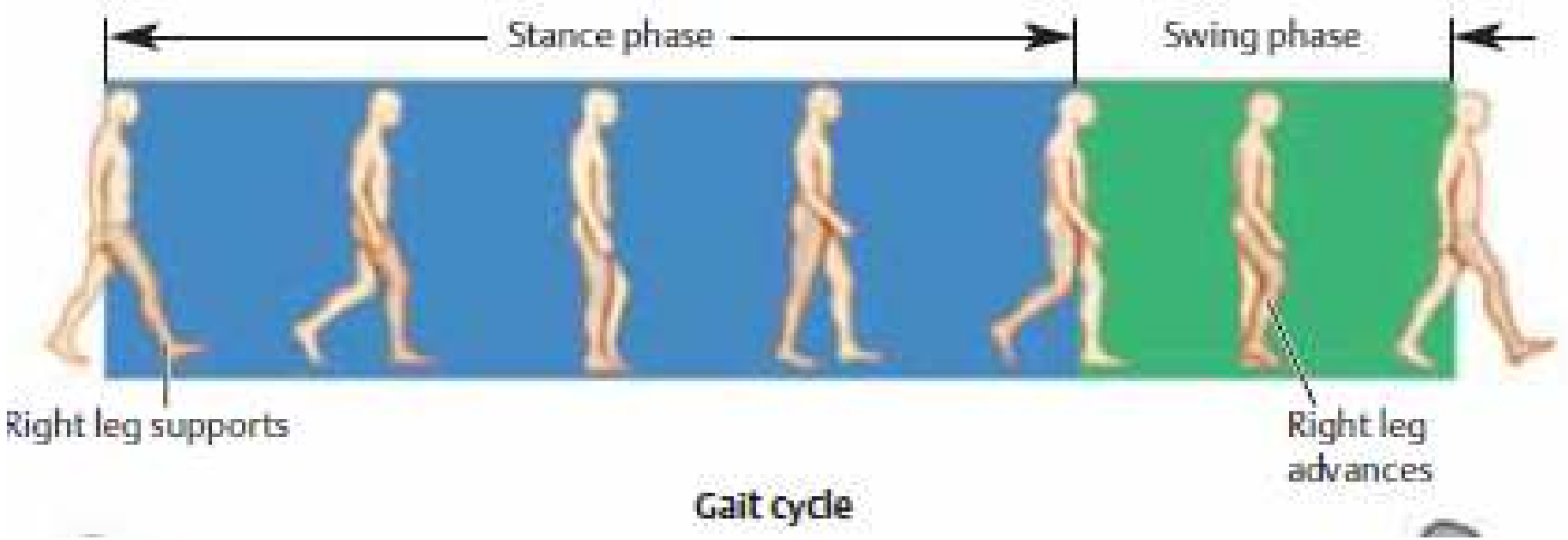
Spinal cord $\rightarrow$segmental signs, paraplegia, quadruplegia

Upper motoneuron disorders =descending tracts lesions



Spasticity

- Higher resistance towards passive movement, accented with higher velocity (scissor gait)
- Hyper-reflexivity
- Central spasticity (abnormal excitation)
- Spinal spasticity (interneurons)
  - Flexor reflexes
  - Extensor spasm (fragment of locomotion?)
  - Sensory neurons


Stance phase
Swing phase
Right leg supports
Right leg advances
Gait cycle

Normal gait

Steppage gait

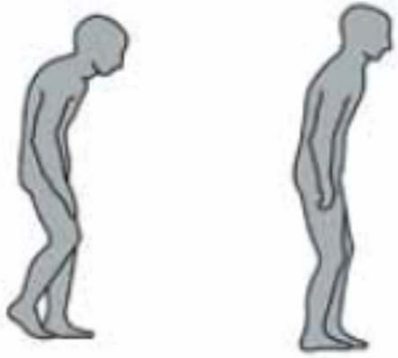
Posture and gait in youth (left) and old age (right)

Knee instability (quadriceps paresis, leg dorsally angulated)

Ataxic gait

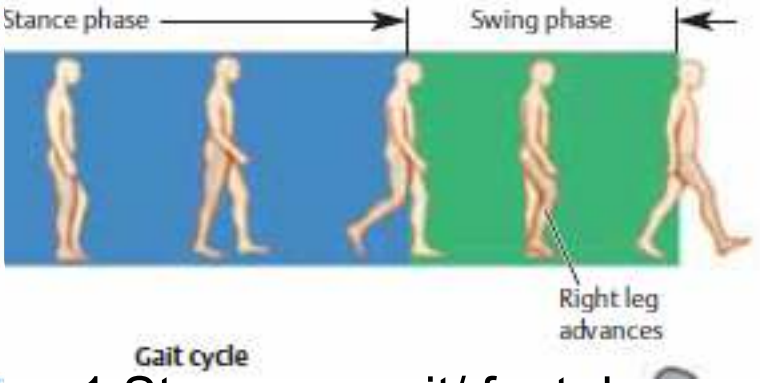
Spastic gait (right hemiparesis)

Spastic gait (spastic paraparesis)



Hypokinetic-rigid gait (left, Parkinson disease; right, start delay/gait apraxia)

Psychogenic gait disturbances (histrionic movements)



Gait cycle

1 Steppage gait/ foot drop: ascending paralysis, polio,
2 Atactic gait: lack of co-ordination, cerebellar, sensory, etc
3 Spastic – upper motoneuron paresis
4 Hypokinetic, ballistic, etc – extrapyramidal
5 Skeletal/ connective tissue problems
6 Other/ antalgic/ psychiatric

Pathological gait-s

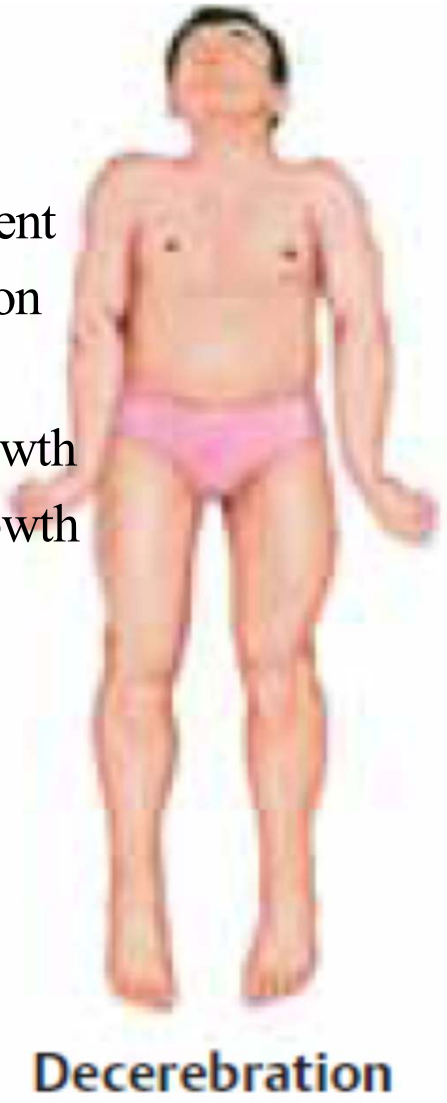
Central Nervous System (CNS) trauma. Spinal Cord Injury (SCI).

Spinal shock in man

Phase	Time	Physical exam finding	Underlying physiological event
1	0-1d	Areflexia/Hyporeflexia	Loss of descending facilitation
2	1-3d	Initial reflex return	Denervation supersensitivity
3	1-4w	Hyperreflexia (initial)	Axon-supported synapse growth
4	1-12m	Hyperreflexia, Spasticity	Soma-supported synapse growth

meningeal irritation position

In both meningeal irritation and spinal shock extensor systems take over flexor systems



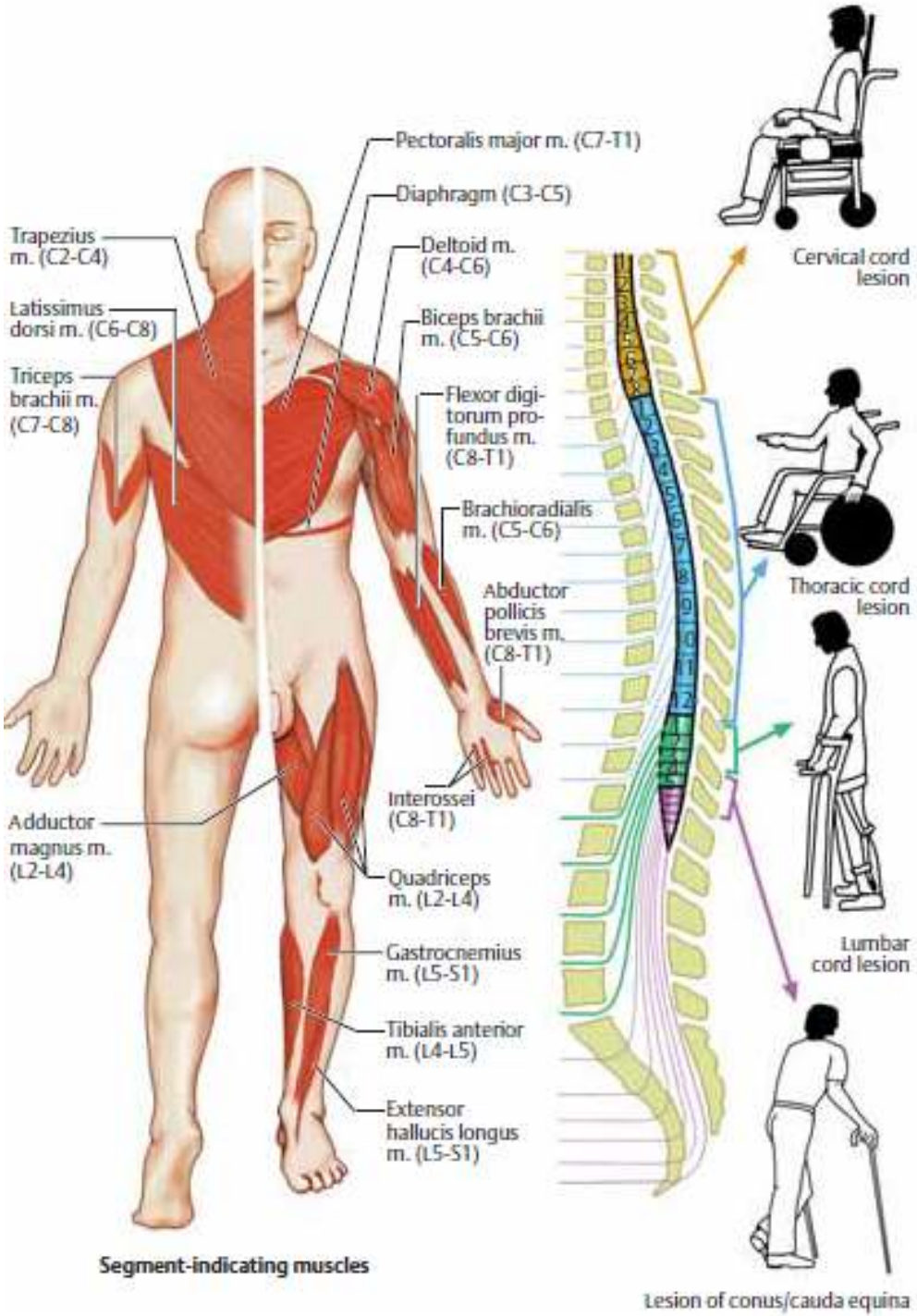
spinal shock position

Comparison of CNS to PNS (central versus peripheral nervous system/ peripheral nerve) injury

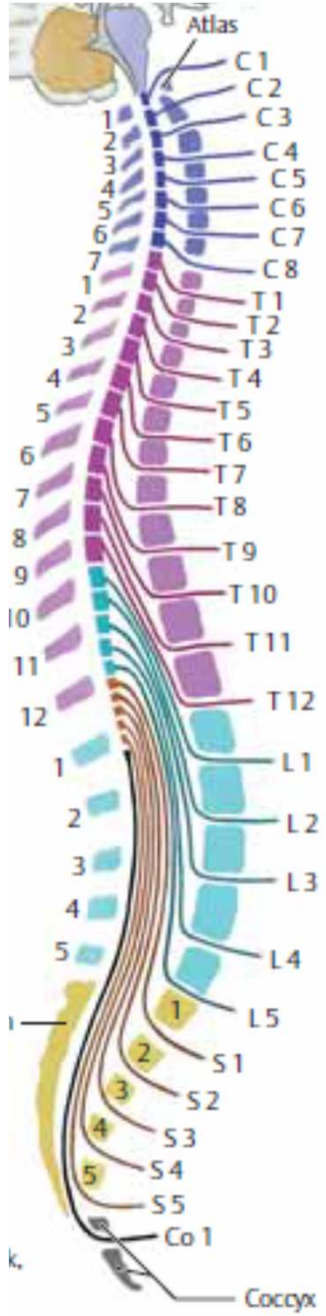
- CNS does not regenerate
- PNS regenerates, Waller degeneration and regeneration, axonal growth…
- Lower species – amphibians – are better
- Why is it so?

Progression of CNS injury (Spinal cord injury as a model)

- local swelling at the site of injury which pinches off blood perfusion → ischemia
- Excessive release of glutamate and excitotoxicity of neurons and oligodendrocytes at the site of injury
- Infiltration by immune cells (microglia, neutrophiles)
- Free radical toxicity
- Apoptosis/ necrosis



Segment-indicating muscles



Spinal nerves

Pathophysiology

- **Common Sites**
  - **C5-6 and T12 ---- L1**
- **higher the injury, the greater the motor/ sensory loss: refer to syllabi/dermatomes**
- **neuro dysfunction depends on the level of the injury**
  - **T1 or above QUAD (tetraplegia)**
  - **T2 or below PARA**
  - **Above C4 Resp. Paralysis**

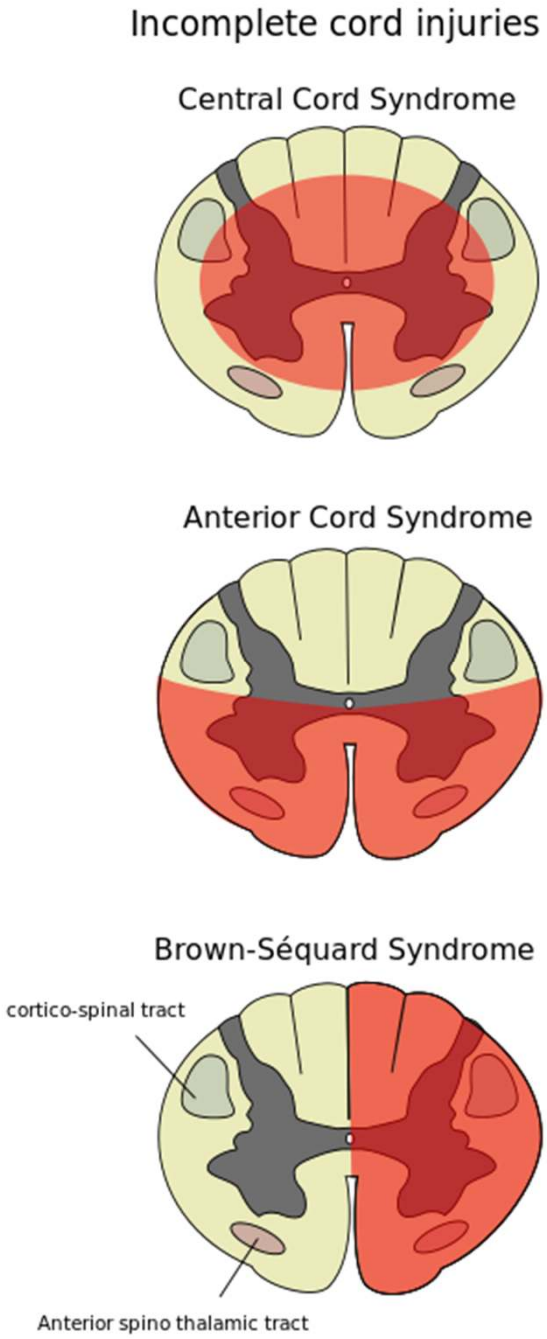
Pathophysiology (Extent of Injury)

Complete

- Loss of voluntary movement/sensation below the injury
- reflex activity below level of lesion may return after spinal shock resolves
- worse prognosis for recovery--

Incomplete

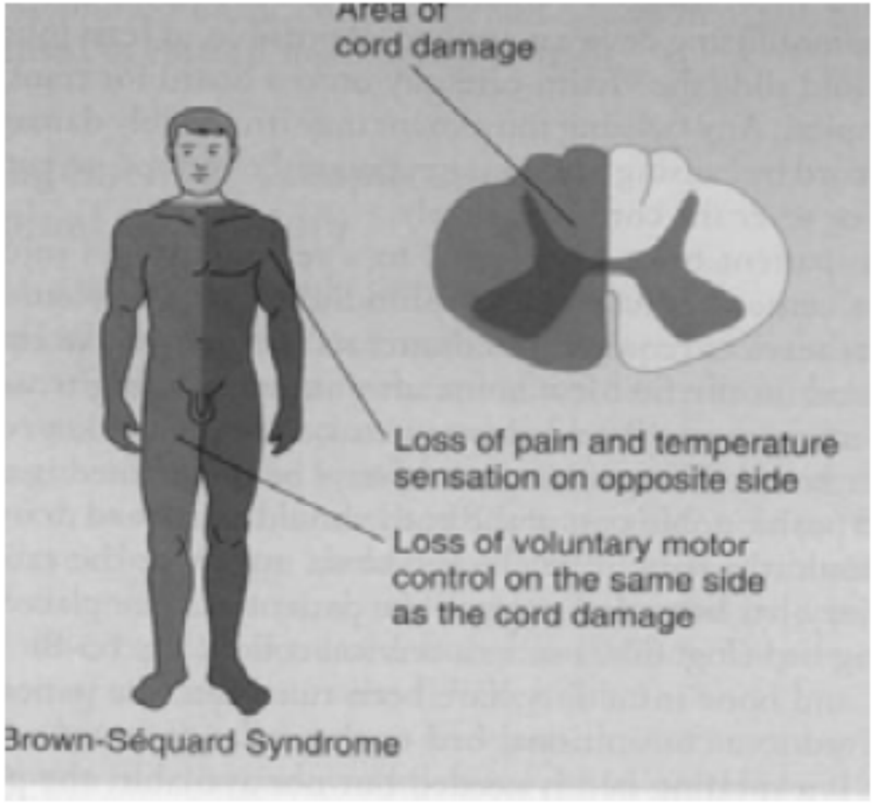
- (1) Varying degrees of motor/sensory loss below the level of injury & (2) central, lateral, posterior injury
  - Three types
    - Central Cord
    - Brown-Sequard
    - Anterior Cord



Types of incomplete spinal cord injury

Spinal Cord Injury (SCI)

Incomplete SCI BROWN-SEQUARD
(cord hemi-section)

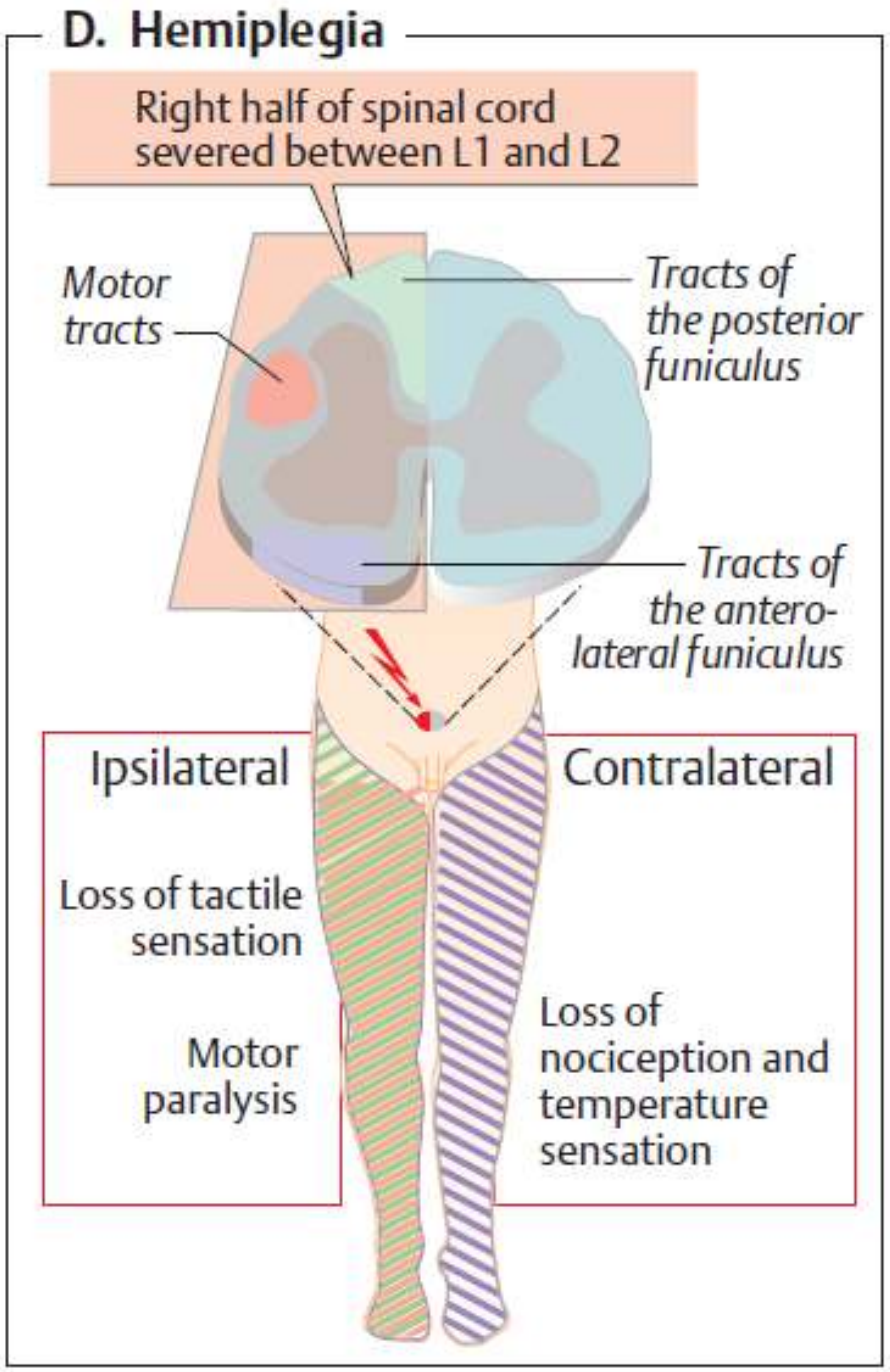


On same side as injury--loss of motor, touch, pressure, vibration BUT, pain/temp intact

On opposite side of injury--loss of pain/temp BUT, motor, touch, sensory vibration intact

Cause: _____

_____



Pathogenesis of Brown-Sequard syndrome

Anterolateral vs.
Dorsal Column Medial Lemniscal

- Medial lemniscus enter spinal cord, ipsilateral dorsal column
  → medulla → synapse on dorsal column nuclei → cross midline
  → ascend to contralateral thalamus
- Anterolateral system information crosses in spinal cord
- Unilateral spinal cord lesion

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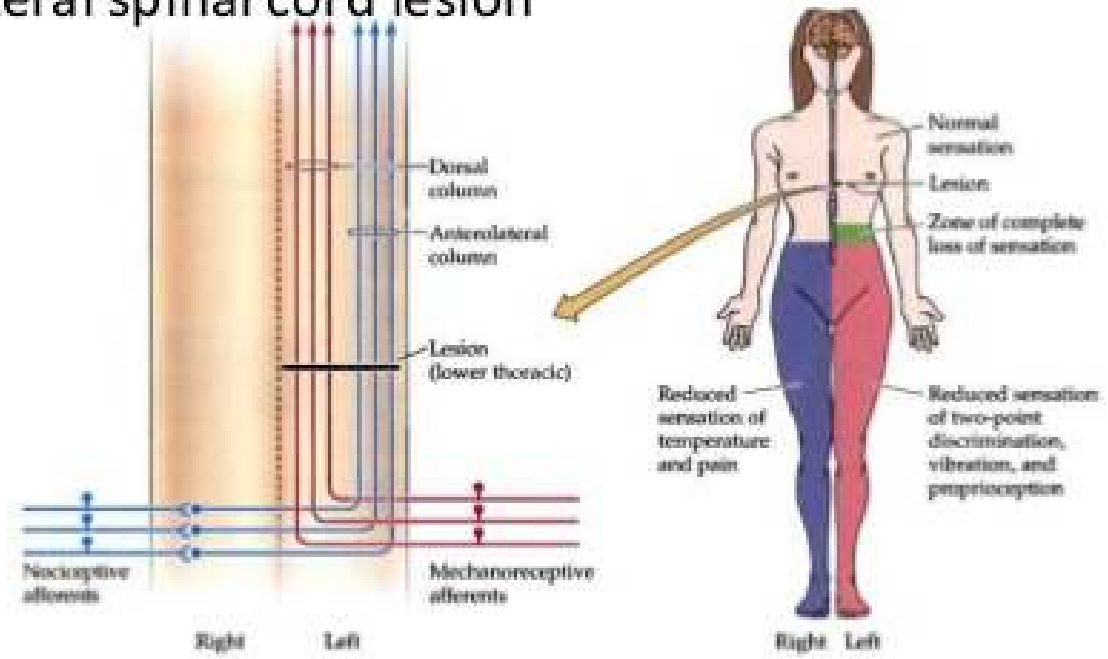


Central cord syndrome

Characterized by:

disproportionately greater motor impairment in upper compared to lower extremities, and variable degree of sensory loss below the level of injury in combination with bladder dysfunction and urinary retention.

Incomplete Spinal Cord Injury (SCI)

Incomplete SCI ANTERIOR

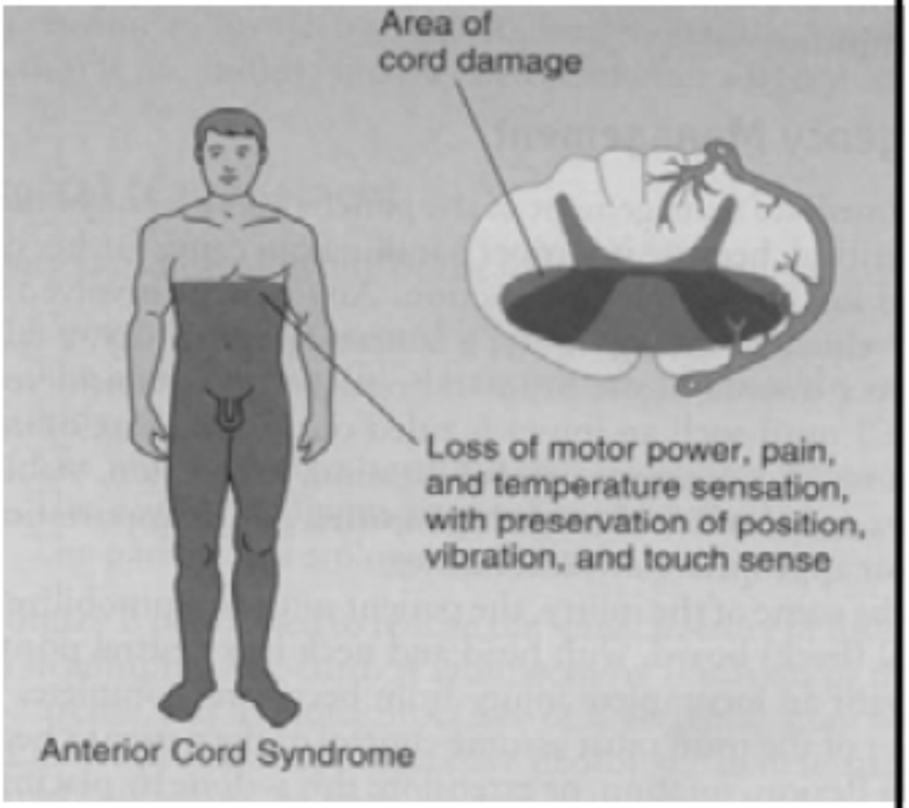
loss of motor, pain/temp

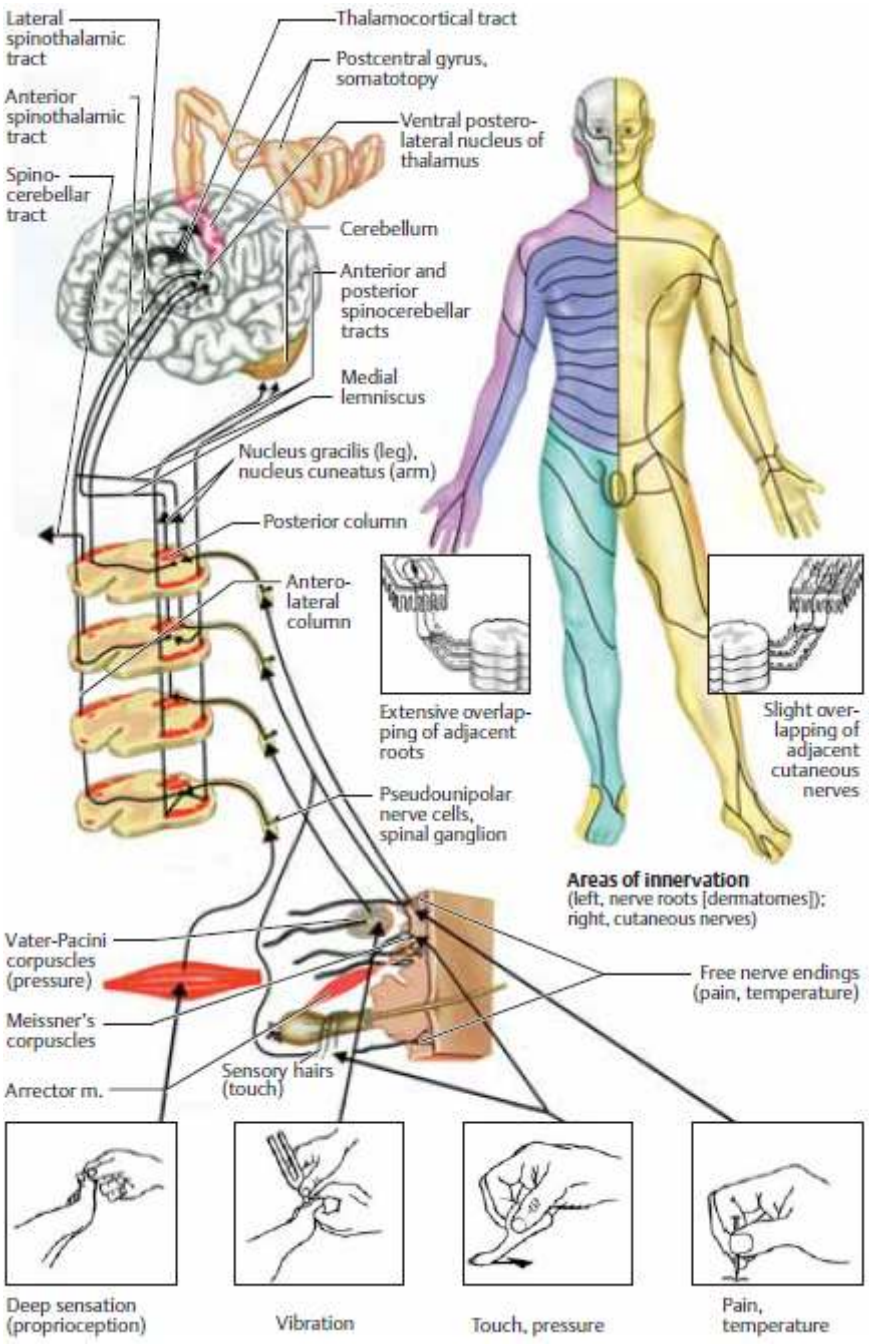
mixed sensory loss

touch, proprioception, vibration remains intact

Cause: _____

_____





4 modalities:
1 deep, 2 vibration,
3 touch, 4 pain and
temperature,

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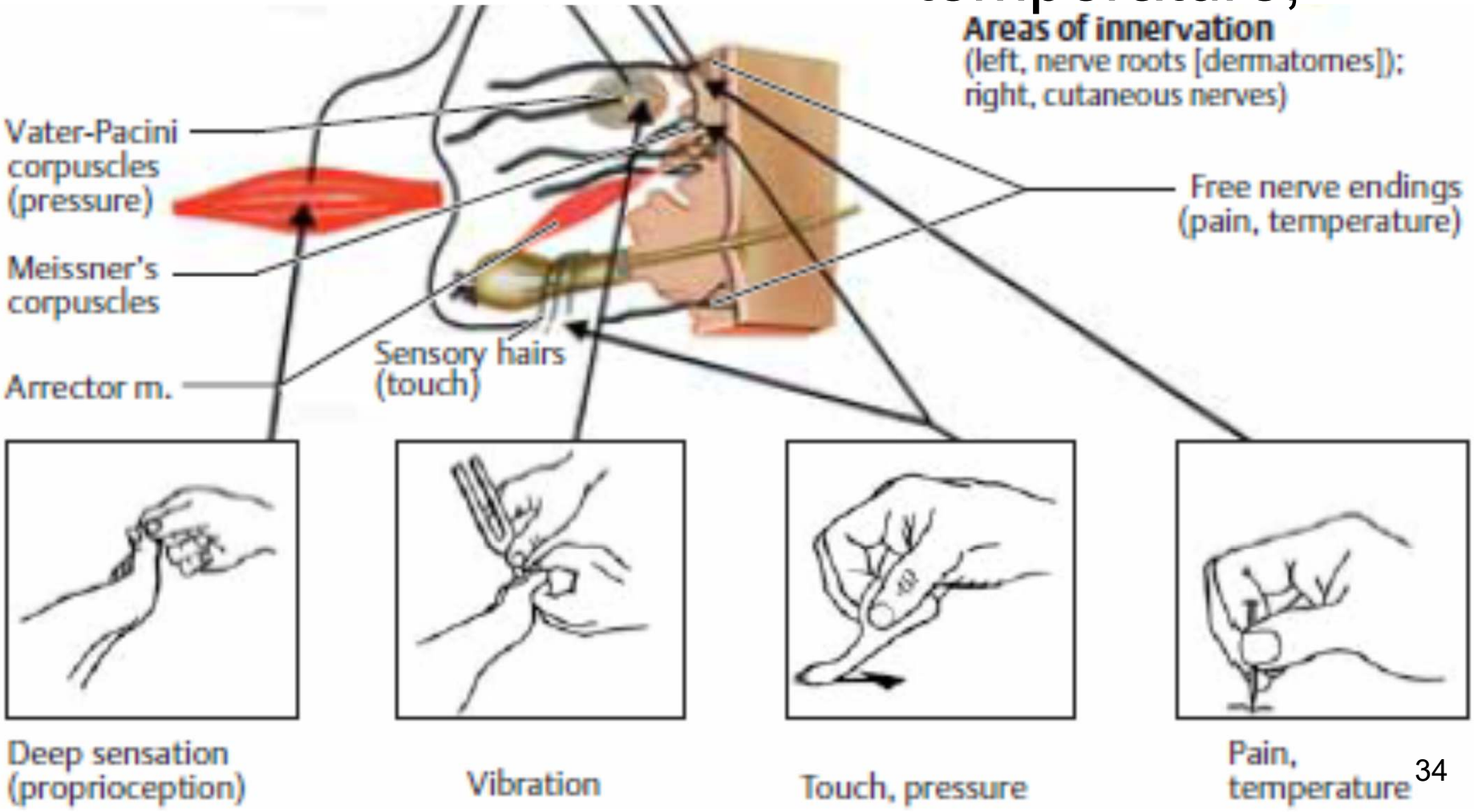
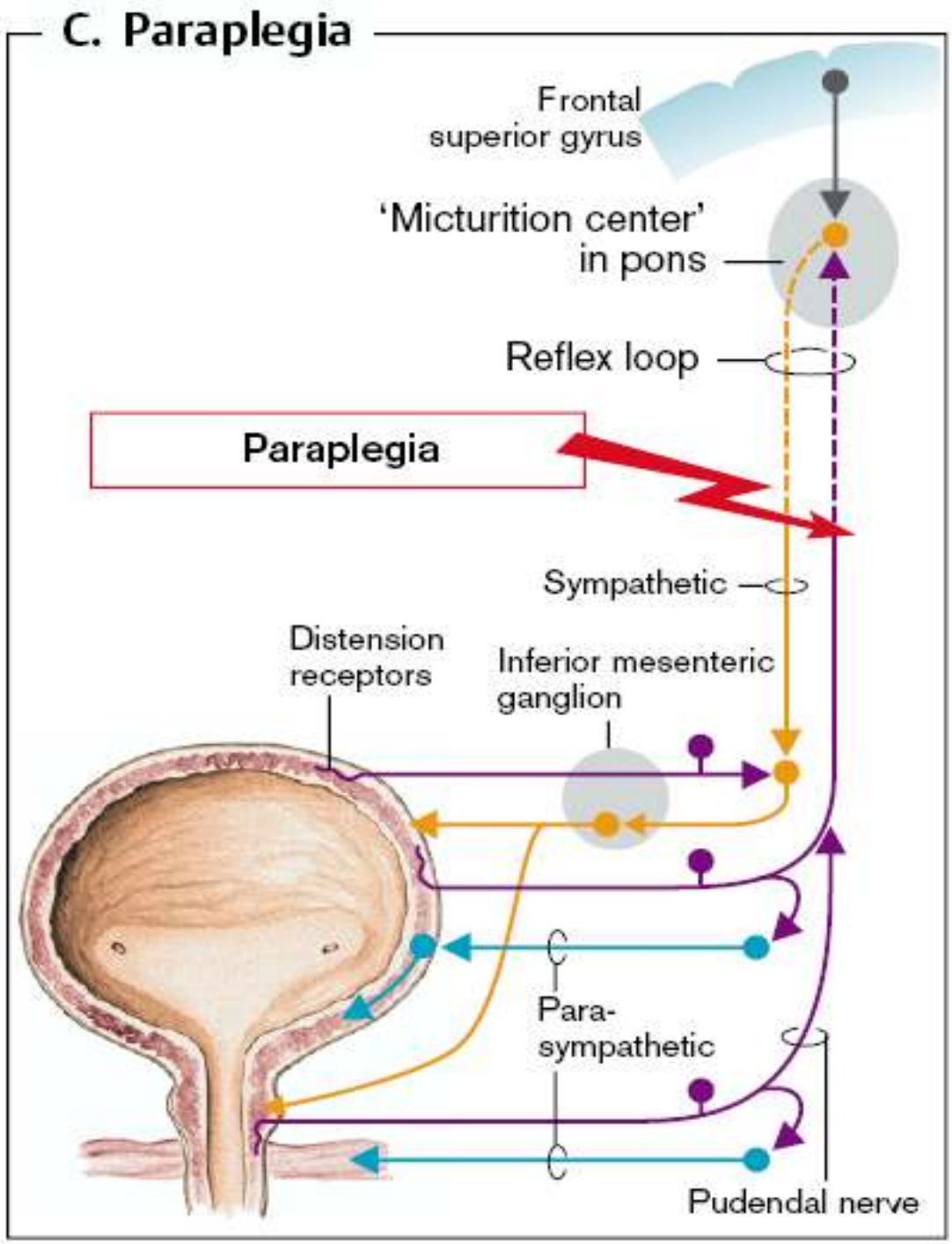


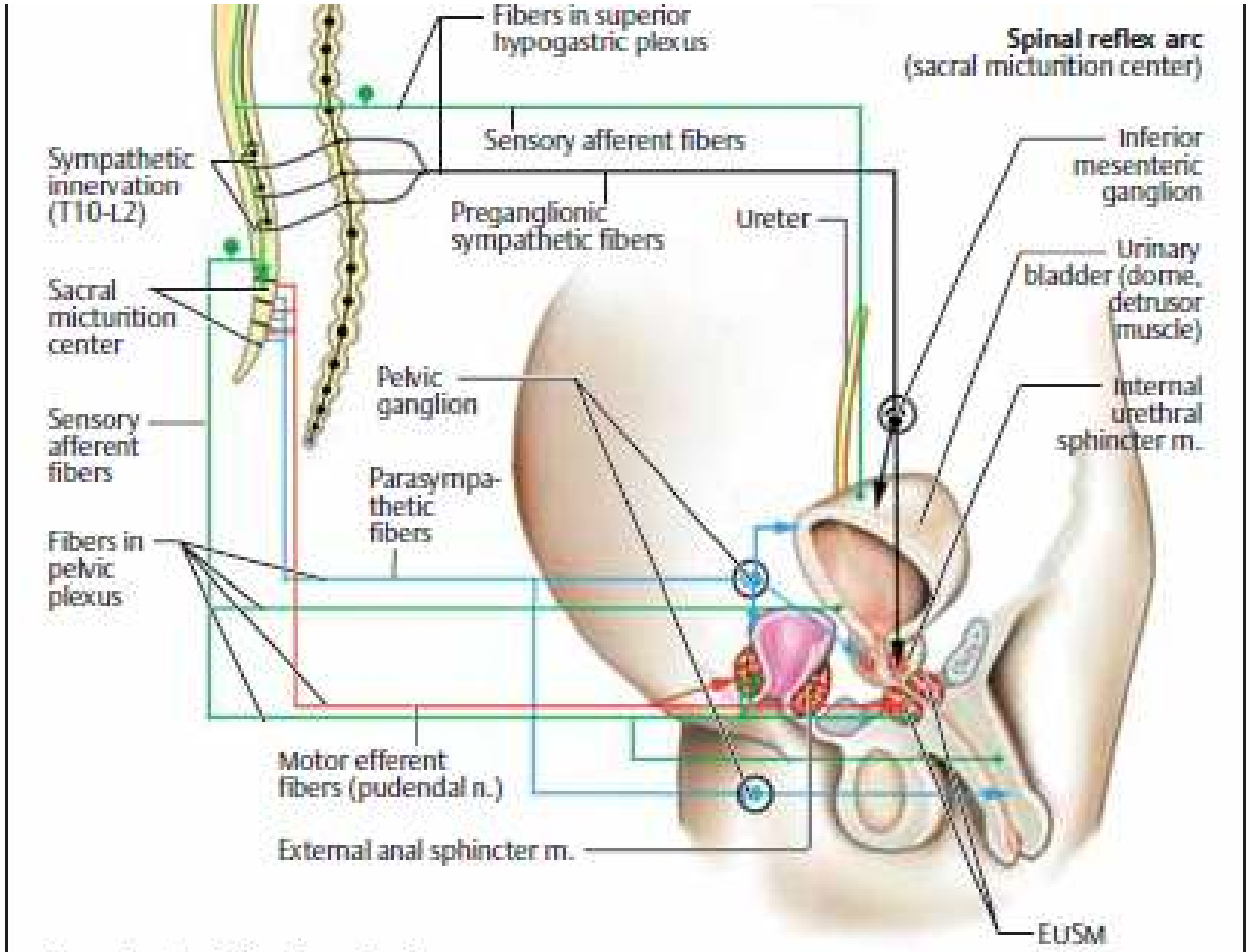
Incomplete SCI

conus medullaris/cauda equina

- Compression of lumbar-sacral area
  - **Conus T11-L1**
  - **Cauda L2-sacral**
- Better prognosis because injury in "horse tail" area
- Loss of motor is variable
- Sensory unimpaired
- Flaccid bowel and bladder
- Impaired sexual function

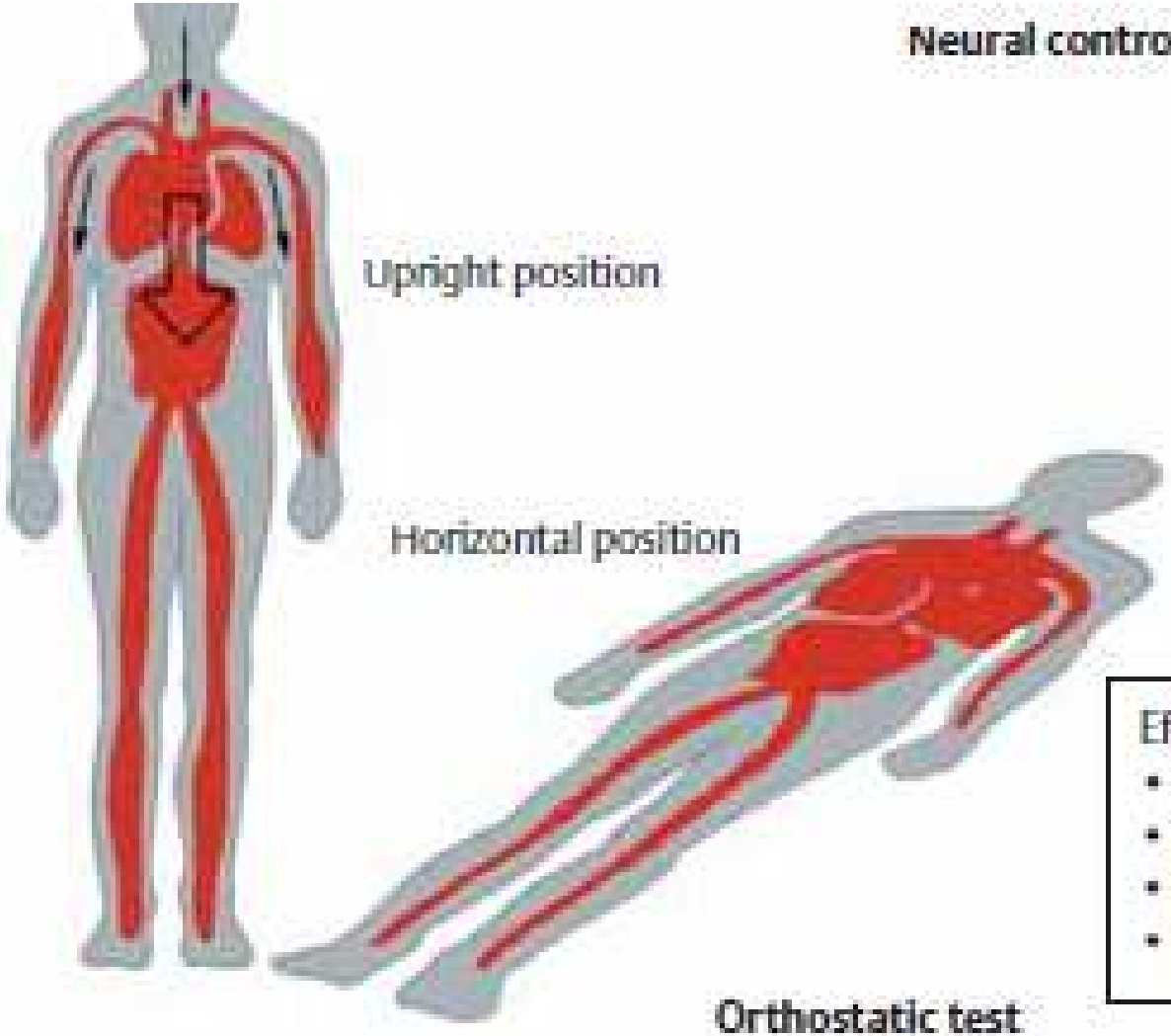
Autonomous urinary bladder





Neural control of urinary bladder
(EUSM = external urethral sphincter m.)

Neural control of circulatory system



Orthostatic test

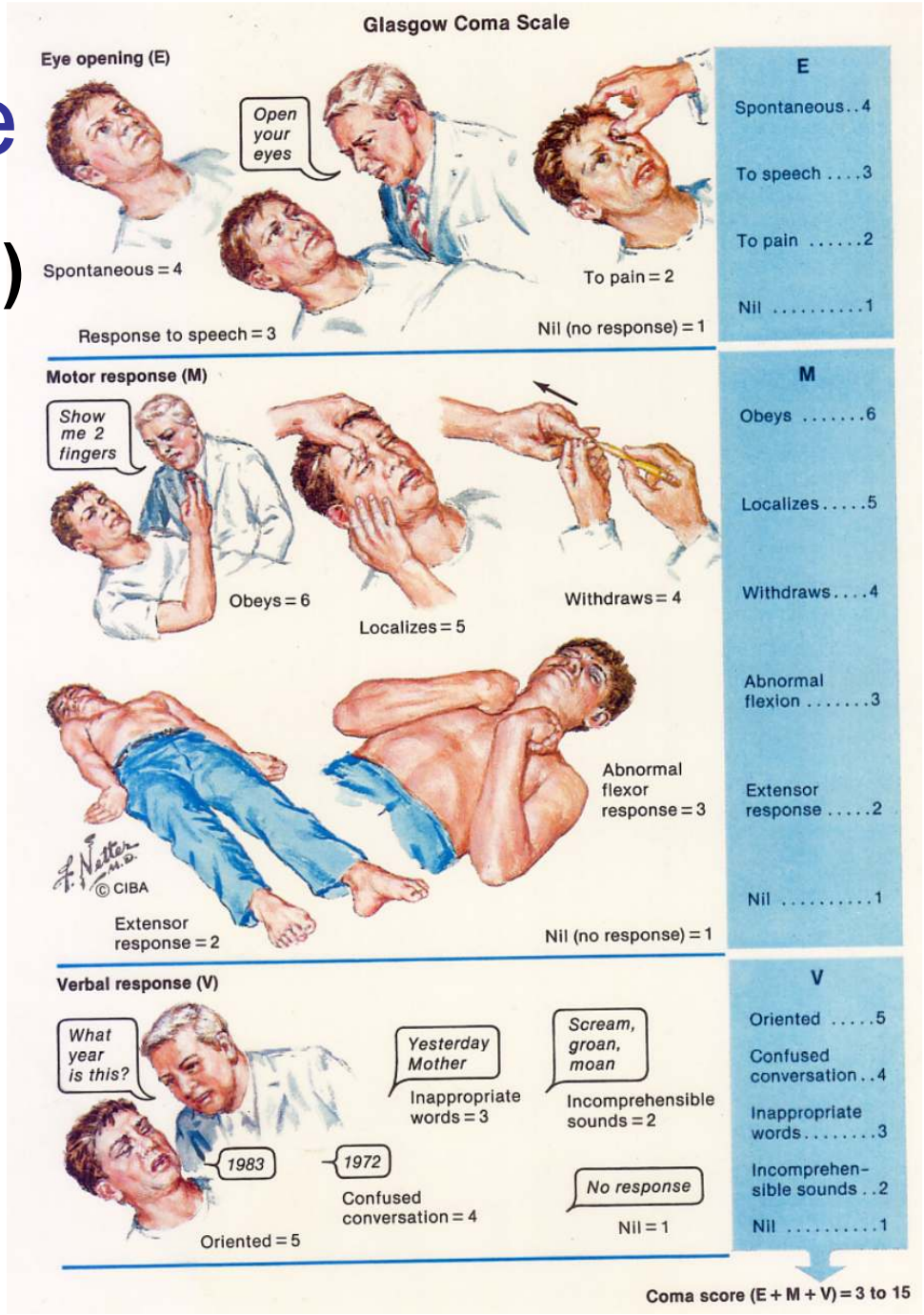
Effects of standing upright:
- Sympathetic activity ↑
- Vagal tone ↓
- Renin-angiotensin system ↑
- Blood flow to skin/fat/muscles ↓

Glasgow coma scale

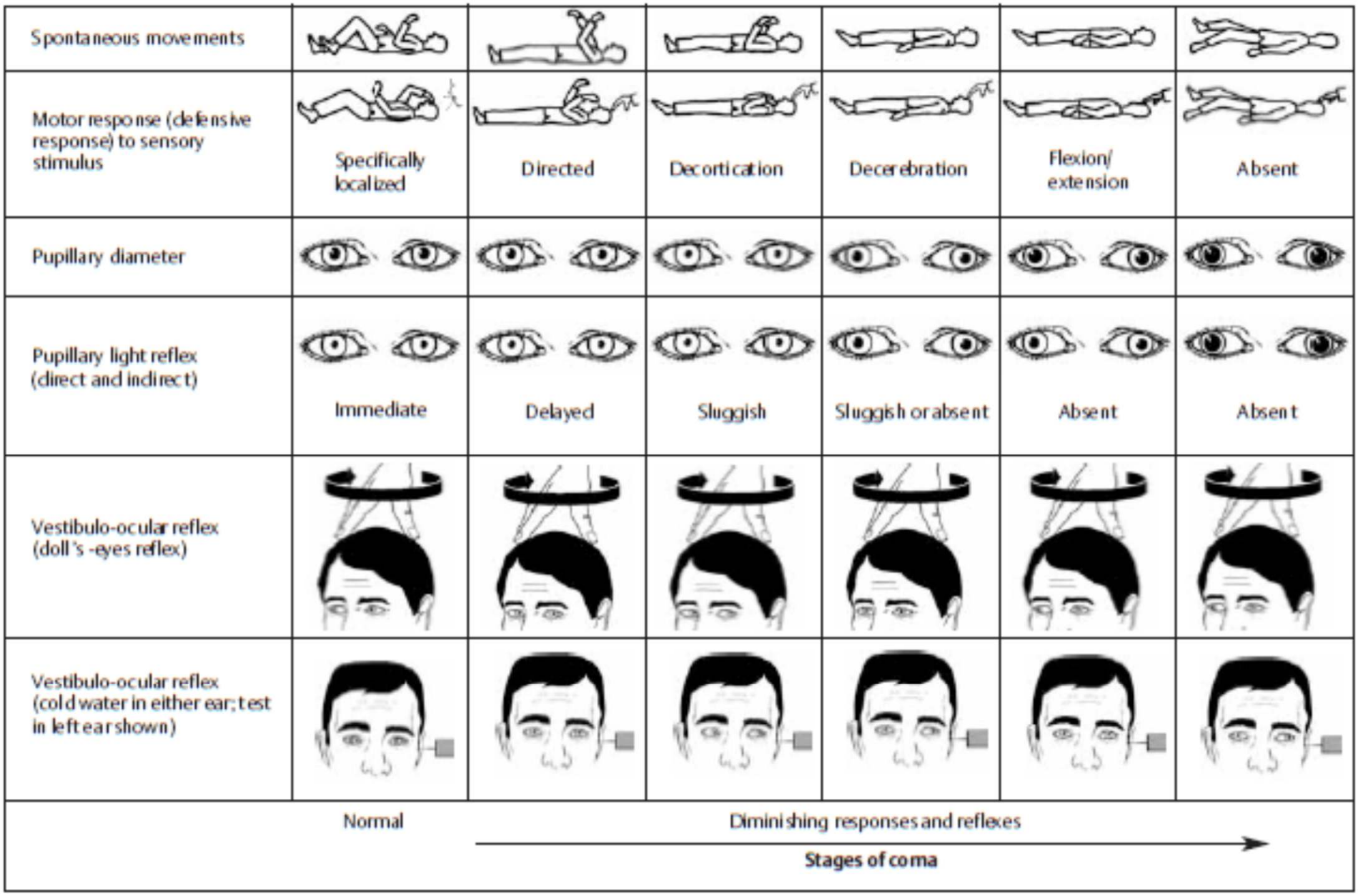
Glasgow coma scale (GCS)

- differences for adults and for small children
- lowest possible score: 3
- highest: 15 (fully conscious)

Sign	Pediatric GCS	Score
Eye opening	Spontaneous	4
	To sound	3
	To pain	2
	None	1
Verbal response	Smile, orientation to sound, interacts, follows objects	5
	Cries, irritable	4
	Cries to pain	3
	Moans to pain	2
	None	1
Motor response	Spontaneous movements (obeys command)	6
	Withdraws to touch (localizes pain)	5
	Withdraws to pain	4
	Abnormal flexion to pain (decorticate)	3
	Abnormal extension to pain (decerebrate)	2
	None	1



Glasgow coma scale, additions



How muscles enable locomotion

- Motors – proper movement source

- Flexors and extensors

- Brakes
- Springs
- Struts - skeletal-like elements

Locomotion in human

Examples

- Motors
- Flexors: biceps fem.
- Extensors: quadriceps fem.
- Brakes – biceps surae
- Springs – ditto, Achilles tendon
- Struts - stiff stuff :-) postural muscles

Special muscles (mm.) groups

- Respiratory mm (run all the time)
- Chewing mm (highest strength/ cross section)
- Fonation (vocalisation) mm (voice origin)
- Sphincters (upper oesophageal and so on)
- Abdominal muscles
- Extensors – posture, muscular corset
- Mimic mm (m.lev.lab.sup.et ang.or.)
- Oculomotor mm (+ levator palpebrae), and so on...

Musculo-Skeletal disorders/ Connective tissue/ Movement disorders

Musculo-skeletal system
Structure and Function - physiology

Interaction of Bones, Joints and Muscles

- **Provide body with sturdy framework**
- **Skeletal muscles attach to bones by tendons, muscle movement moves the skeleton**
- **Movement of joints permit movements of some framework**
- **Extension, flexion – muscles stabilize joints by preventing or aiding in movement**

Musculo-skeletal system disruptions

- **Bones –** development, growth and homeostasis, with components:
  - **Minerals –** calcium, phosphate
  - **Proteins –** collagen
  - **Vitamin C, D** – scurvy, rickets
  - **Living cells, fibroblasts –** mature bone cells (osteocytes), bone-forming cells (osteoblasts), bone-resorbing (osteoclasts)

Fractures of the Bone

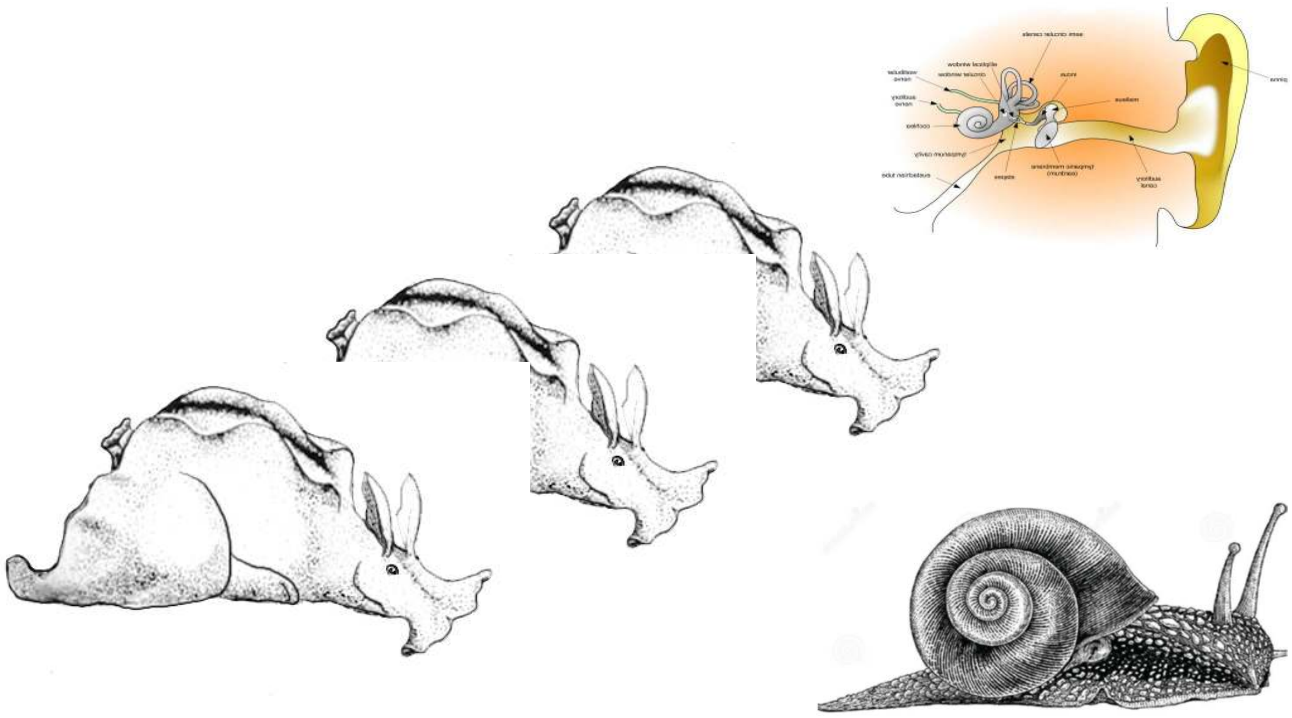
- **”Inadequate” force fracture**
- **Pathologic fracture: bone cyst, osteomyelitis, osteoporosis, osteomalacia, osteogenesis imperfecta, rickets, renal osteodystrophy, tumours, et cetera**

- **Closed – cleanly, no skin penetration**
- **Open – ends protrude, infectious complications**
- **Compression – crushed**
- **Impacted – broken ends forced into each other, eg. skull fractures**
- **Depressed – pressed inward, ditto**
- **Spiral – jagged break due to twisting force**
- **Greenstick – incomplete as a green twig**

Physiologic/ other fracture healing

- **Primary (direct) healing: immobilisation, callus formation, aseptic**
- **Secondary (indirect) healing: ditto, immobilisation, callus formation, generic aseptic inflammatory processes involved**
- **Other: false joint (= pseudo-arthrosis)**
- **Other complications: poor fixation, metabolic disorders, infection (osteomyelitis)**

Metastatic calcification:
(at elevated serum calcium levels)
Located at solid tissues,
where the carbo-anhydrase is:

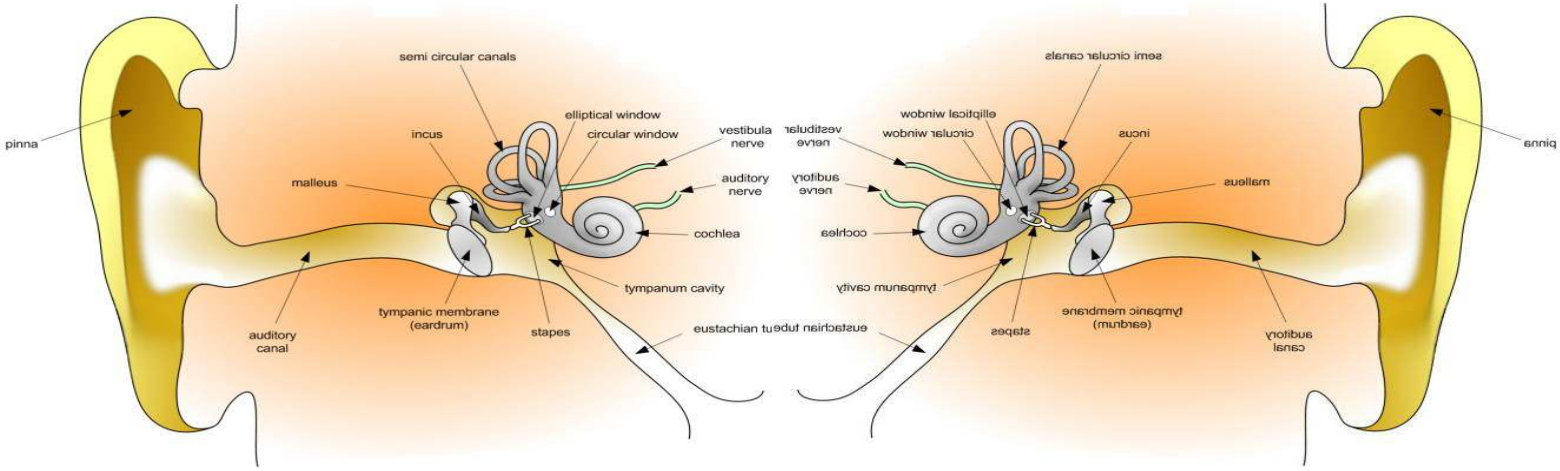


Lung, Pancreas, Kidney, Stomach, where the H_2CO_3 and acid base balance changes are.

Axial symmetry/ symmetry breaking

Situs viscerum inversus

pathogenesis



Diseases of the bone,
typical phenomenologies exist

Diseases of the bone, typical phenomenologies exist

- **Congenital deformities –** developmental errors, example: thalidomide case
- **Osteomyelitis –** infectious causes, pain, redness, heat, chills, fever, tachycardia, nausea, weight loss
- **Rickets –** (vitamin D deficiency in childhood) deformation of bones, knock-knee, bow-leg, curved spine, enlarged/ square head, flaccid muscles, node-swelling at rib ends and joints
- **Osteomalacia –** muscle weakness, weight loss, pain in bones, deformed bones, fractured bones
- **Osteoporosis** - decreased height from vertebral compression fractures, curvature of spine, easily fractured bones

- **Paget's Disease (osteitis deformans) –** enlarged skull, nerve compression curvatures in spine, deformed legs
- **Bone tumors –** osteosarkom/, Ewing's sarcoma, painless lump in bone tissue, (pathologic) fractures without trauma, /or atypical pain, example: first sign of multiple myeloma might be back pain…

Selected disorders:

Joint disorders/ connective tissue disorders

- **Osteoarthritis –** aches, pain, stiff joints, limited range of movement, muscle weakness around joint, enlarged joints, bone spurs, can be in one or in many joints
- **Gout –** severe pain, heat, swelling, redness in joint, acute onset
- **Septic arthritis –** pain, redness, swelling, bone and joint destruction
- **Bursitis -** pain at joint, especially during use
- **Carpal tunnel syndrome -** numbness and tingling of hand, pain radiating to shoulder, limited finger movement, severe at night

Collagen disorders/ and related typical phenomenologies exist

mostly incurable conditions

- **Osteogenesis imperfecta** - collagen type 1, heterogeneous heredity, group of disorders
- **Alport syndrome** – collagen type 4 defect, hearing, vision and kidney problems due to defective basilar membranes in specialized epithelia (genetically heterogeneous, both autosomal and X-linked)
- **Marfan syndrome** – joint and cardiovascular diseases (hereditary – autosomal dominant), fibrilin defect (= extracellular matrix component)

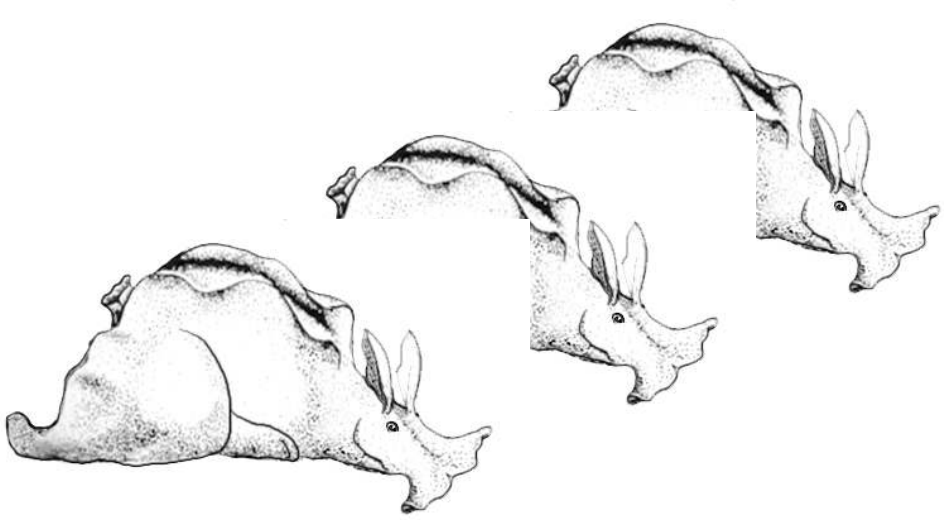
Other connective tissue disorders

- **Systemic lupus erythematosus** - auto-immune disease, HLA associated, genetics?, hormones?
- **Rheumatoid arthritis –** pain and stiffness in joints; swollen, red, warm joints; bilateral involvement exacerbation and remission, rheumatoid nodules, crippling deformities
- **Scleroderma** – auto-immune?, higher collagen production, overshot inflammatory connective tissue recycling…

(Cure: mostly symptomatic therapeutic anri-infammatory, immuno-suppresive protocols)

… end of “last” lecture, …

…questions/ it is your turn now...



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