Spine Structure and Function

- **Flexible column comprised of 26 bones** in a multi-curved shape arising naturally due to vertebral & disk shape, rib cage & inclination of the sacral end plate
  - 7 cervical
  - 12 thoracic
  - 5 lumbar
  - 1 sacral and 1 coccygeal

- **Primary roles**
  - Support mass of body/head and withstand external forces
  - Allows for mobility and flexibility to absorb energy and protect against impact
  - Protects the spinal cord, nerves and the vertebral artery in the cervical area
  - Trunk muscles & ligaments act on individual vertebrae for postural control & spinal stability
Spine Kinematics

- Translation & Rotation around each plane, coupled motion. Main determinant of ROM is orientation of facet joints and the intervertebral discs.

- **Cervical** Spine is dominated by flexion-extension motion with axial rotation and lateral bending also in the upper region.

- **Thoracic** region is characterized by the rib cage and experiences little motion relative to the cervical and lumbar region.

- The **lumbar** region has considerable lateral bending in the middle, with great flex-ext in the LS motion segment, minimum rotation due to facet joint orientation.

- Greater mobility in the cervical and lumbar segments leads to greater stresses in those areas and therefore a clinically-noted increase in pain reporting and injury.
Major Components of Spine

- The spine is typically studied in its motion segments (FSU) consisting of 2 vertebral bodies and the intervening soft tissue. 6DOF 3 translational and 3 rotational.
- The vertebrae is segmented by the anterior elements (load-carrying vertebral body) and the posterior elements.
- The intervertebral disk (made of the annulus fibrosus and the nucleus pulposus, see figure 4) operates to carry loads down the spine, help absorb energy and aid in weight-bearing demands. The disc becomes more compressed and weaker with age.
Common Afflictions of the Spine
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- **Lordosis** “hollow back”, exaggerated convex curve of lumbar region.
- **Kyphosis** “hump back”, exaggerated concave curve in the thorax.
- **Low Back Pain** nonspecific term associated with fractures due to osteoporosis, spondylolisthesis, degenerative disc disorders, trauma or postural deformities.
- **Osteoporosis** bones become fragile and more likely to break.
- **Whiplash** traumatic hyperextension of cervical vertebrae, damage to surrounding soft tissue. May be fracture of the spinous processes and ruptured disks.
- **Spondylosis** degenerative disorder that may cause loss of normal spinal structure and function.
- **Spondylolisthesis** congenital or develop during childhood or later in life. One vertebra slips forward in relation to an adjacent vertebra, usually in the lumbar spine. In advanced cases, may appear swayback with a protruding abdomen, exhibit a shortened torso, and present with a waddling gait.
Assistive Devices for the Spine

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- Soft Collar – transitional flexible brace typically used after a more rigid collar has been worn for the major healing.
- Philadelphia Collar - rigid collar worn 24 hours a day. This collar is used for conditions such as: a relatively stable cervical (upper spine) fracture, cervical fusion surgery, or a cervical strain.
- Sterno-Occipital Mandibular Immobilization Device (SOMI) - prevents flex/ext or axial rotation of the cervical vertebrae.
- Halo most rigid brace, immobilizes head and neck, used after complex cervical spine surgery or if there is an unstable cervical fracture. A titanium ring (halo) encircles the head, secured to the skull by four metal pins. The ring attaches by four bars to a vest that is worn on the chest. The vest offers the weight to hold the ring and neck steadily in place. The Halo is worn 24 hours a day until the spine injury heals.
Common Afflictions of the Spine - Scoliosis

- **Scoliosis** abnormal bending to the side, accompanied by secondary curve.
  - May be caused by congenital deformities, genetic conditions, neuromuscular problems, limb length inequality, CP, spina bifida, MD, muscular atrophy, tumors.
  - It affects 2% of women and 0.5% of men.
  - Over 80% of scoliosis cases, are **idiopathic**, no known cause.

- Idiopathic scoliosis is broken down into **four age-based categories**
  - infantile: children ages 3 and under
  - juvenile: 3-9 years old
  - adolescent: 10-18 years old *most common
  - adult: after skeletal maturity

- **Symptoms and Progression:**
  - Shoulders, Rib cage, waist are at different heights/uneven with prominent hip
  - Head is not centered directly above the pelvis
  - Changes in look or texture of skin overlying the spine
  - Forward bend test, confirmed with x-rays and simple diagnostics.
  - Progression depends on maturity of spine, severity & location of curve.
Assistive Devices for Spinal Correction

- Spinal bracing for scoliosis provides three-point force systems to provide correction or prevent progression of a deformity.

- Traditional Milwaukee Brace starts at hips with a pelvic girdle, 2 posterior metal bars attach to back, 1 anterior. Bars run length of spine and connect to neck ring with plastic throat mold in front and 2 head pieces in back where the occipital portion of the skull rests. Worn 23 hours a day from the age of about 12 to 21 years old.

- TLSO brace is called the “Boston brace” or “underarm” brace. Custom molded to child’s body. Worn up to 23 hours per day and is usually prescribed for curves in the lumbar or thoraco-lumbar part of the spine.

- A “nighttime” brace, Charleston back brace is molded to the patient while they are bent to the side, thus applies more pressure against the curve. This pressure improves the corrective action of the brace. Curves must be in the 20 to 40 degree range and the apex of the curve needs to be below the level of the shoulder blade.