KNOWLEDGE ORGANISER

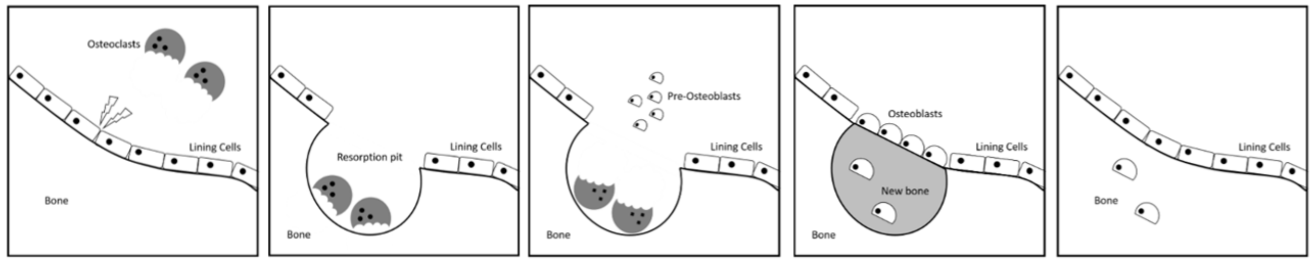
Unit 1 Anatomy & Physiology: The Skeletal System

TYPES OF BONES & THEIR FUNCTIONS

Type of Bone	Function	Example
1. **Long Bones**	Leverage & red blood cell production	Femur, Humerus
2. **Short Bones**	Weight bearing	Tarsals, Carpals
3. **Flat Bones**	Protection	Cranium, Sternum
4. **Sesamoid Bones**	Reducing friction across a joint, embedded in a tendon	Patella
5. **Irregular Bones**	Individualised functions	Pisiform

PROCESS OF BONE GROWTH

1. Activation > 2. Resorption > 3. Reversal > 4. Formation > 5. Quiescence

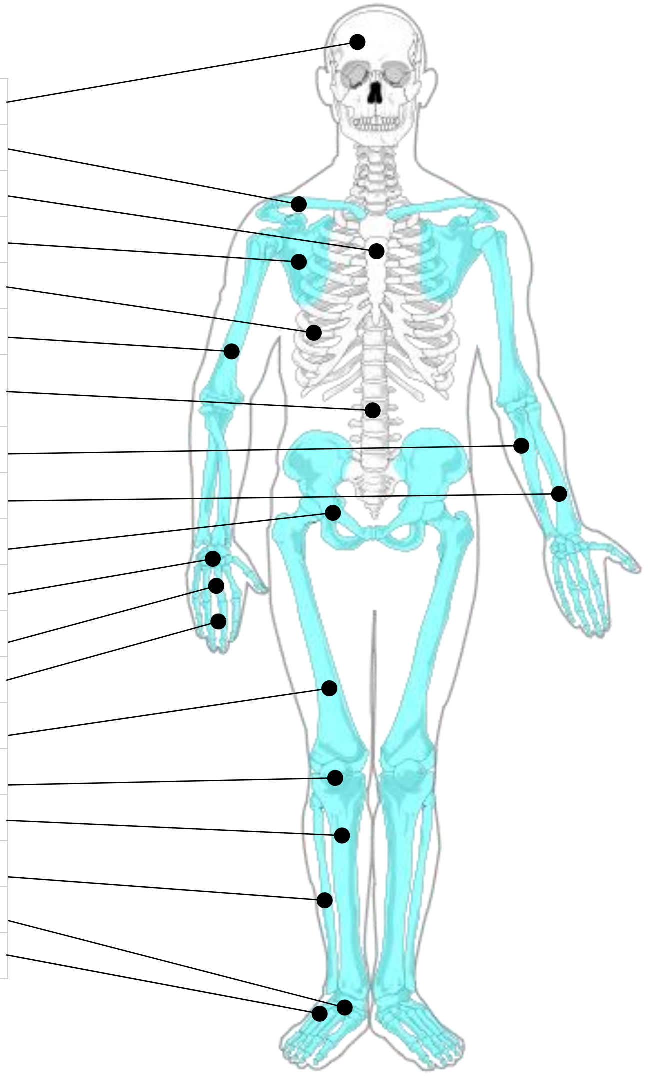


FUNCTIONS OF THE SKELETON

1. Supporting framework
2. Protection
3. Attachment for muscle
4. Blood cell production
5. Store of minerals
6. Leverage
7. Weight bearing
8. Reducing friction across joints

MAJOR BONES

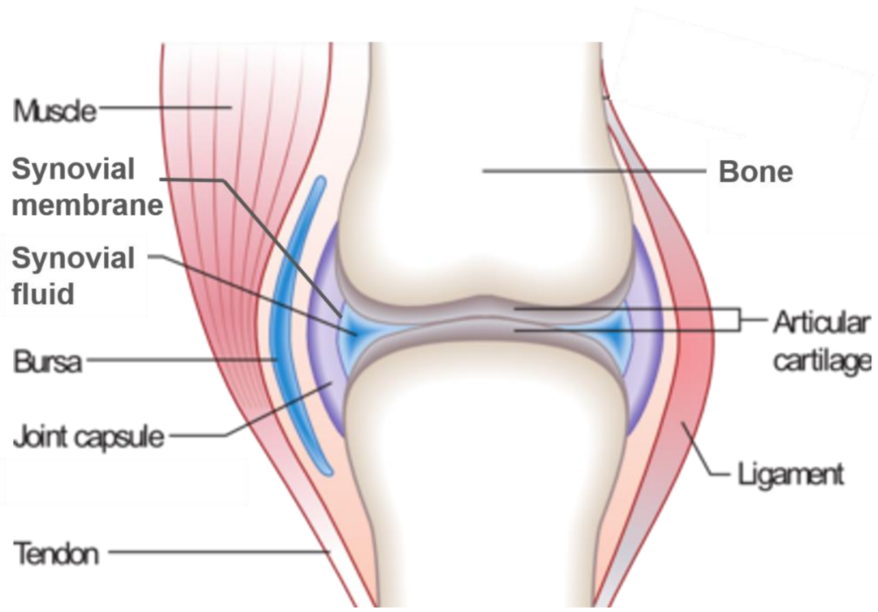
- cranium
- clavicle
- sternum
- scapula
- ribs
- humerus
- vertebral column (details below)
- ulna
- radius
- pelvis
- carpals
- metacarpals
- phalanges
- femur
- patella
- tibia
- fibula
- tarsals
- metatarsals



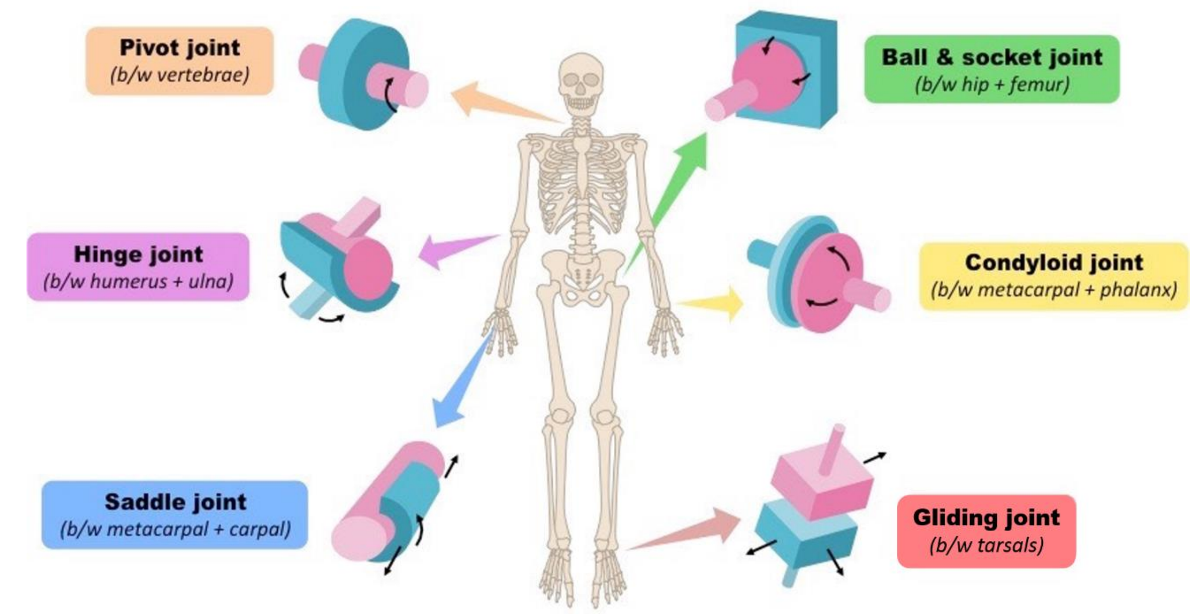
JOINTS

Classifications **1.** Fibrous (fixed) **2.** Cartilaginous (slightly moveable) **3.** Synovial (freely moveable)

Synovial joints



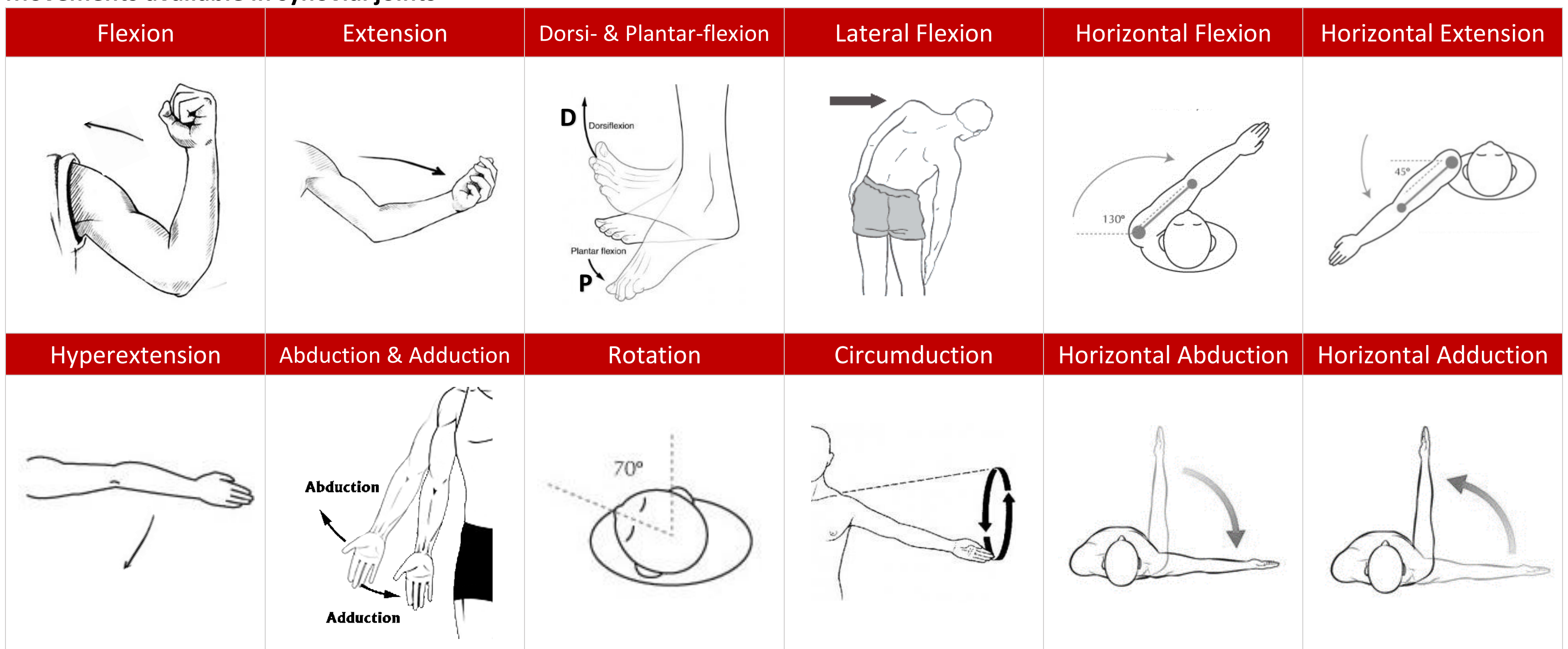
Six types of synovial Joints



Bones forming specific joints

Shoulder
Scapula, Clavicle, Humerus **Joint Type:** Ball & Socket
Elbow
Humerus, Radius, Ulna **Joint Type:** Hinge
Wrist
Carpals, Radius, Ulna **Joint Type:** Hinge
Hip
Illium, Pubis, Ischium, Femur **Joint Type:** Ball & Socket
Knee
Femur, Tibia, Fibula **Joint Type:** Hinge
Ankle
Tibia, Fibula, Talus **Joint Type:** Hinge

Movements available in synovial joints



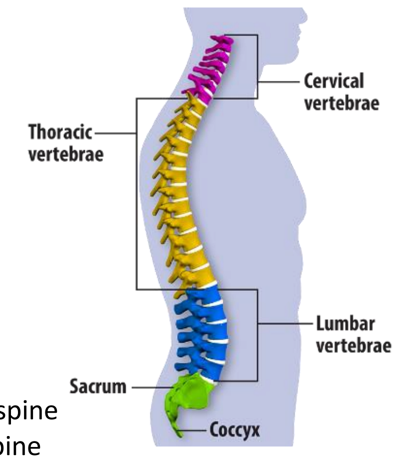
AREAS OF THE SKELETON

Axial in Red & Appendicular in Blue (in diagram above)

Spine:
7 Cervical, 12 Thoracic, 5 Lumbar, 5 Sacral, 4 Coccygeal vertebrae

Curvature & Alignment (as shown)

Postural Deviations
Kyphosis: excessive curvature of *thoracic* spine
Lordosis: excessive curvature of *lumbar* spine



RESPONSES TO EXERCISE (Short Term)

1. Stimulated increase of mineral uptake in bones due to weight bearing exercise

ADAPTATIONS TO EXERCISE (Long Term)

1. Increased bone strength
2. Increased ligament strength

ADDITIONAL FACTORS

1. **Skeletal disease:** exercise offsets the risks of arthritis, osteoporosis
2. **Age:** Young children at risk of greenstick fracture, resistance training may stunt growth (though disputed)

Made by Mike Tyler @MikeTylerSport

KNOWLEDGE ORGANISER
Unit 1 Anatomy & Physiology: The Muscular System

CHARACTERISTICS & FUNCTIONS OF THREE TYPES OF MUSCLE

Muscle	Characteristics	Example
Cardiac	Non-fatiguing, involuntary	Heart (only)
Skeletal	Fatiguing, voluntary	Biceps, Triceps, Soleus, etc.
Smooth	Involuntary, slow contraction	Internal organs, blood vessels

THREE TYPES OF SKELETAL MUSCLE CONTRACTION

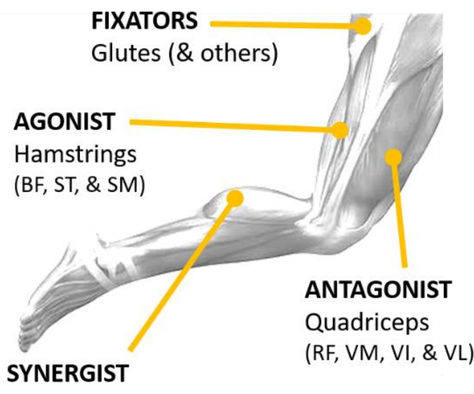
Contraction	As muscle contracts…	Used for…
Isometric	…no change in muscle length	Static holds (e.g. iron cross)
Concentric	…muscle shortens	Movement
Eccentric	…muscle lengthens	Slowing and braking movements

ANTAGONISTIC PAIRS

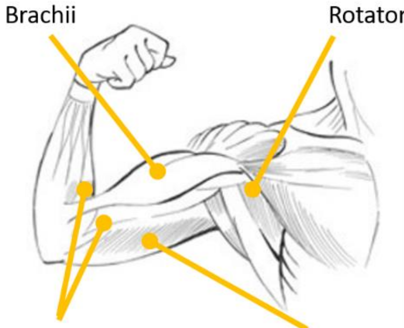
Muscles cannot push so are 'paired' with others that pull in the opposite direction.

1. **Agonist:** muscle that contracts to produce movement (also called prime mover)
2. **Antagonist:** muscle that relaxes (if contracted would make opposite joint movement)
3. **Synergist:** muscle that assists the agonist (in force production)
4. **Fixator:** muscle that assists the agonist (by stabilising the muscle's origin)

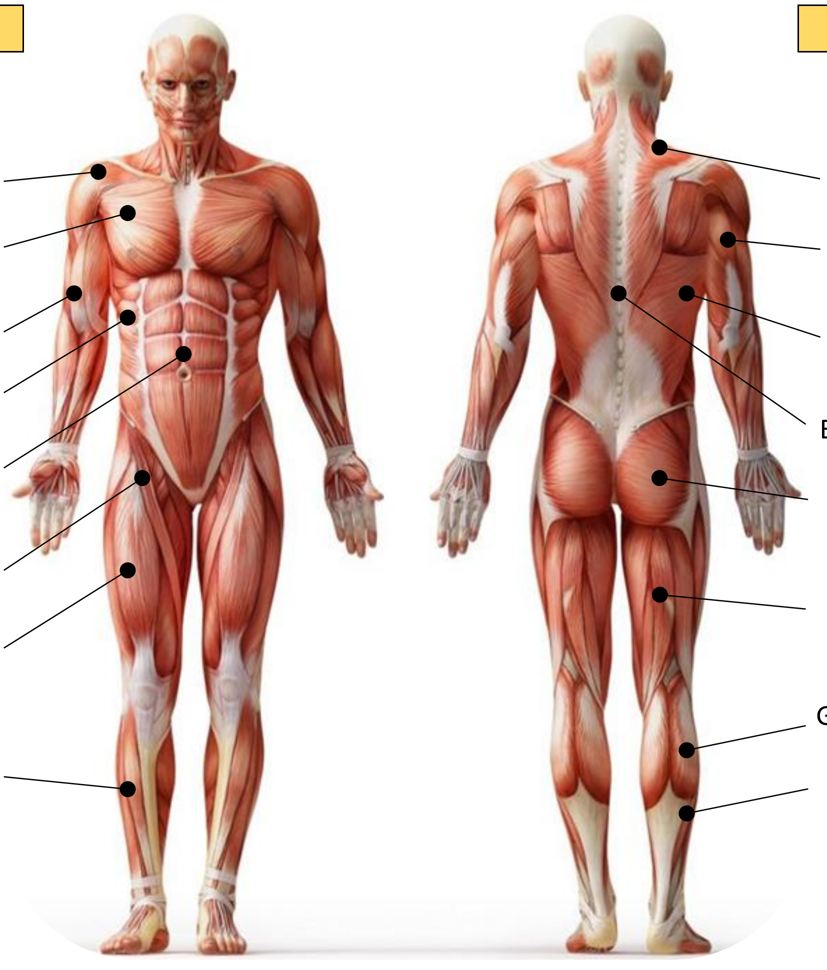
Knee Flexion

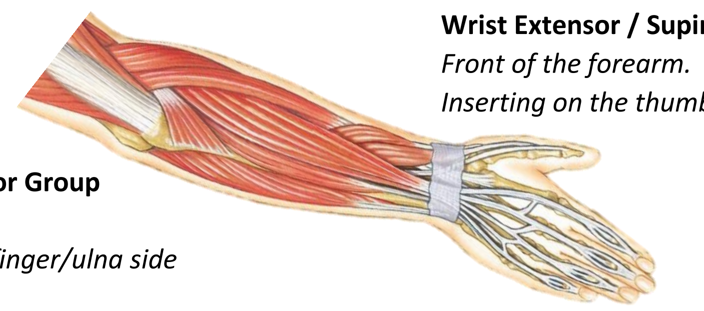


Elbow Flexion



MAJOR SKELETAL MUSCLES





MUSCLE FIBRE TYPES

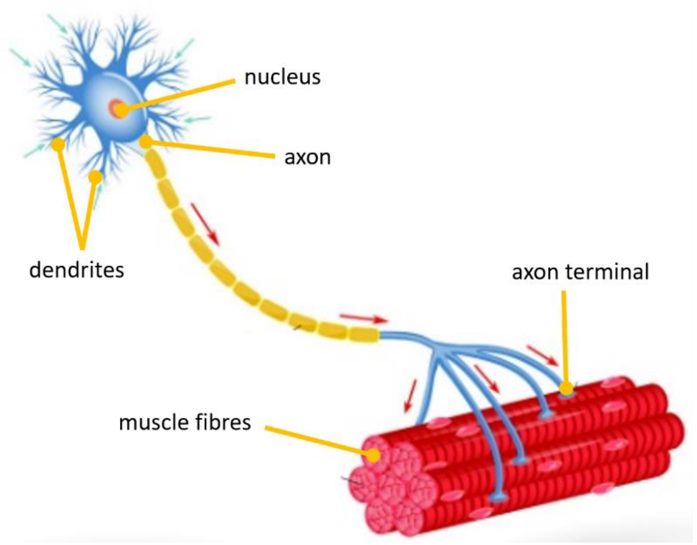
Characteristics of different muscle fibre types

Fibre Type	Type I	Type IIa	Type IIx
Twitch Speed	Slow	Fast	Fast
Force	Low	High	Very High
Fatigue	Slow	Medium	Fast
Recovery	Slow	Medium	Fast
ATP Source	Oxidative	Ox. & Gly.	Glycolytic
Blood Supply	High	High	Low
Myoglobin	High	High	Low
Colour	Red	Red	White
Mitochondria	High	High	Low
Recruitment	First	Second	Third
Diameter	Small	Medium	Large
Suitable for…	Endurance	Games	Speed

NERVOUS CONTROL OF MUSCLE CONTRACTION

Motor Units

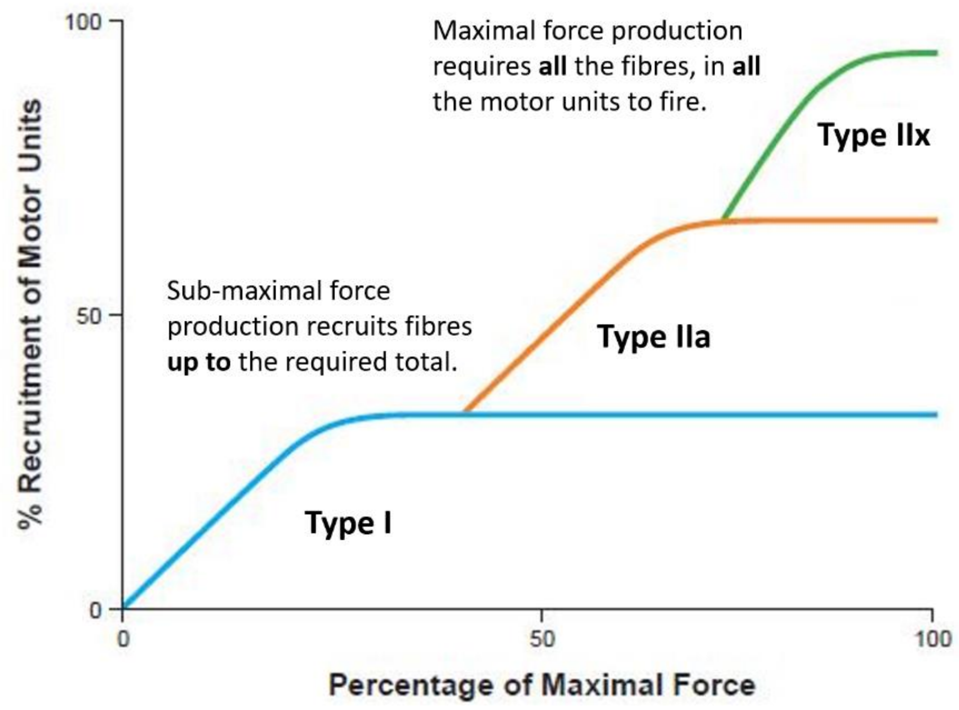
- A motor unit is a **motor neuron** and all the fibres it 'innervates'
- All the fibres in a motor unit are of the same type.
- A muscle (e.g. biceps brachii) is made up of several motor units.



- An electrical impulse is sent along the neuron.
- If the impulse if sufficient **all** the fibres in the motor unit contract.
- Otherwise **none** of them contract. This is the **'all or none law'**.
- To create more force more motor units must be 'innervated'.

NERVOUS CONTROL OF MUSCLE CONTRACTION

Fibre Type Recruitment



RESPONSES TO EXERCISE (Short Term)

1. Increased blood supply
2. Increased muscle temperature
3. Increased muscle pliability
4. Lactate (high intensity exercise)
5. Micro-tears (resistance exercise)

ADAPTATIONS TO EXERCISE (Long Term)

1. Hypertrophy
2. Increased tendon strength
3. Increase in myoglobin stores
4. Increase in number and size of mitochondria
5. Increased storage of glycogen
6. Increased storage of fat
7. Increase tolerance to lactate

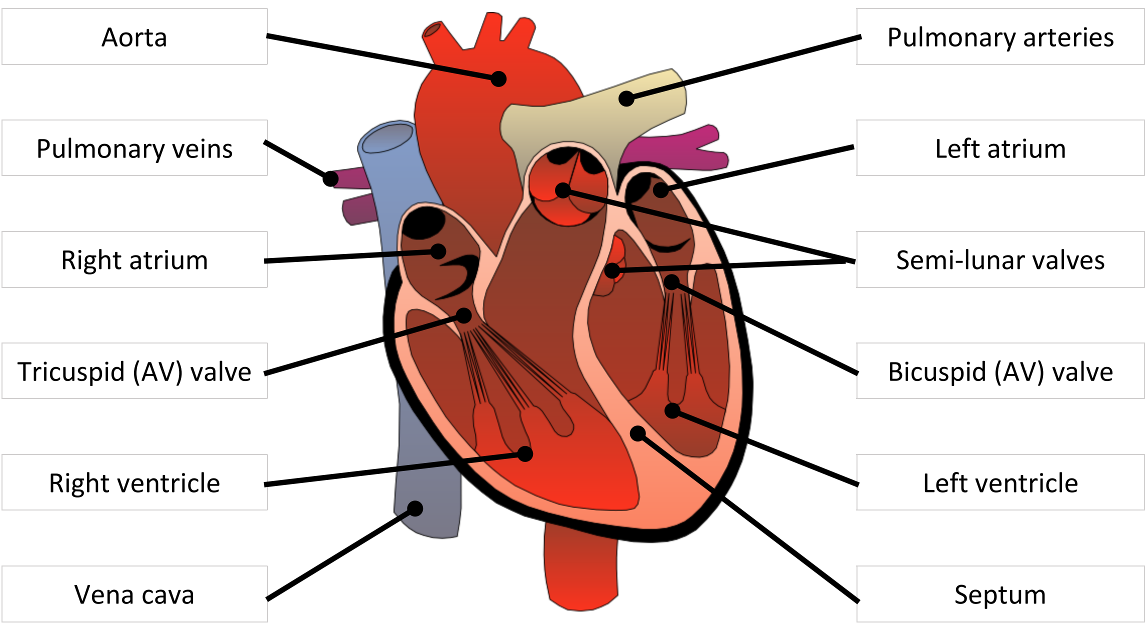
ADDITIONAL FACTORS

1. **Age:** Loss of muscle mass, atrophy
2. **Cramp:** Involuntary, sustained skeletal muscle contraction

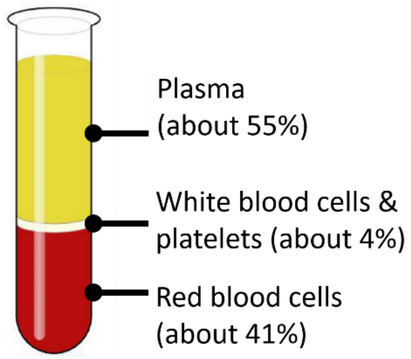
KNOWLEDGE ORGANISER

Unit 1 Anatomy & Physiology: The Cardiovascular System

STRUCTURE OF THE HEART



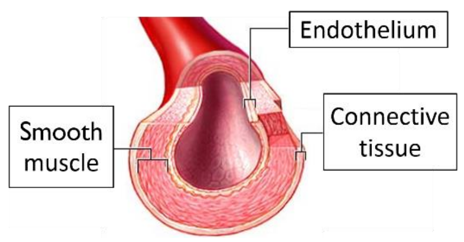
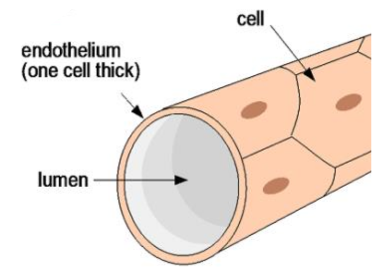
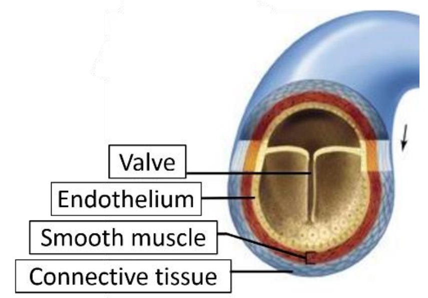
COMPOSITION OF BLOOD



FUNCTIONS OF THE CARDIOVASCULAR SYSTEM

1. Delivery of oxygen and nutrients
2. Removal of waste products
3. Thermoregulation
4. Fight infection
5. Clot blood

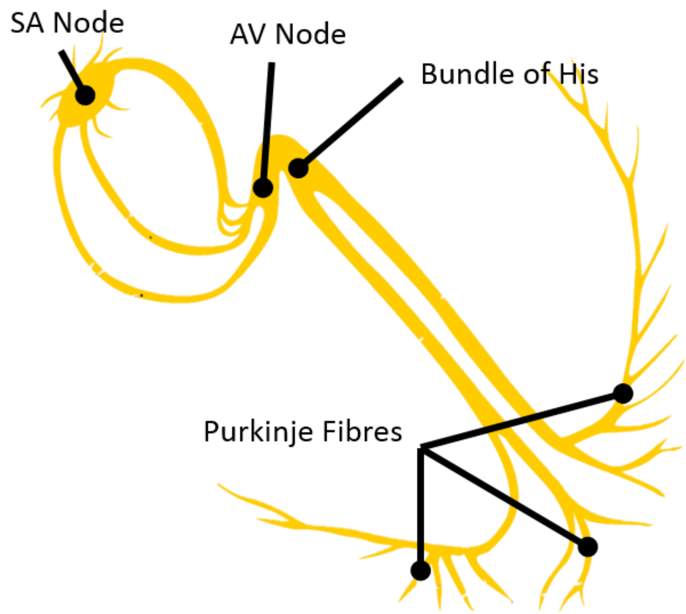
STRUCTURE OF BLOOD VESSELS

ARTERY (& arteriole)	CAPILLARY	VEIN (& venule)
1. Away from the heart 2. Oxygenated blood* 3. Thick walls 4. High pressure	1. In the tissue 2. Gaseous exchange 3. *Very* thin walls 4. High pressure	1. Back to the heart 2. Deoxygenated blood* 3. Thin walls 4. Lower pressure 5. Valves
		

*except for pulmonary artery/pulmonary vein where this is reversed

NERVOUS CONTROL OF THE CARDIAC CYCLE

Electrical Impulse Pathway



1. Sinoatrial Node	2. Atrioventricular Node	3. Bundle of His	4. Purkinje Fibres
Right atrium near vena cava	*Septum near atria*	*Septum*	*Ventricle walls*
Triggers atrial systole	Delays, then conducts through to ventricles	Conducts to base of ventricles	Conducts up ventricle walls

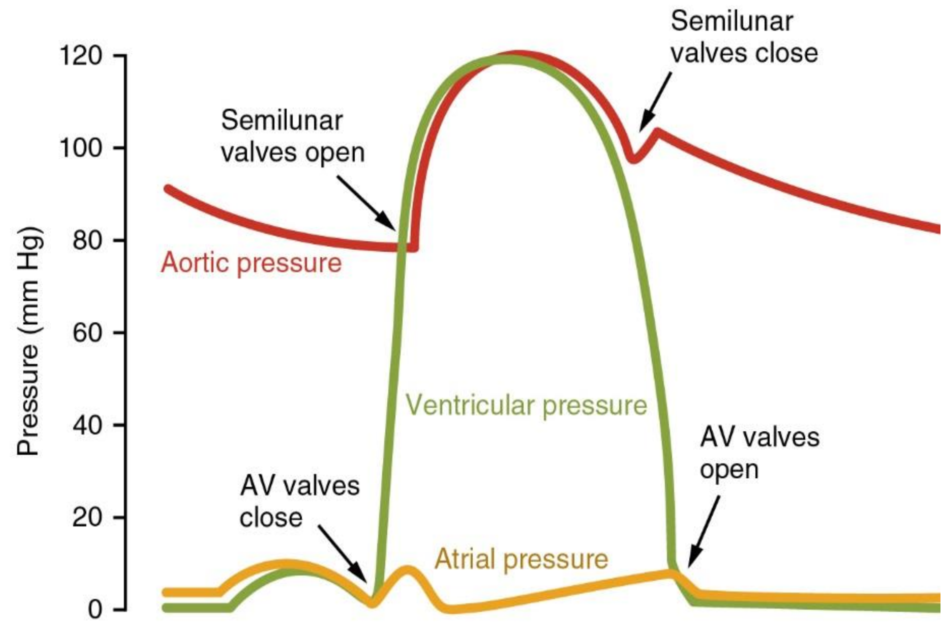
The Cardiac Cycle

1. Atrial Systole
- Both atria contract
- Blood is pushed into ventricles through AV valves

2. Iso-volumetric Contraction
- Pressure pushes AV valves closed ('Lub')
- Pressure forces Semi-lunar valves open

3. Ventricular Ejection
- Both ventricles contract
- Blood is ejected into Aorta / Pulmonary artery

4. Iso-volumetric Relaxation
- Semi-lunar valves close ('Dub')
- Filling occurs passively as blood returns to heart



Influence of the Autonomic Nervous System on the Cardiac Cycle

SYMPATHETIC NERVOUS SYSTEM	PARASYMPATHETIC NERVOUS SYSTEM
EXCITES	CALMS
1. Secretes adrenaline & noradrenaline 2. Increases Heart Rate 3. Increases Blood Pressure 4. Increases contractile force of cardiac muscle 5. Stimulates vasoconstriction/vasodilation.	1. Decreases Heart Rate 2. Decreases Blood Pressure 3. Decreases Cardiac Output (Q)

RESPONSES TO EXERCISE (Short Term)

1. Anticipatory increase in heart rate prior to exercise
2. Increased heart rate
3. Increased cardiac output
4. Increased blood pressure
5. Redirection of blood flow

ADAPTATIONS TO EXERCISE (Long Term)

1. Cardiac hypertrophy
2. Increase in resting and exercising stroke volume
3. Decrease in resting heart rate
4. Capillarisation of skeletal muscle and alveoli
5. Reduction in resting blood pressure
6. Decreased heart rate recovery time
7. Increase in blood volume

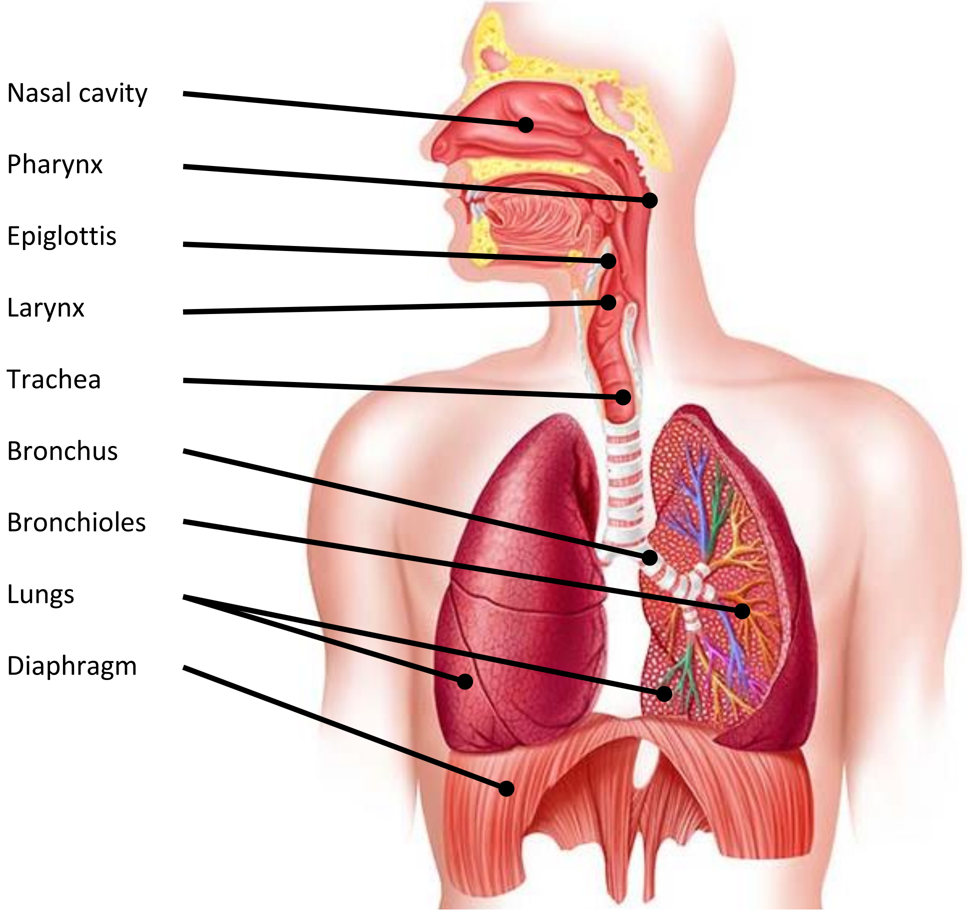
ADDITIONAL FACTORS

1. Sudden arrhythmic death syndrome (SADS)
2. High blood pressure / low blood pressure
3. Hyperthermia / hypothermia

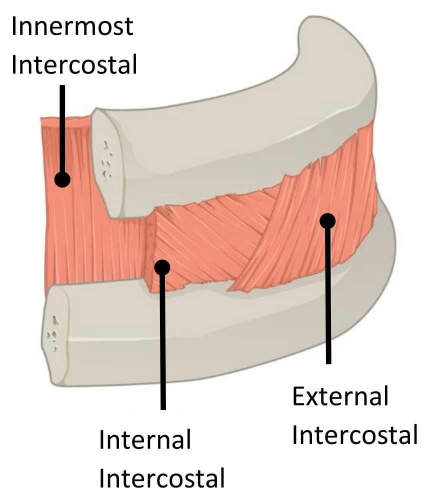
Made by Mike Tyler @MikeTylerSport

KNOWLEDGE ORGANISER — Unit 1 Anatomy & Physiology: The Respiratory System

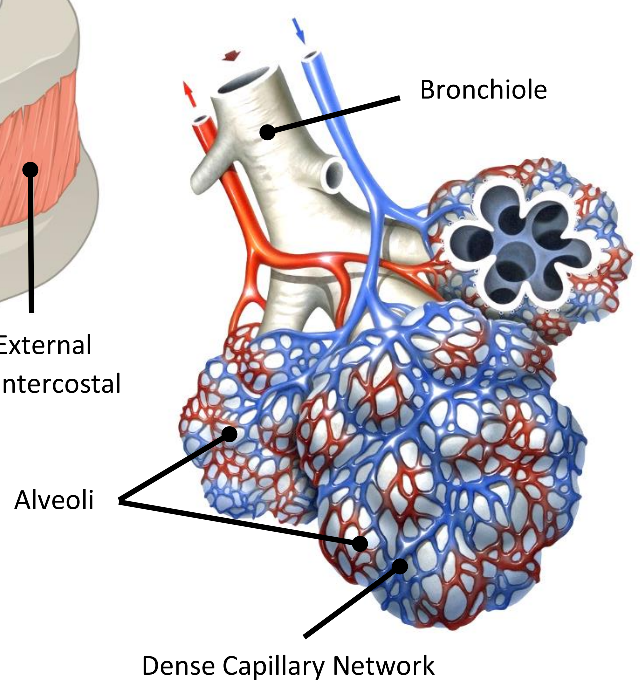
STRUCTURE



INTERCOSTAL MUSCLES



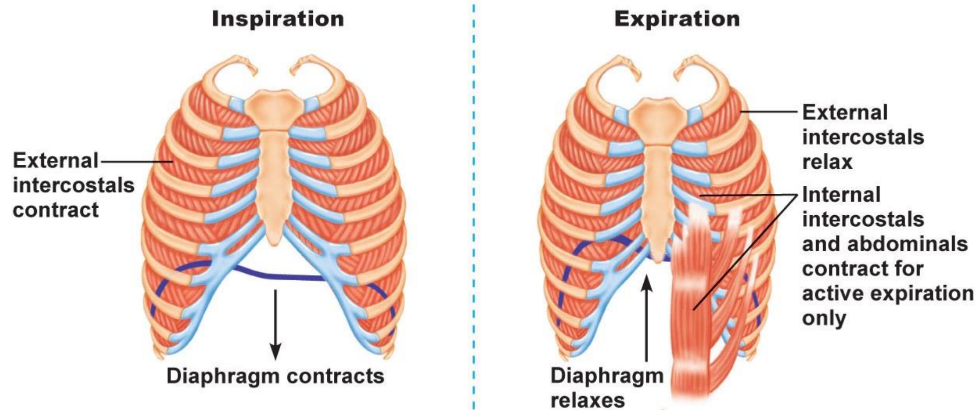
ALVEOLI



MECHANISMS OF BREATHING

	Inspiration	Expiration
Diaphragm	Contracts = Flattens	Relaxes = Domes
External Intercostals	Contract = Lifts rib cage	Relax = Rib cage drops *
Chest cavity	Increases	Decreases
Thoracic Pressure	Drops	Rises
Air flows	In	Out

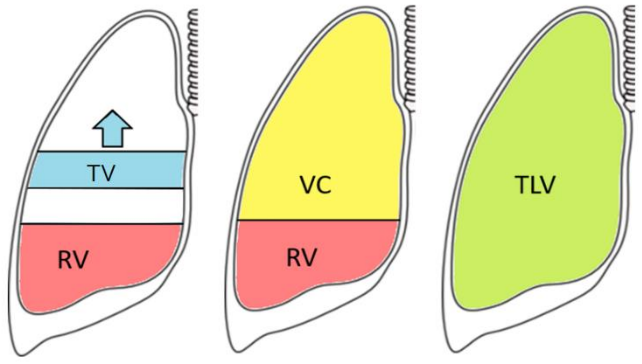
*During exercise exhalation becomes an **active** process.
The internal intercostal muscles contract to pull the rib cage down.



LUNG VOLUMES

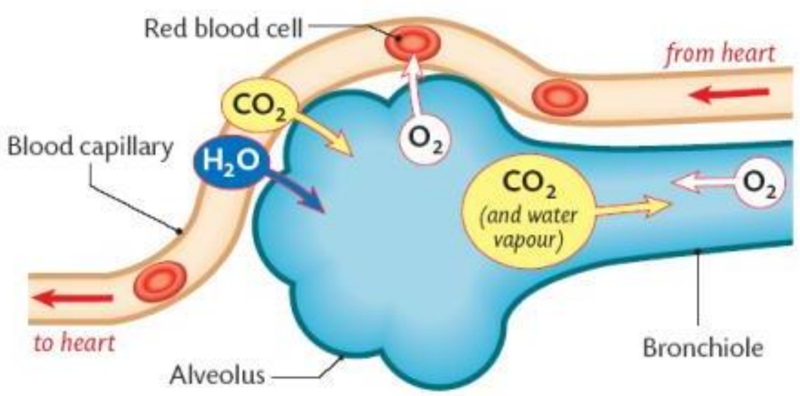
Lung Volume	Definition
Tidal Volume	Total air inhaled/exhaled in one breath under resting conditions*
Vital Capacity	Maximum amount of air that can be expired after a maximum inhalation
Residual Volume	Amount of air remaining in the lungs after a forced exhalation
Total Lung Volume	Maximum amount of air in the lungs after a maximum inspiration
Minute Ventilation (VE)	Total amount of air inhaled / exhaled per minute

*During exercise, **tidal volume** (TV) and **respiratory rate** (RR; breaths per minute) increase.
Together these increase Minute Ventilation (VE). TV x RR = VE



GASEOUS EXCHANGE

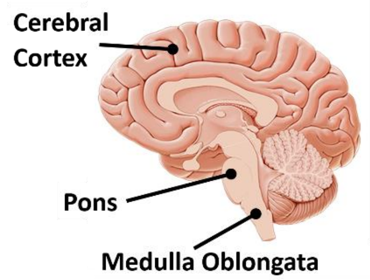
This is where the respiratory and cardiovascular systems meet.



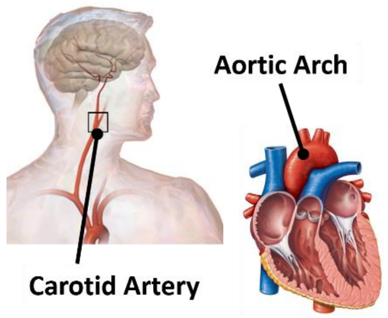
1. Inspired oxygen arrives at the alveoli
2. Oxygen dissolves in the moist alveolar membrane
3. Oxygen diffuses through the membrane
4. Each alveolus is surrounded by capillaries
5. Oxygen is taken up by the red blood cells

1. CO2 is a product of respiration
2. CO2 arrives in the blood from the body
3. CO2 dissolves at the moist membrane
4. CO2 diffuses across the thin alveolar membrane
5. CO2 is breathed out, along with water vapour

CONTROL OF BREATHING



Neural Control	Chemical Control
Involuntary Control Breathing is controlled automatically by the respiratory control centre (the Medulla Oblongata and Pons) **Voluntary Control** Breathing can be controlled voluntarily by the cerebral cortex (e.g. holding your breath or deliberately hyperventilating)	**Chemoreceptors** are located in the aorta, carotid artery & medulla oblongata. They… **Detect change in blood CO2 concentration** • Exercise means CO2 concentration goes up • Breathing rate is increased • CO2 removal speeds up **Detect change in pH (acidity)** • Exercise means blood lactate (acidic) builds up • Breathing rate is increased • Lactate breakdown speeds up



RESPONSES TO EXERCISE (Short Term)

1. Increase in breathing rate
2. Increased tidal volume

ADAPTATIONS TO EXERCISE (Long Term)

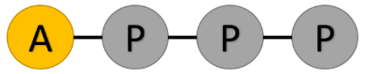
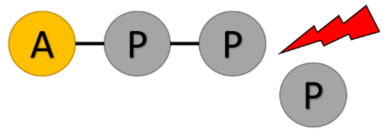
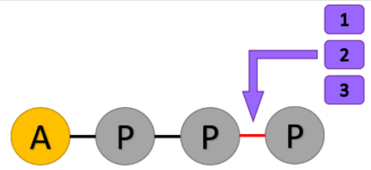
1. Increased vital capacity
2. Increased strength of the respiratory muscles
3. Increase in oxygen and carbon dioxide diffusion rates

ADDITIONAL FACTORS

1. Asthma
2. Effects of altitude/partial pressure on the respiratory system

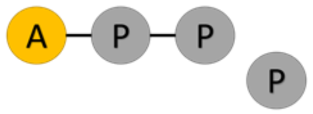
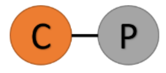
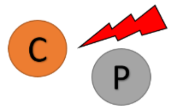
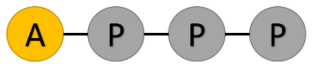
Made by Mike Tyler @MikeTylerSport

THE ROLE OF ATP IN EXERCISE

1. ATP Availability	2. ATP Structure	3. ATP Breakdown	4. ATP Resynthesis
			
ATP is stored in the muscles. It is readily available to be broken down. No other compound can be used by the body.	ATP consists of 3 phosphates attached to an Adenine group.	The final phosphate is broken off & energy is released. Energy is now available for muscular contraction. ADP is left.	Resynthesis of ATP from ADP occurs via 3 pathways. The pathway used will be determined by intensity/duration, fuel source & availability of oxygen.

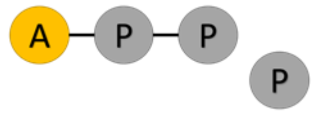
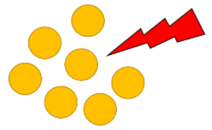
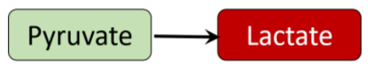
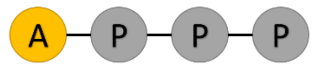
1. THE ATP-PC (ALACTIC) ENERGY SYSTEM

Type: Anaerobic
Fuel Source: Creatine Phosphate (PC)
Duration: Approx. 6-10 seconds
Recovery Time: About 3 mins
Used in: Sports requiring explosive power

1		ATP requires resynthesizing
2		Creatine Phosphate is present in the muscle cell
3		Creatine Phosphate is broken down to provide the energy required.
4		**1 PC molecule produces 1 new ATP molecule.**

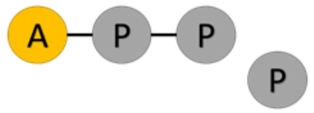
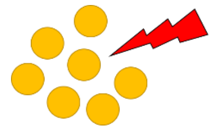
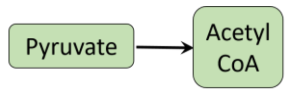
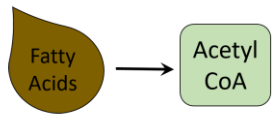
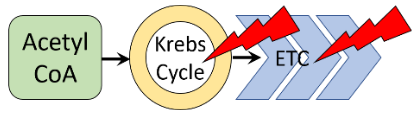
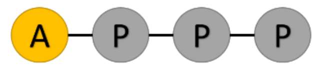
2. THE LACTATE ENERGY SYSTEM

Type: Anaerobic Glycolysis
Fuel Source: Glycogen
Duration: Approx. 10 secs to 2 mins
Recovery Time: 1-2 hours
Used in: Stop/start games, field & court sports

1		ATP requires resynthesizing
2		Glycogen is present in the muscle cell and in the liver. Glucose is present in the bloodstream
3		Glucose/Glycogen is broken down to provide the energy required. Enzymes speed up the process.
4		Pyruvate is also produced. Since no oxygen is available this is converted into lactate.
5		**1 Glycogen molecule produces 3 new ATP molecules.**

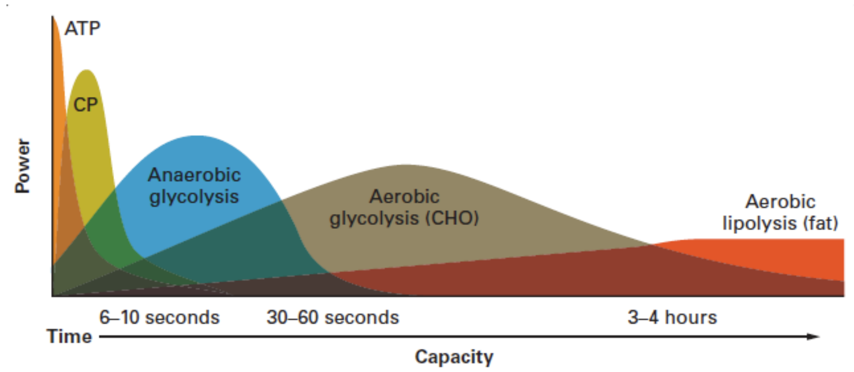
3. THE AEROBIC ENERGY SYSTEM

Type: Aerobic Glycolysis (& Lipolysis)
Fuel Source: Glycogen and Fat
Duration: Longer than 2 mins
Recovery Time: 24-48 hours
Used in: Long distance & endurance events

1		ATP requires resynthesizing
2		Glycogen is present in the muscle cell and in the liver. Glucose is present in the bloodstream
3		Glucose/Glycogen is broken down to provide the energy required. Enzymes speed up the process.
4		Pyruvate is also produced. Oxygen is available so pyruvate is broken down into Acetyl CoA
5		Or, Acetyl CoA can be created from fats by a process called beta-oxidation
6		Acetyl CoA passes through the Krebs Cycle and the Electron Transport Chain (ETC) By products include CO2, O2 and H2O. More energy is produced here.
7		**1 Glycogen molecule produces up to 38 new ATP molecules.** (But rarely achieves this yield)

ENERGY CONTINUUM

At any given time, all the energy systems are in use. The proportion is determined by intensity of demand for energy.



ADAPTATIONS TO EXERCISE (Long Term)

ATP-PC (alactic) energy system
1. Increased creatine stores.

Lactate energy system
1. Increase tolerance to lactate.

Aerobic energy system
1. Increased use of fats as an energy source.
2. Increased storage of glycogen.
3. Increased numbers of mitochondria.

ADDITIONAL FACTORS

1. Diabetes (hypoglycaemic attack)
2. Children's lack of a lactate system