Smooth Muscle Tissue

shorter than skeletal muscle cells

mechanism of contraction is similar to skeletal muscle cells

called smooth muscle because myofibrils are not arranged in such a fixed overlapping pattern

thick and thin filaments are of varying lengths not organized into sarcomeres

ratio of thick to thin filaments is 10-15:1 vs 2:1 in skeletal muscle cells

produce weaker contractions

allows smooth muscle cells to stretch to much greater extent than skeletal cells and still be able to contract eg. bladder, uterus

poorly developed sarcoplasmic reticulum

no T tubules

contract & relax much more slowly

not as strong of a contraction

don’t need as much energy only need ~1% of energy required by skeletal muscle cells

but since don’t need as much energy, generally don’t fatigue → can maintain a contraction much longer than skeletal muscles can

eg. sphincters usually remain contracted to close off various openings; esophagus, anus, stomach, etc

like skeletal muscle fibers they are innervated by nerve cells but can also be controlled by hormones
Two basic kinds of smooth muscle cells:

**Single Unit**
connected by gap junctions to form large networks
→ allows impulse to spread more easily = **self stimulating**

   every muscle cell does not need direct nervous connection

   eg. surround blood vessels and constrict and dilate to regulate blood pressure and flow to various organs

   eg. intestine, esophagus, ureters, etc
since they are also much slower than skeletal muscle cells
→ leads to **peristalsis**

**Multi-Unit**
individual fibers are not connected directly by gap jcts
each cells in individually innervated
→ not self stimulating

   eg. walls of larger arteries, bronchi and large bronchioles, arrector pili muscles, iris muscles
Cardiac Muscle Tissue

a unique type of contractile tissue found only in the heart

many of its characteristics are intermediate between striated and smooth muscles

has **striations** like skeletal muscle:
same myofibril arrangement

but smaller SR and larger T tubules

→ can contract more strongly than smooth muscle
→ can contract more quickly than smooth muscle
→ requires more energy

has a **single nucleus** and is **self stimulating** like smooth muscle

→ doesn’t need direct innervation of every cell

also has unique features:

**branches** that merge with other cells

**intercalated discs** between cells instead of tapering to point

these are **gap junctions**
→ direct connections between cells

=**syncytium** → no boundary between cells;
form branching 3-D network
contracts as a single unit

eg. all cardiac muscle cells of atria are interconnected and all cardiac muscle cells of ventricles are interconnected
→ atria contract as a unit
→ ventricles contract as a unit

are self stimulating

cells contract and relax rhythmically and continuously even without a nervous connection
~ 75 bpm
innervation just allows control of heart beat:
speeds up or slows down as needed
Cardiac muscle cells are more active than smooth muscle cells yet cannot fatigue or you would die

→ require constant supply of O2 for aerobic respiration

  inadequate oxygen can quickly damage heart tissue

→ but can use glucose or lactic acid as energy source;
  benefit during exercise

Cardiac cells have a **longer contraction period**
  remain contracted 10-15 x’s longer than skeletal muscle cells
  due to Ca++ remaining in sarcoplasm longer

Cardiac cells also have a **longer refractory period**
  (~300ms)
  → prevents tetanus

**Disorders of the Muscular System**

1. **Convulsions and Spasms**
   abnormal uncoordinated contractions of various muscle groups

2. **Fibrillation** (cardiac muscle)
   asynchronous contraction of individual cardiac muscle cells

3. **Poisons and Toxins**
   mainly affect Ach at NM jcts and in brain where it is used as a NT
   **Botulism toxin** – blocks exocytosis & release of Ach
     → paralysis
     = **Botox**: relieves crossed eyes and uncontrolled blinking, also relaxes muscles that cause facial wrinkles
   **Tetanus toxin** – interferes with inhibition of antagonists
     → all muscles contract
   **Black widow toxin** – stimulates massive release of Ach
     → intense cramping & spasms
   **Nicotine** - mimics Ach
     → prolongs hyperactivity
   **Atropine, curare** - binds to and prevents Ach from binding to receptors → paralysis
4. **Disuse Atrophy:**
   lack of stimulation or immobilization (splint, cast)
   muscle cell mass can decrease 5%/day down to 25% loss
   muscle tissue replaced by connective tissue (fibrosis)
   can stimulate muscles electrically to reduce atrophy

5. **Fibrosis**
   skeletal muscle fibers degenerate and are replaced by fibrous connective tissue
   associated with aging
   loss of strength

6. **Hernia**
   occurs because of weakness in body wall may cause rupture
   wall is weak because of spaces between bundles of muscle fibers
   undue pressure on abdominal viscera may force a portion of parietal peritoneum and intestine through these weak spots
   most common at inguinal area

7. **Muscular Dystrophy** (muscle destroying diseases)
   Duchenes: sex linked recessive trait
   sarcolemma deteriorates
   progresses from extremities upward
   most die by 20 yrs old
   biotech trying to replace gene that makes missing protein

8. **Myasthenia Gravis** (Heavy weakness)
   weakness of skeletal muscles, esp face and neck muscles:
   drooping eyelids
difficulty talking and swallowing
shortage of Ach receptors → autoimmune disease
   prevents fibers from contracting
   mostly women, 20-50 yrs old

9. **Steroid abuse**
   normally testosterone promotes bone development and muscle mass
could megadoses help body builders?

by 2000 nearly 1 in 10 young men have tried steroids
take high doses (to 200mg/d) during heavy resistance training
positive data:
   increases isometric strength
   rise in body weight
not sure if these changes result in better PERFORMANCE
negative data:
   bloated faces
   shriveled testes
   infertility
   liver damage
   alters blood cholesterol levels
   1/3rd of users exhibit serious mental problems such as
      manic behaviors