

Case 14: Spinal Cheat Sheets
(Topics in order of Case 14 Timetable)

Spinal Anatomy:

- 1. General Structure:**
 - The spine is divided into several regions: cervical (neck), thoracic (upper back), lumbar (lower back), sacral (pelvis), and coccygeal (tailbone).
 - There are 33 vertebrae in total: 7 cervical, 12 thoracic, 5 lumbar, 5 sacral (fused into the sacrum), and 4 coccygeal (fused into the coccyx).
- 2. Vertebrae Structure:**
 - **Body:** The anterior, weight-bearing part.
 - **Vertebral Arch:** Posterior to the body, consists of pedicles, laminae, and a spinous process.
 - **Transverse Processes:** Project laterally from the junction of pedicles and laminae.
 - **Articular Processes:** Superior and inferior, form facet joints with adjacent vertebrae.
- 3. Intervertebral Discs:**
 - Situated between adjacent vertebral bodies.
 - Consist of an outer fibrous ring (annulus fibrosus) and an inner gel-like core (nucleus pulposus).
 - Act as shock absorbers and facilitate movement.
- 4. Spinal Cord and Nerves:**
 - The spinal cord extends from the brainstem to the lower back, terminating in the conus medullaris.
 - Nerve roots emerge from the spinal cord and exit through intervertebral foramina.
 - Cauda equina: A bundle of spinal nerves and spinal nerve roots below the conus medullaris.
- 5. Ligaments and Muscles:**
 - Ligaments support the spine, including the anterior and posterior longitudinal ligaments, ligamentum flavum, interspinous ligaments, and supraspinous ligament.
 - Numerous muscles support and facilitate movement of the spine.
- 6. Vascular Supply:**
 - The spinal cord is supplied by the anterior and posterior spinal arteries.
 - Vertebrae and discs receive blood supply from segmental arteries.
- 7. Regional Characteristics:**
 - **Cervical:** C1 (atlas) and C2 (axis) have unique structures for head rotation.
 - **Thoracic:** Articulate with ribs and are characterized by longer spinous processes.
 - **Lumbar:** Larger bodies to bear more weight.
 - **Sacral and Coccygeal:** Fused vertebrae forming the back of the pelvis and the tailbone, respectively.
- 8. Spinal Curvatures:**
 - Normal spinal curvatures include cervical lordosis, thoracic kyphosis, lumbar lordosis, and sacral kyphosis.
 - Help in weight distribution and shock absorption.

Neurophysiology:

- 1. Basic Structure of a Nerve:**
 - **Neurons:** The basic functional units of the nervous system.
 - **Cell Body:** Contains the nucleus and essential organelles.
 - **Dendrites:** Receive signals from other neurons.
 - **Axon:** Conducts electrical impulses away from the cell body.
 - **Myelin Sheath:** Insulates axons to speed up signal transmission.
 - **Nodes of Ranvier:** Gaps in the myelin sheath where action potentials are regenerated.
- 2. Types of Neurons:**
 - **Sensory (Afferent) Neurons:** Carry signals to the CNS from sensory receptors.
 - **Motor (Efferent) Neurons:** Transmit signals from the CNS to muscles or glands.
 - **Interneurons:** Facilitate communication within the CNS.
- 3. Nerve Impulse Transmission:**
 - **Resting Membrane Potential:** A voltage difference across the neuron's membrane at rest.
 - **Action Potential:** A temporary reversal of the membrane potential that propagates along the neuron.
 - **Depolarization:** Inward flow of sodium ions, making the inside of the cell more positive.
 - **Repolarization:** Outward flow of potassium ions, restoring the resting membrane potential.
- 4. Synaptic Transmission:**
 - **Synapse:** Junction between neurons or between a neuron and an effector cell.
 - **Neurotransmitters:** Chemicals released by neurons to send signals across synapses.
 - **Receptors:** Proteins on the receiving cell's surface that bind neurotransmitters.
- 5. Types of Neurotransmitters:**
 - **Excitatory:** Promote the generation of an action potential (e.g., glutamate).
 - **Inhibitory:** Prevent action potentials (e.g., GABA).
- 6. Nerve Conduction:**
 - **Myelinated Axons:** Conduct impulses quickly via saltatory conduction.
 - **Unmyelinated Axons:** Slower conduction due to the continuous propagation of action potentials.
- 7. Neuroplasticity:**
 - The ability of the nervous system to change its structure and function in response to experience.
- 8. Peripheral Nervous System (PNS):**
 - **Somatic Nervous System:** Controls voluntary movements.
 - **Autonomic Nervous System:** Regulates involuntary functions, divided into sympathetic and parasympathetic divisions.
- 9. Central Nervous System (CNS):**
 - Comprises the brain and spinal cord.
 - Processes sensory information and issues motor commands.
- 10. Blood-Brain Barrier:**
 - A selective barrier that protects the brain from foreign substances in the blood.
- 11. Glial Cells:**
 - **Astrocytes:** Provide support and nutrition, maintain homeostasis.
 - **Oligodendrocytes and Schwann Cells:** Form myelin in the CNS and PNS, respectively.
 - **Microglia:** Act as immune cells in the CNS.
- 12. Neural Repair and Regeneration:**
 - Limited in the CNS but more effective in the PNS.
 - Involves processes like axon sprouting and remyelination.

Nerve Injury:

1. **Types of Nerve Injuries:**
 - **Neurapraxia:** The mildest form, with temporary loss of function due to myelin sheath damage.
 - **Axonotmesis:** Involves axonal damage with preservation of the myelin sheath; can lead to Wallerian degeneration.
 - **Neurotmesis:** The most severe form, involving complete disruption of the nerve and its surrounding structures.
2. **Etiology:**
 - Trauma (most common).
 - Compression or entrapment (e.g., carpal tunnel syndrome).
 - Stretch injury.
 - Ischemic injury.
 - Iatrogenic (surgical) injury.
 - Infectious, inflammatory, or autoimmune conditions.
3. **Clinical Presentation:**
 - Loss of sensory function in the nerve distribution.
 - Muscle weakness or paralysis.
 - Pain or discomfort, which may include burning, tingling, or shooting pain.
 - Changes in autonomic functions, if autonomic fibers are involved.
4. **Diagnosis:**
 - Clinical history and physical examination.
 - Electromyography (EMG) and nerve conduction studies.
 - Imaging (MRI or ultrasound) for anatomical details.
 - Blood tests if a systemic cause is suspected.
5. **Treatment:**
 - Conservative management includes physical therapy, occupational therapy, and pain management.
 - Pharmacologic interventions: Pain medications, corticosteroids, or nerve growth factors.
 - Surgical intervention might be necessary for severe injuries or when conservative management fails.
6. **Recovery and Prognosis:**
 - Depends on the type of injury; neurapraxia usually recovers fully.
 - Axonotmesis and neurotmesis have more variable outcomes.
 - Nerve regeneration occurs at a rate of approximately 1 mm/day after the initial lag phase.
7. **Prevention:**
 - Minimizing risk factors for trauma and compression.
 - Proper ergonomic practices to avoid repetitive strain injuries.
 - Careful surgical techniques to avoid iatrogenic nerve damage.
8. **Complications:**
 - Chronic pain or neuropathic pain syndromes.
 - Muscle atrophy.
 - Permanent sensory or motor deficits.
 - Complex regional pain syndrome (CRPS).
9. **Rehabilitation:**
 - Focus on maintaining muscle strength and flexibility.
 - Neuromuscular re-education.
 - Adaptive techniques and use of assistive devices if necessary.
10. **Emerging Therapies:**
 - Nerve grafting and nerve transfer techniques.
 - Stem cell therapy and regenerative medicine approaches.

Bone Physiology:

- 1. Basic Structure of Bone:**
 - **Compact Bone:** Dense outer layer that provides strength and rigidity.
 - **Spongy Bone (Cancellous Bone):** Lighter, porous inner layer that contains bone marrow.
 - **Bone Marrow:** Red marrow produces blood cells; yellow marrow stores fat.
 - **Periosteum:** Outer fibrous layer covering bones, containing nerves and blood vessels.
- 2. Cell Types in Bone:**
 - **Osteoblasts:** Responsible for bone formation.
 - **Osteocytes:** Mature bone cells that maintain bone tissue.
 - **Osteoclasts:** Involved in bone resorption (breakdown).
- 3. Bone Formation and Growth:**
 - **Intramembranous Ossification:** Direct conversion of mesenchymal tissue to bone; forms flat bones like the skull.
 - **Endochondral Ossification:** Cartilage is replaced by bone; responsible for the formation of long bones.
- 4. Bone Remodeling:**
 - Continuous process of bone resorption by osteoclasts and formation by osteoblasts.
 - Influenced by mechanical stress, hormones (e.g., parathyroid hormone, calcitonin), and dietary factors (calcium and vitamin D levels).
- 5. Hormonal Regulation:**
 - **Parathyroid Hormone (PTH):** Increases blood calcium levels by stimulating bone resorption.
 - **Calcitonin:** Lowers blood calcium levels by inhibiting bone resorption.
 - **Vitamin D:** Promotes calcium absorption in the gut and maintains calcium and phosphate levels for bone formation.
- 6. Mechanical Stress and Bone Density:**
 - **Wolff's Law:** Bone density and shape adapt to the mechanical stresses placed upon it.
 - Weight-bearing exercises and physical activity can increase bone strength.
- 7. Bone Healing:**
 - In response to a fracture, involves stages of hematoma formation, fibrocartilaginous callus formation, bony callus formation, and bone remodeling.
- 8. Blood Supply and Innervation:**
 - Bones are richly supplied by blood vessels.
 - Nerves mostly accompany these blood vessels, providing sensation to the periosteum.
- 9. Aging and Bone:**
 - Bone density peaks in early adulthood and then gradually decreases.
 - Osteoporosis is a common condition in older adults, characterized by reduced bone mass and increased fracture risk.
- 10. Common Disorders:**
 - **Osteoporosis:** Reduced bone density and strength.
 - **Osteomalacia/Rickets:** Softening of bones due to vitamin D deficiency.
 - **Osteoarthritis:** Degeneration of joint cartilage and underlying bone.
 - **Paget's Disease:** Disorganized bone remodeling.

Bone Injury and Healing:

1. **Types of Bone Injuries:**
 - **Fractures:** Breaks in the continuity of the cortex of a bone, which can range from simple (clean break, no displacement) to complex (multiple fragments, displacement).
 - **Stress Fractures:** Small cracks in the bone, often caused by repetitive forces.
 - **Avulsion:** Occurs when a fragment of bone tears away due to a tendon or ligament pulling on the bone.
2. **Phases of Bone Healing:**
 - **Inflammatory Phase:** Starts immediately after the injury. Blood vessels break, forming a hematoma around the fracture site. Inflammation occurs, drawing in cells that begin the healing process.
 - **Reparative Phase:** Includes the formation of a soft callus as new blood vessels develop, and the migration and proliferation of osteoblasts. This is followed by a hard callus formation as the mineralization increases.
 - **Remodeling Phase:** The final phase where the bone gradually returns to its original shape. The hard callus is remodeled by osteoclasts and osteoblasts, restoring the bone's normal structure and function.
3. **Factors Influencing Healing:**
 - **Age:** Younger patients typically heal faster.
 - **Nutrition:** Adequate nutrition, including calcium and vitamin D, is crucial for bone healing.
 - **Smoking and Alcohol Use:** Can impair bone healing.
 - **Medical Conditions:** Diabetes, osteoporosis, and other conditions can slow the healing process.
 - **Medications:** Some medications, like corticosteroids, can impede bone repair.
4. **Treatment of Bone Injuries:**
 - **Fracture Management:** Includes realignment (reduction) and immobilization (casts, splints).
 - **Surgery:** May be required for complex fractures; involves the use of metal plates, screws, or rods to stabilize the bone.
 - **Physical Therapy:** Essential for restoring function after the bone has healed.
5. **Complications:**
 - **Non-union or Malunion:** When the bone doesn't heal properly or heals in a wrong position.
 - **Infection:** Particularly in open fractures or after surgery.
 - **Osteonecrosis:** Death of bone tissue due to a lack of blood supply.
 - **Chronic Pain:** Can occur, especially in cases of complex fractures.
6. **Prevention:**
 - Adequate calcium and vitamin D intake.
 - Regular exercise to strengthen bones.
 - Fall prevention strategies, especially in the elderly.
7. **Rehabilitation:**
 - Gradual return to activity and exercises to strengthen muscles and improve flexibility.

Bone Diseases:

1. **Osteoarthritis:**
 - Degenerative joint disease; wear and tear of joint cartilage and bone.
 - Common in older adults, affecting knees, hips, hands, and spine.
 - Symptoms: Joint pain, stiffness, limited motion.
2. **Rheumatoid Arthritis:**
 - Autoimmune disorder causing chronic inflammation of joints.
 - Symmetric polyarthritis, often affecting hands and feet.
 - Systemic symptoms: Fatigue, weight loss, anemia.
3. **Ankylosing Spondylitis:**
 - Chronic inflammation of the spine and sacroiliac joints.
 - More common in men and often begins in late adolescence or early adulthood.
 - Symptoms: Back pain, stiffness, reduced range of motion; may have systemic features.
4. **Gout:**
 - Metabolic disorder characterized by elevated serum uric acid levels and deposition of urate crystals in joints.
 - Acute and chronic arthritis, commonly affecting the big toe.
 - Associated with renal impairment, hypertension, obesity, and alcohol intake.
5. **Pseudogout:**
 - Similar to gout, but caused by calcium pyrophosphate dihydrate (CPPD) crystal deposition.
 - Affects larger joints, such as knees.
 - May be associated with aging, trauma, or metabolic diseases.
6. **Osteoporosis:**
 - Reduction in bone mass and density, increasing fracture risk.
 - Common in postmenopausal women and older adults.
 - Often asymptomatic until a fracture occurs.
7. **Hyperparathyroidism:**
 - Overactivity of the parathyroid glands leading to high levels of parathyroid hormone (PTH).
 - Causes bone resorption, hypercalcemia, renal stones, and osteopenia.
 - Primary (gland dysfunction) or secondary (response to low calcium/vitamin D).
8. **Renal Osteodystrophy:**
 - Bone disorder resulting from chronic kidney disease.
 - Imbalance of calcium, phosphate, PTH, and vitamin D.
 - Presents with bone pain, fractures, and altered bone mineral metabolism.
9. **Rickets/Osteomalacia:**
 - Rickets in children and osteomalacia in adults.
 - Softening and weakening of bones due to vitamin D deficiency or phosphate metabolism disorders.
 - Symptoms: Bone pain, weakness, deformities.
10. **Paget's Disease of Bone:**
 - Chronic disorder of bone remodeling; excessive bone breakdown and disorganized new bone formation.
 - Common in older adults; often affects pelvis, skull, spine, and legs.
 - Symptoms: Bone pain, deformities, fractures; may be asymptomatic.
11. **Bone Metastases:**
 - Secondary tumors in bone originating from other sites (e.g., breast, prostate, lung cancer).
 - Causes pain, fractures, hypercalcemia.
 - Diagnosis often involves imaging and biopsy.

Spinal Radiology:

1. **Imaging Modalities:**
 - **X-ray (Radiographs):** First-line imaging for initial assessment of spinal anatomy, alignment, bone density, and any gross pathology.
 - **Computed Tomography (CT):** Provides detailed images of bone structures. Useful for assessing fractures, bone spurs, and other bony abnormalities.
 - **Magnetic Resonance Imaging (MRI):** Best for soft tissue evaluation including discs, nerves, spinal cord, ligaments, and muscles. Preferred in suspected spinal cord pathology, disc herniation, or infections.
 - **Myelography:** Involves injecting contrast dye into the spinal canal, followed by X-ray or CT. Useful for evaluating the spinal canal and nerve root compression, especially in patients who cannot undergo MRI.
2. **Common Findings and Pathologies:**
 - **Degenerative Changes:** Disc space narrowing, vertebral osteophytes, facet joint arthropathy.
 - **Disc Herniation:** Displacement of disc material beyond the intervertebral disc space.
 - **Spinal Stenosis:** Narrowing of the spinal canal or neural foramina, often evident on CT or MRI.
 - **Spondylolisthesis:** Forward slippage of one vertebra over another.
 - **Fractures:** Assessed by CT for detail; MRI can evaluate associated soft tissue injury.
 - **Infections (e.g., Osteomyelitis, Discitis):** MRI is more sensitive in early stages.
 - **Spinal Tumors:** MRI provides detailed information about tumor size, location, and involvement of adjacent structures.
3. **Interpreting Spinal Radiographs:**
 - **Alignment:** Check for any curvature abnormalities like scoliosis or kyphosis.
 - **Bones:** Look for fractures, alignment, bone density, and lesions.
 - **Cartilage:** Disc space narrowing can indicate degenerative changes.
 - **Soft Tissues:** Evaluate for any signs of swelling or other abnormalities.
4. **Special Views and Techniques:**
 - **Flexion and Extension Views:** Assess spinal stability, especially in trauma cases.
 - **Oblique Views:** Can help in visualizing certain structures like neural foramina and facet joints.
 - **CT Myelography:** Used when MRI is contraindicated or in postsurgical assessments.
5. **Radiological Signs of Specific Conditions:**
 - **Ankylosing Spondylitis:** Bamboo spine appearance on X-ray.
 - **Vertebral Compression Fractures:** Height loss of the vertebral body; may indicate osteoporosis or metastatic disease.
 - **Cauda Equina Syndrome:** MRI to assess compression of the nerve roots.
6. **Radiation Safety:**
 - Always consider the necessity and frequency of radiological exams, especially CT, to minimize radiation exposure.
 - Use of shielding and appropriate imaging protocols.
7. **Advanced Imaging:**
 - **Nuclear Medicine Scans (e.g., Bone Scan):** For detecting metastases, infections, or other pathologies involving bone metabolism.

Spinal Trauma:

1. **Types of Spinal Trauma:**
 - **Fractures:** Can occur in vertebral bodies, spinous processes, or facets.
 - **Subluxations / Dislocations:** Misalignment of vertebrae, which can cause cord compression (partial and complete loss of continuity of a joint).
 - **Fracture-Dislocations:** A combination of both, often leading to severe instability and high risk of neurological injury.
2. **Mechanism of Injury:**
 - **Flexion Injuries:** Often lead to compression fractures or dislocations anteriorly.
 - **Extension Injuries:** Typically result in injuries to the posterior elements of the spine.
 - **Rotation Injuries:** Can cause fracture-dislocations, leading to high instability.
 - **Vertical Compression Injuries:** Can result in burst fractures, with potential retropulsion of bone fragments.
3. **Common Sites of Injury:**
 - **Cervical Spine:** Particularly vulnerable due to its mobility; C1-C2 and C5-C7 are common sites.
 - **Thoracolumbar Junction:** T12-L2, a transition area from the rigid thoracic spine to the more mobile lumbar spine.
4. **Clinical Presentation:**
 - Pain and tenderness at the site of injury.
 - Neurological deficits, ranging from radiculopathy to complete spinal cord injury.
 - Signs of shock in severe cases, especially with high cervical spine injuries.
5. **Assessment and Management:**
 - Initial assessment following Advanced Trauma Life Support (ATLS) protocols.
 - Spinal immobilization is crucial until spinal injury is ruled out.
 - Detailed neurological examination to assess the level and severity of injury.
 - Imaging: X-rays, CT, and MRI as indicated based on the clinical and initial radiologic evaluation.
6. **Classification of Spinal Cord Injury:**
 - **Complete:** No sensory or motor function below the level of injury.
 - **Incomplete:** Partial preservation of sensory or motor function below the injury level.
 - Common syndromes: Central cord syndrome, Anterior cord syndrome, Brown-Séquard syndrome, Conus medullaris and Cauda equina syndromes.
7. **Treatment:**
 - **Non-operative:** For stable injuries; includes pain management and rehabilitation.
 - **Operative:** Indicated in unstable fractures, dislocations, or when there is cord compression. Techniques include decompression, realignment, and stabilization.
8. **Complications:**
 - Chronic pain, bladder and bowel dysfunction.
 - Respiratory complications, especially in high cervical injuries.
 - Pressure ulcers, deep vein thrombosis, pulmonary embolism.
 - Long-term disability and need for rehabilitation.
9. **Rehabilitation:**
 - Early intervention for mobilization, physical therapy, occupational therapy.
 - Multidisciplinary approach including pain management, psychological support, and adaptation to new functional capabilities.
10. **Prevention:**
 - Education on safe practices, use of protective gear in sports, and workplace safety measures.

Spinal Cord Injury:

1. **Etiology:**
 - Traumatic SCI is most commonly due to motor vehicle accidents, falls, violence (e.g., gunshot wounds), and sports injuries.
 - Non-traumatic SCI can result from diseases like cancer, infection, spinal disc degeneration, or inflammation.
2. **Anatomy and Physiology:**
 - The spinal cord extends from the base of the brain to the lower back and is protected by the vertebral column.
 - It transmits signals between the brain and the rest of the body.
 - Segments of the spinal cord correspond to different body regions and functions.
3. **Classification of SCI:**
 - **Complete SCI:** Total loss of motor and sensory function below the level of injury.
 - **Incomplete SCI:** Partial preservation of sensory or motor function below the level of injury.
 - Incomplete injuries are further classified based on patterns of weakness and sensation loss (e.g., anterior cord syndrome, central cord syndrome, Brown-Séquard syndrome).
4. **Assessment and Diagnosis:**
 - Initial assessment using the ABCs (Airway, Breathing, Circulation) of trauma care.
 - Neurological examination to determine the level and completeness of the injury.
 - Imaging studies (X-rays, CT, MRI) to evaluate the spine.
5. **Acute Management:**
 - Spinal immobilization and careful transportation to prevent further injury.
 - Surgical intervention may be required to stabilize the spine or relieve pressure on the spinal cord.
6. **Complications:**
 - Respiratory issues, especially in cervical or high thoracic injuries.
 - Loss of bowel and bladder control.
 - Skin breakdown and pressure ulcers.
 - Cardiovascular problems, such as blood pressure instability and heart rate abnormalities.
 - Chronic pain and spasticity.
7. **Rehabilitation:**
 - Begins as soon as the patient is medically stable.
 - Goals include maximizing physical functioning, preventing complications, and adapting to new lifestyle changes.
 - Involves a multidisciplinary team including physiotherapists, occupational therapists, nurses, social workers, and psychologists.
8. **Long-term Management:**
 - Ongoing medical care to manage complications and secondary conditions.
 - Adaptive equipment and home modifications may be necessary.
 - Psychological support and counseling.
9. **Research and Emerging Therapies:**
 - Ongoing research into neuroprotective strategies, nerve regeneration, and stem cell therapy.
 - Development of advanced assistive technologies and neuroprosthetics.

Back Pain in the Child:

1. **Epidemiology:**
 - Less prevalent than in adults but not uncommon, especially in older children and adolescents.
 - Often related to physical activity, but can also indicate an underlying pathology.
2. **Common Causes:**
 - **Muscular Strain:** From sports, heavy backpacks, or poor posture.
 - **Spondylolysis and Spondylolisthesis:** Stress fractures in the vertebrae, common in athletes.
 - **Scheuermann's Kyphosis:** A developmental disorder causing abnormal curvature of the spine.
 - **Discitis or Vertebral Osteomyelitis:** Infection in the disc space or vertebrae.
 - **Injury or Trauma:** Falls or accidents.
 - **Juvenile Idiopathic Arthritis:** An autoimmune disorder causing inflammation of the joints.
3. **Red Flags:**
 - Persistent pain, especially in young children.
 - Night pain or pain at rest.
 - Fever, weight loss, or general malaise.
 - Neurological symptoms like weakness, numbness, or bladder/bowel changes.
 - History of trauma.
 - Pain that is worsening or not responding to conservative treatment.
4. **Diagnosis:**
 - Thorough history and physical examination.
 - Imaging studies if indicated (X-rays, MRI, CT scans) especially if red flags are present.
 - Laboratory tests to rule out infection or inflammatory conditions.
5. **Treatment:**
 - Depends on the underlying cause.
 - For most benign causes (like muscular strain), conservative treatment with rest, physical therapy, and pain management is sufficient.
 - Specific treatments for underlying conditions like antibiotics for infection, rest for spondylolysis, or surgery in severe cases of spondylolisthesis.
6. **Prognosis:**
 - Generally good for benign causes.
 - Long-term prognosis depends on the underlying condition and its management.
7. **Prevention:**
 - Encouraging good posture.
 - Proper backpack ergonomics.
 - Regular physical activity and stretching.
8. **Parental and Patient Education:**
 - Importance of reporting symptoms early.
 - Understanding the nature of the child's back pain and the treatment plan.
9. **When to Refer:**
 - Persistent, worsening, or unexplained back pain.
 - Presence of any red flags.

Spinal Deformity:

1. **Types of Spinal Deformities:**
 - **Scoliosis:** Lateral curvature of the spine, often accompanied by vertebral rotation.
 - **Kyphosis:** Excessive outward curvature of the spine, resulting in a hunched back.
 - **Lordosis:** Excessive inward curvature of the lower spine.
2. **Etiologies:**
 - **Idiopathic:** Cause unknown, most common in adolescent scoliosis.
 - **Congenital:** Due to malformations of the spine present at birth.
 - **Neuromuscular:** Associated with conditions like cerebral palsy or muscular dystrophy.
 - **Degenerative:** Due to wear and tear, more common in older adults.
 - **Traumatic:** Resulting from spinal injuries.
3. **Clinical Presentation:**
 - Asymmetry in shoulder height, scapular or flank shape, or hip height.
 - Back pain, which may be more common in degenerative cases.
 - Neurological symptoms, such as numbness or weakness, can occur in severe cases.
4. **Diagnosis:**
 - Physical examination including the Adam's forward bend test for scoliosis.
 - Radiographic evaluation with standing X-rays to assess the curve magnitude (measured using the Cobb angle).
 - MRI or CT scans may be needed for detailed evaluation or if there are neurological concerns.
5. **Management:**
 - **Observation:** For mild cases or non-progressive curves.
 - **Bracing:** Common in adolescents with idiopathic scoliosis to prevent curve progression.
 - **Physical Therapy:** Focuses on strengthening and flexibility exercises.
 - **Surgical:** Indicated for severe or progressive curves, significant pain, or neurological compromise. Common procedures include spinal fusion and rod placement.
6. **Prognosis:**
 - Varies depending on the type and severity of the deformity, and the patient's age.
 - Most cases of mild idiopathic scoliosis do not progress significantly and have a normal life expectancy.
 - Severe curves can impact lung function and mobility.
7. **Complications:**
 - Respiratory and cardiovascular problems in severe cases.
 - Chronic back pain, especially in degenerative deformities.
 - Psychosocial impact, particularly in adolescents.
8. **Prevention and Screening:**
 - Early detection through regular screening, especially in school-aged children.
 - Maintaining good posture, core strength, and flexibility.
9. **Patient Education:**
 - Understanding the nature of the deformity.
 - Compliance with treatment plans, especially in bracing.
10. **Special Considerations:**
 - Pregnancy management in women with significant spinal deformities.
 - Long-term monitoring for progressive or degenerative conditions.

Spinal Infection:

1. **Etiology:**
 - Bacterial (most common): Staphylococcus aureus, Mycobacterium tuberculosis (Pott's disease), E. coli, Pseudomonas aeruginosa.
 - Viral, fungal, and parasitic infections are less common.
2. **Risk Factors:**
 - Immunocompromised state (HIV, chemotherapy, chronic steroid use).
 - Recent spinal procedure or surgery.
 - Intravenous drug use.
 - Chronic medical conditions (diabetes, renal failure).
3. **Pathophysiology:**
 - Hematogenous spread (most common).
 - Direct inoculation during surgery or trauma.
 - Contiguous spread from adjacent tissues.
4. **Clinical Presentation:**
 - Back pain (most common symptom).
 - Fever, chills.
 - Neurological deficits depending on the level of infection (e.g., weakness, numbness).
 - Radiculopathy or myelopathy if nerve roots or spinal cord are involved.
5. **Diagnosis:**
 - Laboratory tests: Elevated ESR, CRP, leukocytosis.
 - Imaging: MRI with contrast (gold standard), CT, X-ray.
 - Biopsy and culture for definitive diagnosis and antibiotic sensitivity.
6. **Treatment:**
 - Empiric antibiotic therapy initially, then tailored based on culture results.
 - Surgical intervention may be required for abscess drainage, decompression, or stabilization.
 - Long-term antibiotic therapy (often 6-12 weeks).
7. **Complications:**
 - Abscess formation.
 - Spinal instability.
 - Chronic pain.
 - Neurological impairment (paralysis, incontinence).
8. **Prevention:**
 - Prompt treatment of bloodstream infections.
 - Aseptic technique during spinal procedures.
 - Monitoring in high-risk patients (e.g., immunocompromised).
9. **Prognosis:**
 - Varies based on causative organism, patient's overall health, and timeliness of treatment.
 - Can range from complete recovery to chronic pain or disability.

Spinal Tumours:

1. **Classification:**
 - **Primary Spinal Tumors:** Originate in the spine or spinal cord.
 - **Intradural-Extramedullary:** Arise in the spinal cord's covering or nerve roots (e.g., meningiomas, schwannomas).
 - **Intramedullary:** Arise within the spinal cord (e.g., astrocytomas, ependymomas).
 - **Secondary (Metastatic) Spinal Tumors:** More common than primary tumors, originating from cancer elsewhere in the body that has spread to the spine.
2. **Symptoms:**
 - Back pain, often worsened at night or with activity.
 - Neurological symptoms depend on the tumor's location and may include weakness, numbness, or difficulty walking.
 - Bladder and bowel dysfunction in severe cases.
3. **Diagnosis:**
 - Detailed neurological examination.
 - Imaging studies: MRI is the preferred method for detailed imaging of spinal tumors; CT scans and X-rays can also be useful.
 - Biopsy may be required for definitive diagnosis and to guide treatment.
4. **Treatment:**
 - **Steroids:** Reduced the tumour swelling / oedema and reduce the cord compression.
 - **Surgery:** Mainstay for many spinal tumors, aiming to remove as much of the tumor as possible while preserving neurological function.
 - **Radiation Therapy:** Used postoperatively or as a primary treatment for tumors that are inoperable or only partially resected.
 - **Chemotherapy:** Utilized for certain types of tumors, especially systemic cancers with spinal metastasis.
 - **Targeted Therapy and Immunotherapy:** Emerging treatments for specific tumor types.
5. **Prognosis:**
 - Depends on the type of tumor, its location, size, patient's overall health, and response to treatment.
 - Primary spinal cord tumors tend to have a better prognosis than metastatic spinal tumors.
6. **Rehabilitation:**
 - Focuses on improving function, managing pain, and adapting to any neurological deficits.
 - Multidisciplinary approach involving physical therapists, occupational therapists, and pain management specialists.
7. **Complications:**
 - Permanent nerve damage and paralysis.
 - Pain syndromes and mobility issues.
 - Recurrence after treatment.
8. **Prevention and Screening:**
 - No specific prevention strategies; early detection is key in individuals with known risk factors or primary cancers prone to spinal metastasis.
 - Regular follow-up and imaging for patients with a history of cancer.

Metastatic Spinal Cord Compression:

1. **Etiology and Epidemiology:**
 - MSCC most commonly arises from metastasis of cancers like breast, lung, prostate, and renal cell carcinoma.
 - It can occur in up to 10% of cancer patients and is a major cause of morbidity.
2. **Pathophysiology:**
 - Cancer cells spread to the vertebral column, grow, and compress the spinal cord and nerves.
 - Can occur due to direct invasion, hematogenous spread, or lymphatic spread.
3. **Clinical Presentation:**
 - Back pain is the most common and often the earliest symptom; may be localized or radicular.
 - Neurological deficits such as weakness, numbness, or paralysis.
 - Bowel and bladder dysfunction in advanced cases.
 - Symptoms often progress rapidly.
4. **Diagnosis:**
 - High suspicion in any cancer patient with new onset back pain.
 - MRI is the gold standard imaging modality for diagnosis.
 - CT scans and bone scans can also be used for evaluation.
5. **Management:**
 - **Early Recognition and Prompt Treatment:** Key to preventing irreversible spinal cord damage.
 - **Corticosteroids:** To reduce spinal cord oedema.
 - **Radiotherapy:** The mainstay of treatment for most patients.
 - **Surgery:** Indicated in selected cases for decompression and stabilization, especially if there is spinal instability or failure of radiation therapy.
 - **Chemotherapy:** Depending on the primary cancer type.
6. **Prognosis:**
 - Depends on the type of primary cancer, extent of spinal involvement, and speed of intervention.
 - Early treatment improves the chance of preserving neurological function.
7. **Complications:**
 - Permanent neurological deficits including paralysis.
 - Chronic pain.
 - Increased risk of pressure sores, urinary tract infections, and deep vein thrombosis due to immobility.
8. **Rehabilitation:**
 - Physical therapy to maintain muscle strength and flexibility.
 - Occupational therapy for adapting to any disabilities.
 - Pain management and psychological support.
9. **Prevention and Screening:**
 - Regular follow-up and imaging in patients with known cancers, especially those with a high risk of bone metastasis.
 - Education of patients and healthcare providers about early symptoms of MSCC.

Spinal Stenosis:

1. **Types of Spinal Stenosis:**
 - **Lumbar Spinal Stenosis:** Most common, occurs in the lower back.
 - **Cervical Spinal Stenosis:** Occurs in the neck.
2. **Etiology:**
 - Degenerative changes due to aging are the most common cause.
 - Other causes include congenital spinal deformities, spinal injuries, tumors, and bone diseases.
 - More common in older adults due to degenerative changes in the spine.
3. **Pathophysiology:**
 - Narrowing of the spinal canal or neural foramina due to factors such as disc herniation, thickening of ligaments, or osteophyte formation.
 - Compression of the spinal cord or nerve roots.
4. **Clinical Presentation:**
 - **Lumbar Stenosis:** Presents with neurogenic claudication (pain, numbness, or weakness in the legs that worsens with walking and improves with rest).
 - **Cervical Stenosis:** Can cause neck pain and neurological symptoms in the arms; severe cases might lead to spinal cord compression (myelopathy).
5. **Diagnosis:**
 - Based on history, physical examination, and radiological findings.
 - Imaging studies include X-rays, MRI, and CT scans.
6. **Treatment:**
 - **Conservative:** Physical therapy, anti-inflammatory medications, and epidural steroid injections.
 - **Surgical:** Laminectomy (removal of part of the vertebra), foraminotomy (widening of the nerve root canal), or spinal fusion, indicated in cases with severe symptoms not relieved by conservative measures.
7. **Prognosis:**
 - Varies based on severity and response to treatment.
 - Many patients find relief with conservative management, but some may require surgery.
8. **Complications:**
 - Chronic pain, loss of sensation, muscle weakness.
 - In severe cases, loss of bowel or bladder control.
9. **Prevention:**
 - General measures include maintaining a healthy weight, regular exercise, and good posture.
 - Early intervention in degenerative spinal conditions can slow progression.

Spondylolisthesis:

1. **Types of Spondylolisthesis:**
 - **Isthmic Spondylolisthesis:** Caused by a defect in the pars interarticularis, often due to a stress fracture; common in adolescents. L5/S1.
 - **Degenerative Spondylolisthesis:** Due to age-related degenerative changes in the spine; more common in adults over 50. L4/5.
 - Other types include traumatic, pathological, and dysplastic spondylolisthesis.
2. **Etiology:**
 - Congenital structural abnormalities of the spine.
 - Stress fractures (common in athletes).
 - Degenerative changes in the spine (e.g., arthritis).
 - Trauma or injury to the spine.
3. **Pathophysiology:**
 - Vertebra slips due to a defect or degeneration of the facet joints and intervertebral discs.
 - This slippage can narrow the spinal canal or compress nerve roots, leading to pain and neurological symptoms.
4. **Clinical Presentation:**
 - Lower back pain, which may radiate to the buttocks or legs.
 - Muscle tightness or stiffness.
 - In severe cases, nerve compression can cause numbness, tingling, or weakness in the legs.
5. **Diagnosis:**
 - Physical examination focusing on the range of motion, flexibility, and neurologic function.
 - Imaging studies: X-rays to confirm the presence of slippage, MRI or CT scans for detailed views of the spinal anatomy.
6. **Grading:**
 - Graded I to V based on the degree of slippage: Grade I being mild (less than 25% slippage) and Grade V being severe (spondyloptosis, where the vertebral body completely slips off the one below).
7. **Treatment:**
 - **Conservative:** Physical therapy, anti-inflammatory medications, and pain relief measures. Bracing in some pediatric cases. Spinal injections.
 - **Surgical:** Indicated for severe pain, high-grade slippage, or neurological symptoms. Procedures include spinal fusion and decompression.
8. **Prognosis:**
 - Many cases respond well to conservative treatment.
 - Surgical outcomes are generally positive, particularly in patients with significant symptoms and high-grade spondylolisthesis.
9. **Prevention:**
 - General spine health maintenance, including regular exercise, maintaining a healthy weight, and proper lifting techniques.
 - Early detection and treatment of symptoms in athletes and individuals with high physical demands.
10. **Complications:**
 - Chronic pain, increased risk of arthritis in the affected segment.
 - In severe cases, permanent nerve damage leading to weakness or loss of sensation in the legs.

Spinal Cord Anatomy:

- 1. General Anatomy:**
 - The spinal cord is a long, thin, tubular structure made up of nervous tissue, extending from the brainstem (medulla oblongata) to the lumbar region of the vertebral column.
 - It's protected by the bony vertebral column and cushioned by cerebrospinal fluid in the subarachnoid space.
- 2. Segments:**
 - Divided into 31 segments: 8 cervical (C1-C8), 12 thoracic (T1-T12), 5 lumbar (L1-L5), 5 sacral (S1-S5), and 1 coccygeal.
 - Each segment gives rise to a pair of spinal nerves.
- 3. External Anatomy:**
 - **Cervical Enlargement:** Corresponds to the shoulders and upper limbs.
 - **Lumbosacral Enlargement:** Corresponds to the pelvis and lower limbs.
 - **Conus Medullaris:** Tapered end of the spinal cord, around the L1-L2 level.
 - **Cauda Equina:** A bundle of spinal nerves and spinal nerve roots below the conus medullaris.
- 4. Internal Anatomy:**
 - **Grey Matter:** Butterfly-shaped in cross-section, consisting of neuronal cell bodies, divided into dorsal (posterior) horns, ventral (anterior) horns, and lateral horns (in thoracic and lumbar regions).
 - **White Matter:** Myelinated nerve fibers, organized into tracts or columns (dorsal, lateral, and ventral).
- 5. Spinal Tracts:**
 - **Ascending Tracts:** Carry sensory information to the brain (e.g., spinothalamic tract, dorsal columns).
 - **Descending Tracts:** Conduct motor signals from the brain to the body (e.g., corticospinal tract, rubrospinal tract).
- 6. Blood Supply:**
 - Supplied by the anterior spinal artery and paired posterior spinal arteries.
 - Venous drainage through a series of spinal veins.
- 7. Meninges:**
 - The spinal cord is surrounded by three protective layers: dura mater, arachnoid mater, and pia mater.
 - The space between the arachnoid mater and pia mater is the subarachnoid space, containing cerebrospinal fluid.
- 8. Spinal Nerves:**
 - Each spinal nerve arises from the combination of a dorsal root (sensory) and a ventral root (motor).
 - Exit the vertebral column through the intervertebral foramina.
- 9. Functional Anatomy:**
 - The spinal cord serves as a conduit for motor information traveling down from the brain and sensory information traveling up to the brain.
 - Involved in reflex actions via the reflex arc.
- 10. Clinical Correlation:**
 - Understanding spinal cord anatomy is crucial for diagnosing and managing spinal cord injuries, neurological disorders, and diseases affecting spinal cord function.

Spinal Cord Syndromes and Cauda Equina Syndrome:

- 1. Central Cord Syndrome:**
 - Most common incomplete spinal cord injury, often due to hyperextension injuries.
 - Greater motor impairment in upper limbs than lower limbs.
 - Variable sensory loss below the level of injury.
- 2. Anterior Cord Syndrome:**
 - Caused by damage to the anterior part of the spinal cord.
 - Loss of motor function, pain, and temperature sensation below the level of injury.
 - Proprioception and vibration sensation are typically preserved.
- 3. Brown-Séquard Syndrome:**
 - Results from hemisection of the spinal cord.
 - Ipsilateral (same side as injury) loss of motor function, proprioception, and vibratory sense.
 - Contralateral (opposite side) loss of pain and temperature sensation.
- 4. Posterior Cord Syndrome:**
 - Least common; involves the dorsal columns of the spinal cord.
 - Loss of proprioception, vibration, and fine touch sensation.
 - Motor function and pain and temperature sensation are preserved.
- 5. Conus Medullaris Syndrome:**
 - Injury to the conus medullaris (terminal portion of the spinal cord).
 - Presents with lower back pain, motor weakness in the lower limbs, and bowel and bladder dysfunction.
 - May have a mix of upper and lower motor neuron signs.
- 6. Cauda Equina Syndrome:**
 - Caused by compression of the cauda equina (nerve roots extending from the lower end of the spinal cord).
 - Symptoms include severe low back pain, sciatica, saddle anesthesia (loss of sensation in the buttocks, perineum, and inner thighs), bowel and bladder dysfunction, and lower limb motor weakness and sensory loss.
 - It is a surgical emergency; delayed treatment can result in permanent damage.
- 7. Diagnosis:**
 - Based on clinical presentation and confirmed by imaging studies (MRI or CT myelography).
 - Important to differentiate between spinal cord syndromes and cauda equina syndrome as the management differs.
- 8. Treatment:**
 - Central Cord, Anterior Cord, Brown-Séquard, Posterior Cord, and Conus Medullaris Syndromes: Management involves stabilization of the spine and rehabilitation.
 - Cauda Equina Syndrome: Immediate surgical decompression to prevent permanent nerve damage.
- 9. Rehabilitation:**
 - Early intervention with physical and occupational therapy.
 - Focus on maximizing functional recovery and adapting to limitations.
- 10. Long-term Management:**
 - Regular follow-up for complications like chronic pain, bladder and bowel dysfunction, and psychological support.

Cervical Myelopathy:

1. **Etiology:**
 - Degenerative changes in the spine, such as cervical spondylosis, are the most common cause.
 - Other causes include spinal stenosis, disc herniation, and trauma.
2. **Pathophysiology:**
 - Spinal cord compression in the cervical region leads to neurological deficits.
 - Chronic compression can result in spinal cord atrophy and irreversible damage.
3. **Clinical Presentation:**
 - Neck pain and stiffness.
 - Progressive weakness in the arms and/or legs.
 - Numbness and tingling in the hands and fingers.
 - Difficulty with fine motor skills, such as buttoning a shirt or handwriting.
 - Gait disturbances and balance problems.
 - In advanced cases, bowel and bladder dysfunction.
4. **Diagnosis:**
 - Clinical examination revealing hyperreflexia, muscle weakness, sensory changes, and possible Babinski sign.
 - MRI is the gold standard for imaging to visualize spinal cord compression.
 - Electrophysiological studies, like nerve conduction studies and somatosensory evoked potentials, can help assess the functional status of the spinal cord.
5. **Treatment:**
 - **Conservative:** May include physical therapy, cervical collars, and pain management, though this is typically insufficient for moderate to severe cases.
 - **Surgical:** The primary treatment for significant or progressive symptoms. Various procedures like decompression surgery, laminectomy, and spinal fusion might be indicated to relieve pressure on the spinal cord.
6. **Prognosis:**
 - Early surgical intervention generally offers the best outcomes.
 - Delayed treatment can lead to permanent spinal cord damage and disability.
7. **Complications:**
 - Ongoing neurological deficits, including chronic pain, muscle weakness, and impaired coordination.
 - Increased risk of falls and injuries due to balance and gait disturbances.
8. **Prevention and Screening:**
 - Early recognition and treatment of cervical spondylosis and other risk factors can prevent progression to myelopathy.
 - Regular follow-up for patients with known cervical spine disorders.
9. **Rehabilitation:**
 - Postoperative physical therapy is crucial for improving strength and function.
 - Occupational therapy for adapting to any residual disabilities.

Low Back Pain:

1. **Definition and Epidemiology:**
 - Low back pain (LBP) is pain located below the costal margin and above the inferior gluteal folds.
 - Extremely common, affecting up to 80% of the population at some point in their lives.
2. **Etiology:**
 - **Mechanical causes (90% of cases):** Includes muscle or ligament strain, degenerative changes (disc degeneration, facet arthritis), spondylolisthesis, and compression fractures.
 - **Non-mechanical spinal conditions:** Includes infections (e.g., osteomyelitis), tumors, inflammatory diseases (e.g., ankylosing spondylitis).
 - **Visceral diseases:** Renal disorders, pelvic diseases, aortic aneurysms.
3. **Risk Factors:**
 - Age (more common in middle-aged and older adults).
 - Sedentary lifestyle.
 - Excess body weight.
 - Occupational hazards (heavy lifting, prolonged sitting).
 - Smoking.
 - Psychological factors (stress, depression).
4. **Clinical Presentation:**
 - Acute (<6 weeks), Subacute (6-12 weeks), Chronic (>12 weeks).
 - Pain, muscle spasm, limited mobility.
 - May have leg pain (sciatica) if nerve root compression.
 - Red flags: Weight loss, fever, trauma, neurologic symptoms, history of cancer.
5. **Diagnosis:**
 - Clinical history and physical examination.
 - Imaging (X-ray, MRI, CT) generally reserved for red flag symptoms or if no improvement after conservative treatment.
 - Laboratory tests are not routinely required but may be needed for red flags.
6. **Treatment:**
 - **Non-pharmacological:** Education and reassurance, physical therapy, exercise, heat therapy.
 - **Pharmacological:** NSAIDs, paracetamol, muscle relaxants. Opioids only in carefully selected patients.
 - **Interventional:** Spinal injections, surgery (rarely indicated and typically for cases with neurological deficits or severe, chronic pain unresponsive to other treatments).
7. **Prevention:**
 - Regular exercise, maintaining a healthy weight, proper lifting techniques, ergonomics in the workplace.
8. **Prognosis:**
 - Generally favorable. Most acute episodes resolve within weeks.
 - Recurrence is common.
 - Chronic low back pain can be more challenging and may require a multidisciplinary approach.

Sciatica / Radicular Leg Pain:

1. **Definition:**
 - Sciatica refers to pain radiating along the path of the sciatic nerve, which runs from the lower back down each leg.
 - Radicular leg pain is a symptom of nerve root irritation or compression in the lumbar spine.
2. **Etiology:**
 - Most commonly caused by a herniated disc pressing on the nerve root.
 - Other causes include spinal stenosis, spondylolisthesis, and piriformis syndrome.
 - Less common causes: Tumours, infections, cauda equina syndrome.
3. **Risk Factors:**
 - Age (middle-aged individuals are more susceptible).
 - Obesity.
 - Occupation requiring heavy lifting, prolonged sitting, or twisting movements.
 - Diabetes (due to potential nerve damage).
 - Sedentary lifestyle.
4. **Clinical Presentation:**
 - Pain radiating from the lower back to the buttocks and down the back of one leg.
 - Numbness, tingling, or muscle weakness in the affected leg or foot.
 - Pain that worsens with sitting, coughing, or sneezing.
 - Typically, symptoms are only on one side of the body.
5. **Diagnosis:**
 - Based largely on patient history and physical examination (straight leg raise test).
 - Imaging (MRI or CT scan) if severe or persistent symptoms, or if there are red flags indicating a more serious underlying condition.
 - Electromyography (EMG) may be used in complex cases.
6. **Treatment:**
 - **Conservative Treatment:** Most cases resolve with rest, physical therapy, and NSAIDs for pain relief.
 - **Epidural Steroid Injections:** For persistent pain.
 - **Surgery:** Considered when conservative treatment fails or in cases with significant neurological deficits (e.g., microdiscectomy).
7. **Prevention:**
 - Regular exercise, particularly core strengthening.
 - Proper body mechanics when lifting.
 - Maintaining a healthy weight.
 - Ergonomic workplace adjustments.
8. **Prognosis:**
 - Good for most patients; symptoms often improve within a few weeks.
 - Chronic pain or recurrent episodes can occur.
 - Early intervention and treatment usually lead to better outcomes.