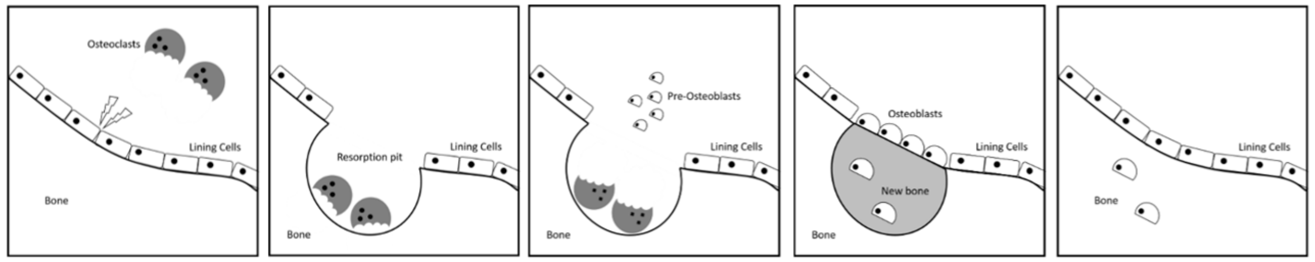
# KNOWLEDGE ORGANISER — Unit 1 Anatomy & Physiology: The Skeletal System

## 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

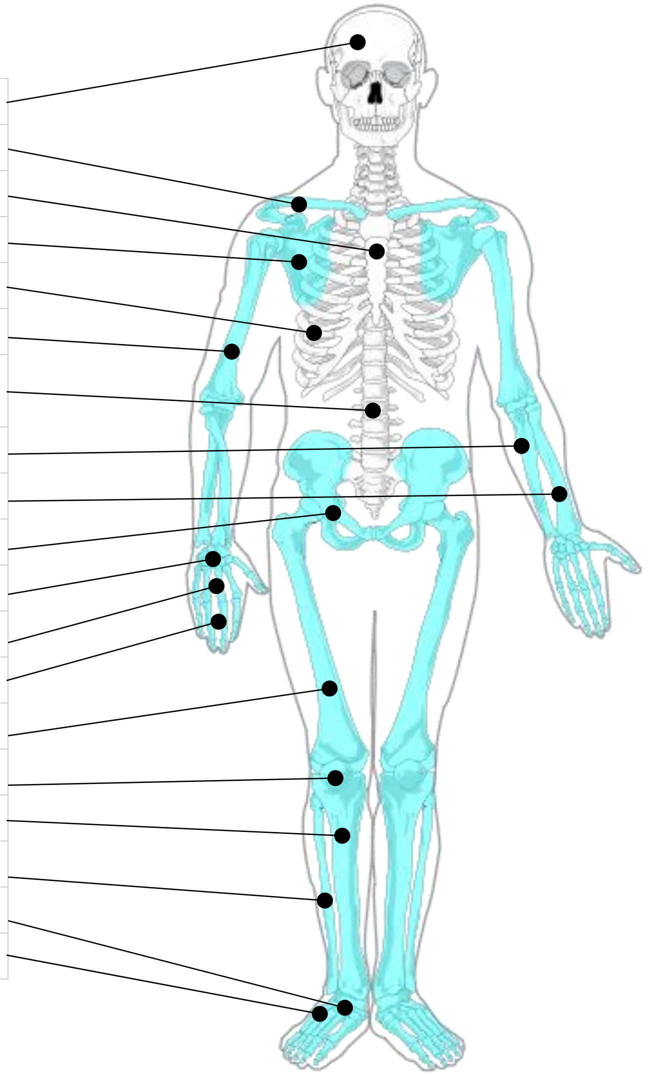



## FUNCTIONS OF THE SKELETON

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



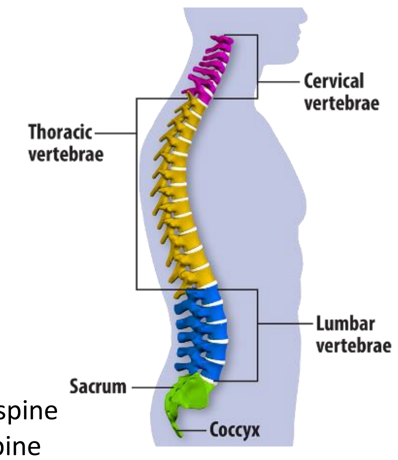
## AREAS OF THE SKELETON

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)

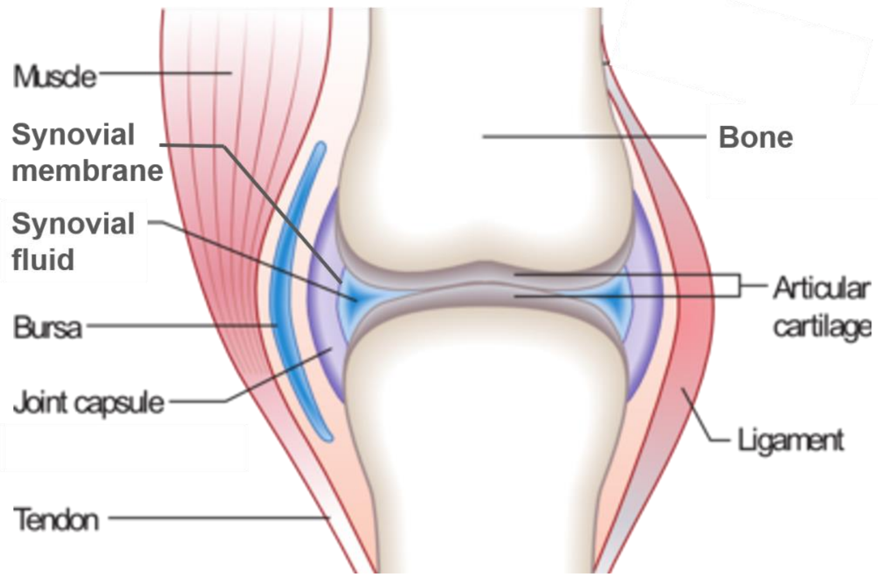
**Postural Deviations**
Kyphosis: excessive curvature of *thoracic* spine
Lordosis: excessive curvature of *lumbar* spine



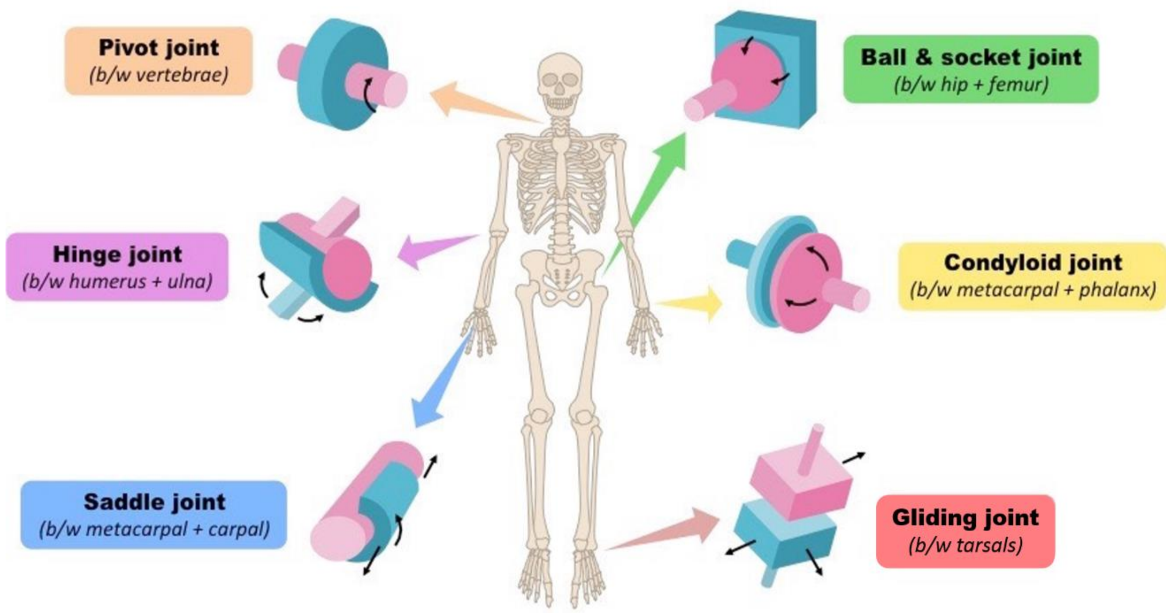

## JOINTS

**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

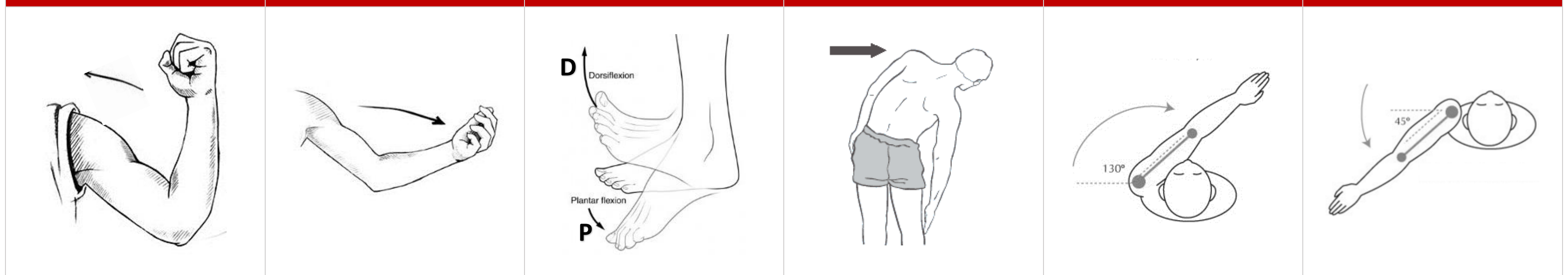
**Hip**
Illium, Pubis, Ischium, Femur
**Joint Type:** Ball & Socket

**Knee**
Femur, Tibia, Fibula
**Joint Type:** Hinge

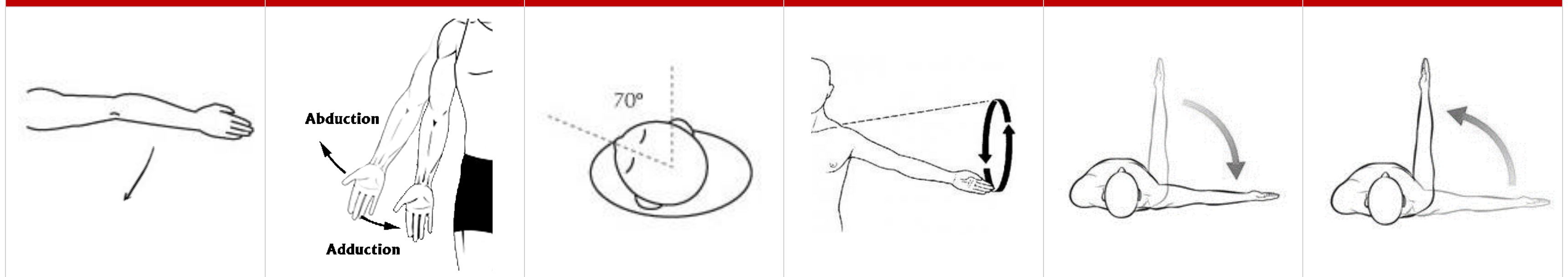
**Ankle**
Tibia, Fibula, Talus
**Joint Type:** Hinge

### Movements available in synovial joints

| Flexion | Extension | Dorsi- & Plantar-flexion | Lateral Flexion | Horizontal Flexion | Horizontal Extension |
|---|---|---|---|---|---|




| Hyperextension | Abduction & Adduction | Rotation | Circumduction | Horizontal Abduction | Horizontal Adduction |
|---|---|---|---|---|---|




## 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

**Skeletal disease:** exercise offsets the risks of arthritis, osteoporosis
**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

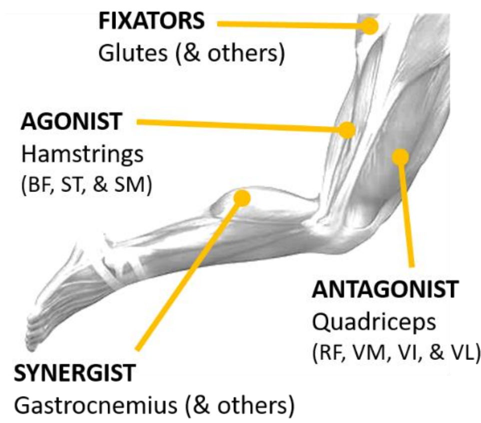
| Contraction | As muscle contracts… | Used for… |
|---|---|---|
| **Isometric** | …no change in muscle length | Static holds (e.g. iron cross) |
| **Concentric** | …muscle shortens | Movement |
| **Eccentric** | …muscle lengthens | Slowing and braking movements |

## ANTAGONISTIC PAIRS

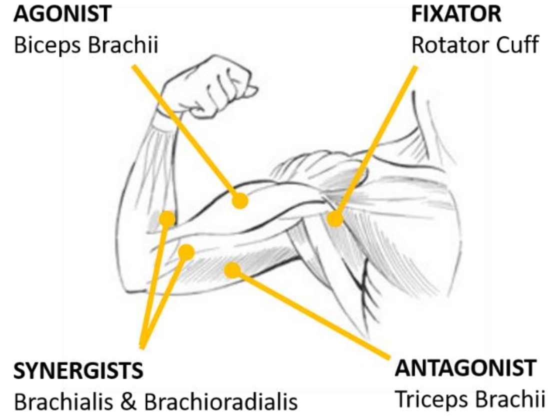
Muscles cannot push so are 'paired' with others that pull in the opposite direction.

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)

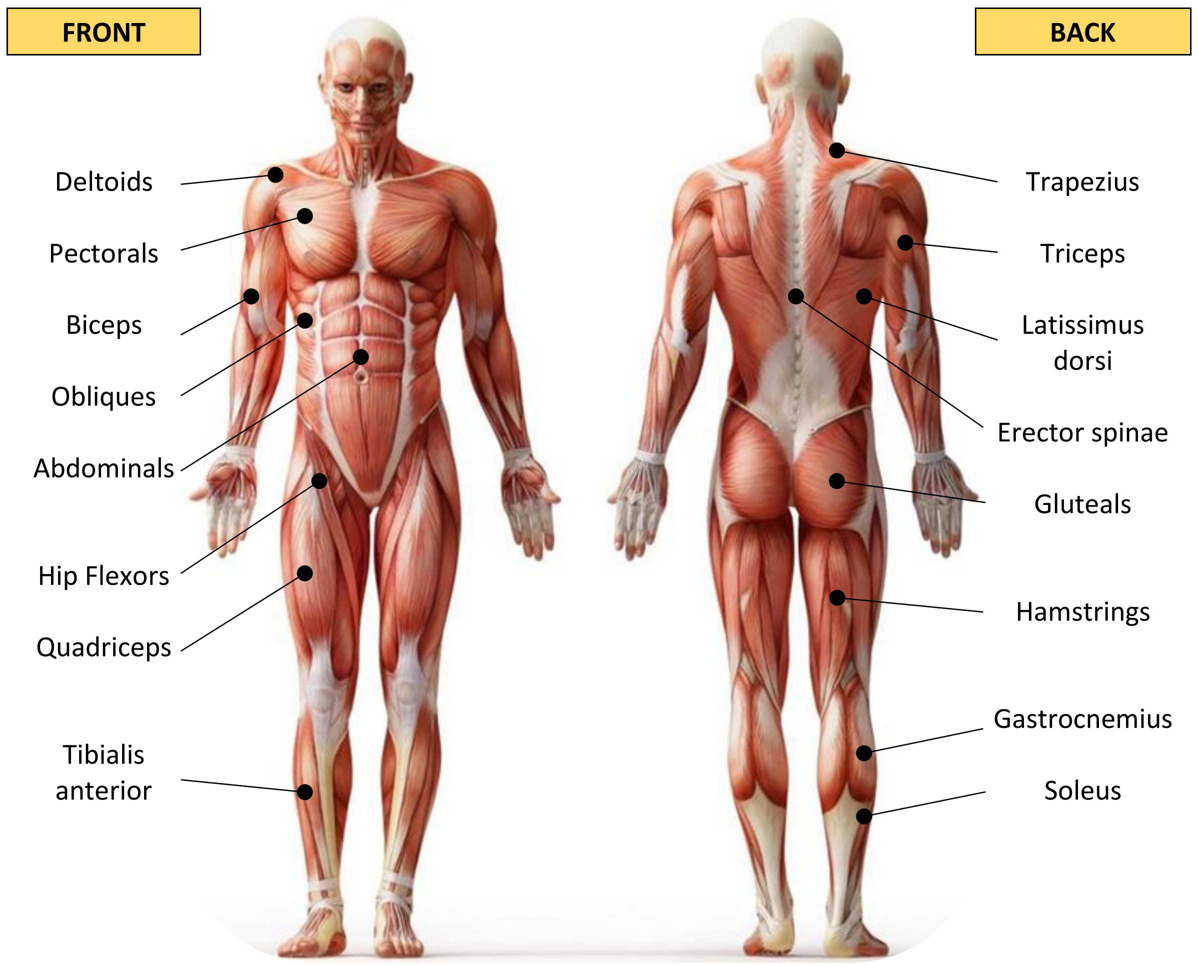
### Knee Flexion

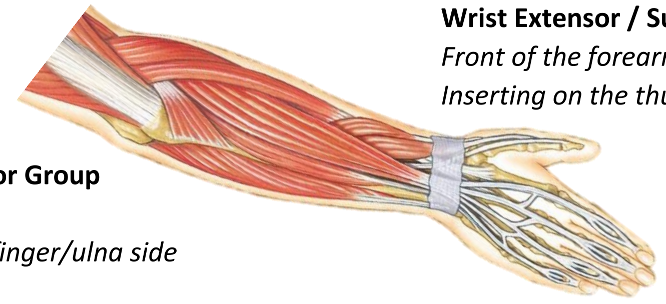



### Elbow Flexion




## MAJOR SKELETAL MUSCLES



**Wrist Extensor / Supinator Group**
*Front of the forearm.*
*Inserting on the thumb/radius side*

**Wrist Flexor / Pronator Group**
*Back of the forearm*
*Inserting on the little finger/ulna side*

## MUSCLE FIBRE TYPES

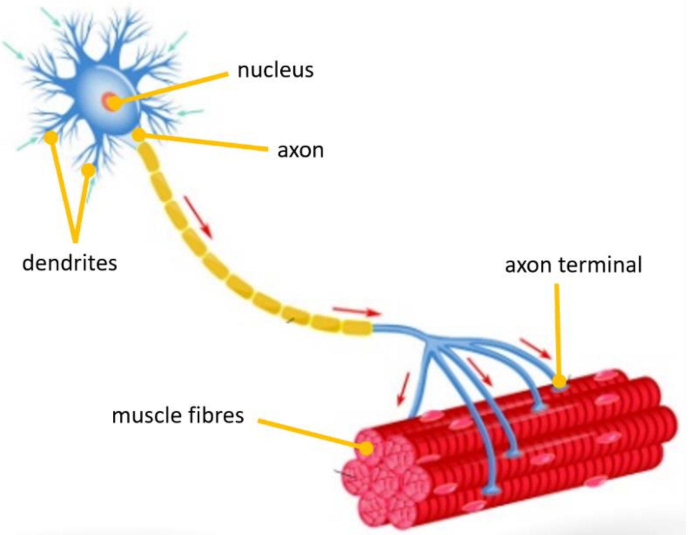
**Characteristics of different muscle fibre types**

| 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**

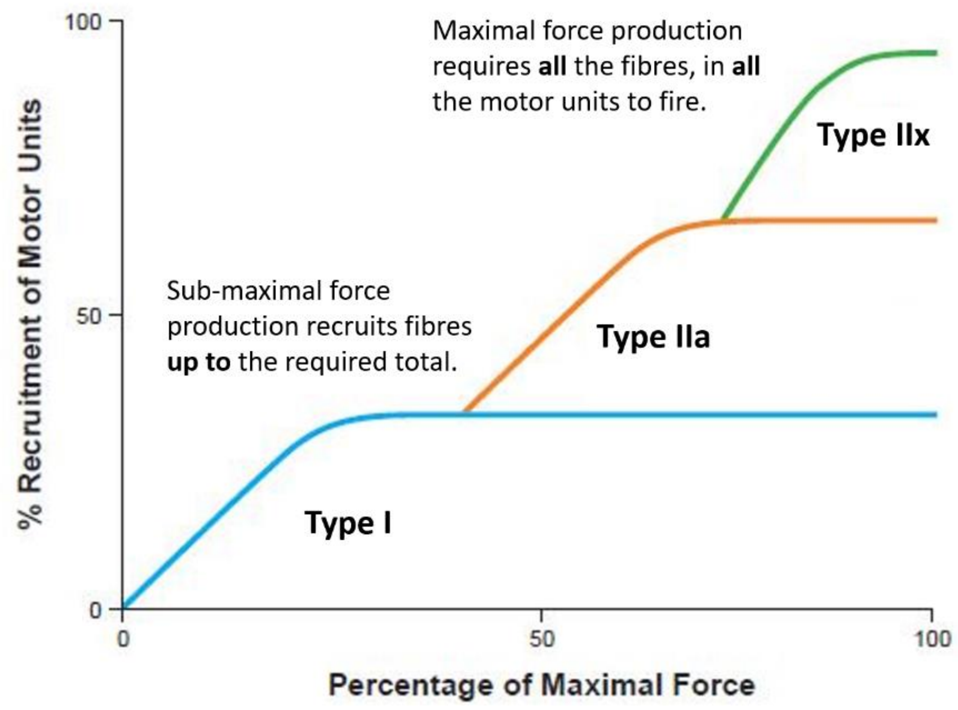
- A motor unit is a **motor neuron** and all the fibres it 'innervates'
- All the fibres in a motor unit are of the same type.
- A muscle (e.g. biceps brachii) is made up of several motor units.




- 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)

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

## ADAPTATIONS TO EXERCISE (Long Term)

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

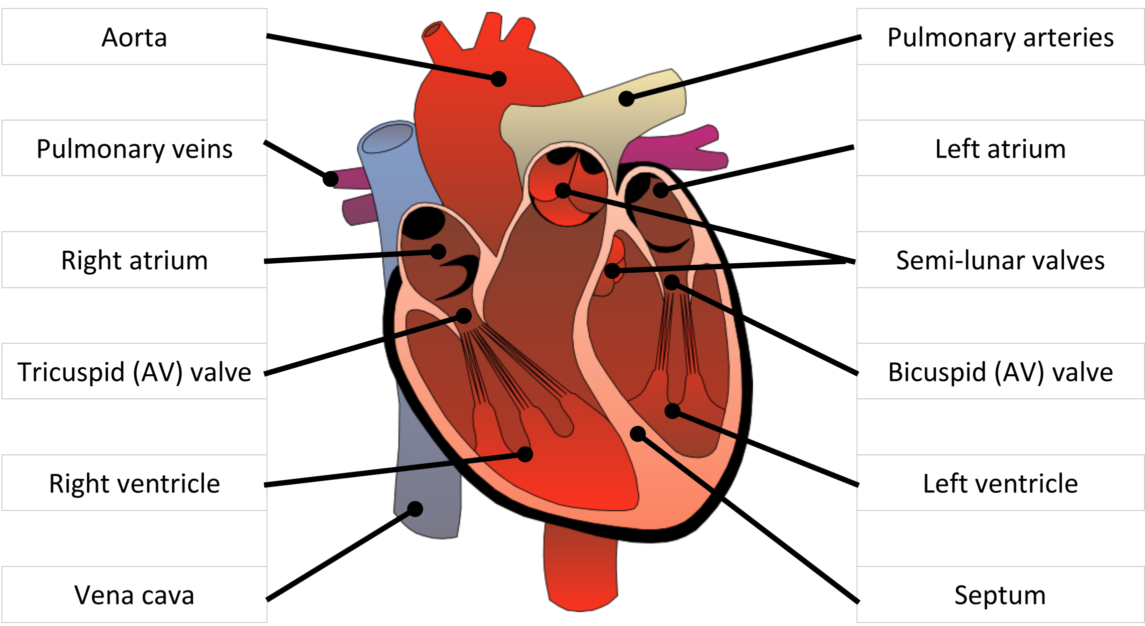
## ADDITIONAL FACTORS

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

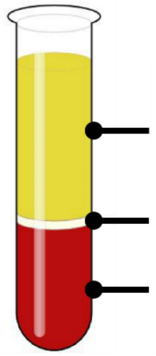
Made by Mike Tyler @MikeTylerSport

# KNOWLEDGE ORGANISER — Unit 1 Anatomy & Physiology: The Cardiovascular System

## STRUCTURE OF THE HEART




## COMPOSITION OF BLOOD

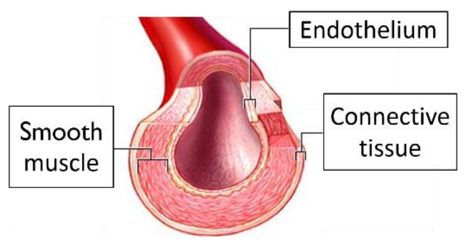


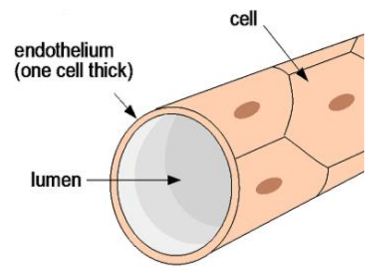

## FUNCTIONS OF THE CARDIOVASCULAR SYSTEM

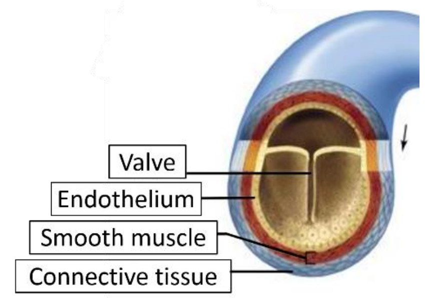
1. Delivery of oxygen and nutrients
2. Removal of waste products
3. Thermoregulation
4. Fight infection
5. Clot blood

## STRUCTURE OF BLOOD VESSELS

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



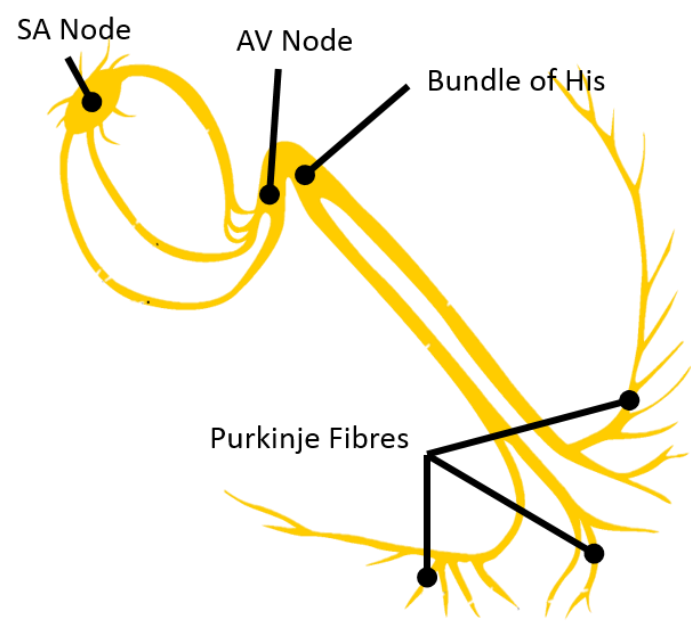




*except for pulmonary artery/pulmonary vein where this is reversed

## 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 |

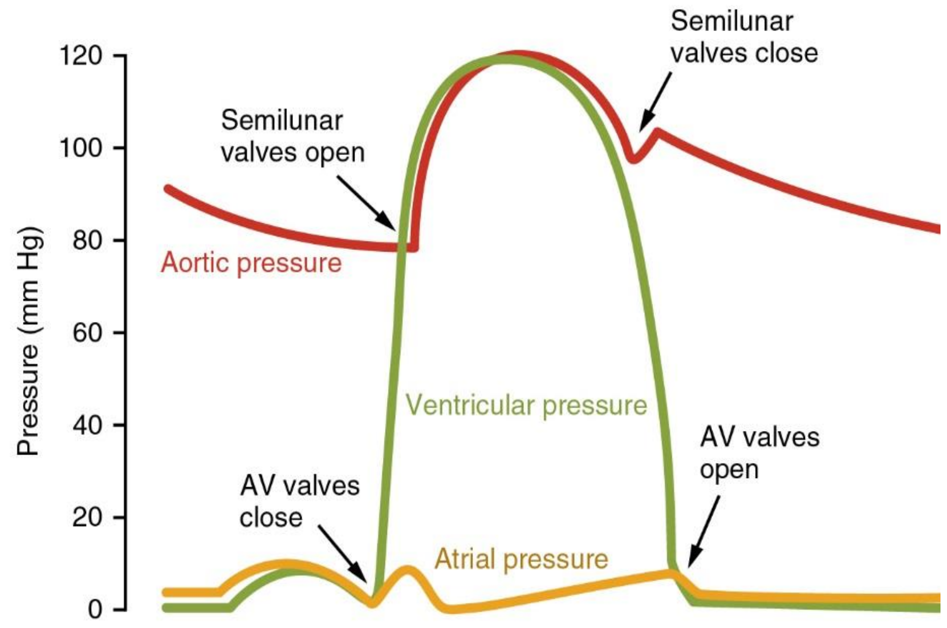
### The Cardiac Cycle

**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 | 1. Decreases Heart Rate |
| 2. Increases Heart Rate | 2. Decreases Blood Pressure |
| 3. Increases Blood Pressure | 3. Decreases Cardiac Output (Q) |
| 4. Increases contractile force of cardiac muscle | |
| 5. Stimulates vasoconstriction/vasodilation. | |

## 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

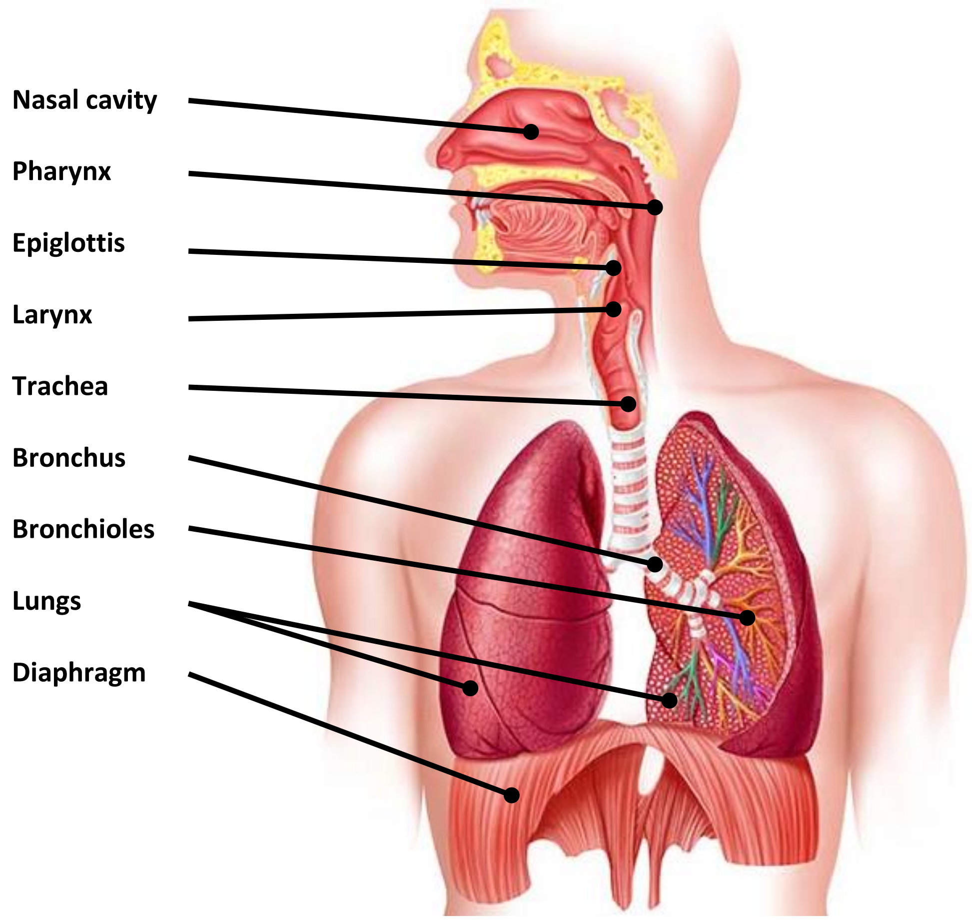
1. Sudden arrhythmic death syndrome (SADS)
2. High blood pressure / low blood pressure
3. Hyperthermia / hypothermia

Made by Mike Tyler @MikeTylerSport

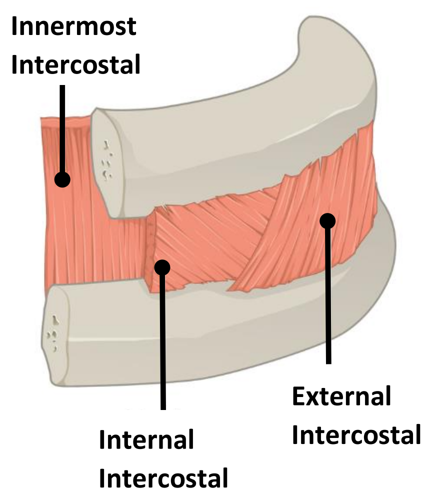
# KNOWLEDGE ORGANISER

# Unit 1 Anatomy & Physiology: The Respiratory System

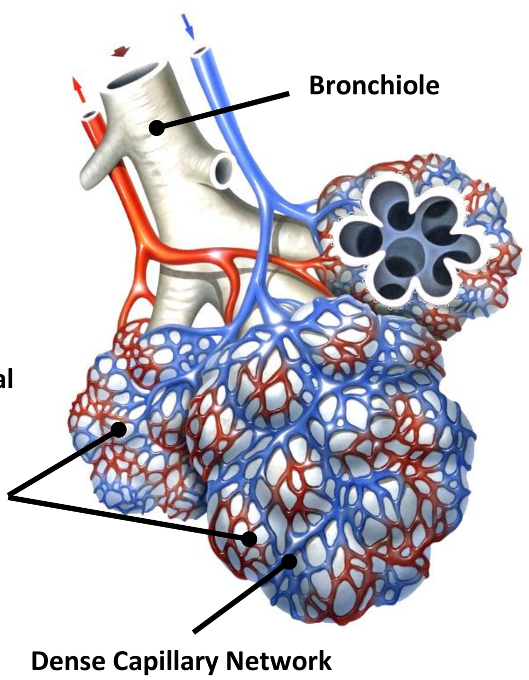
## STRUCTURE




### INTERCOSTAL MUSCLES



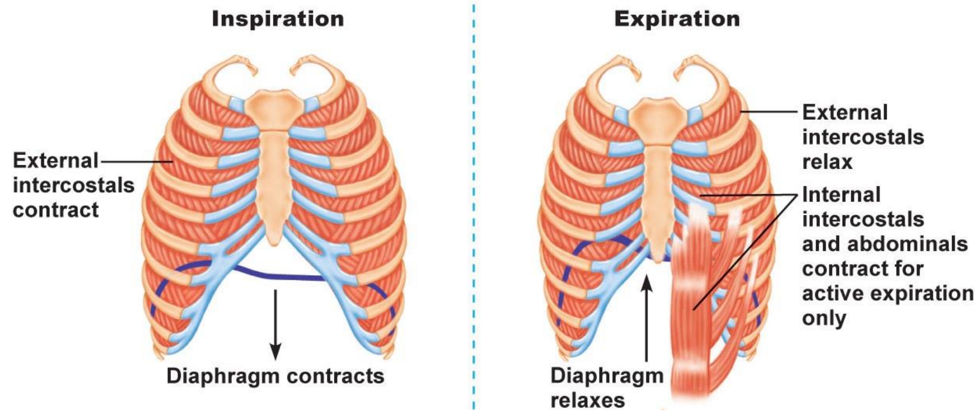

### ALVEOLI




## 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 |

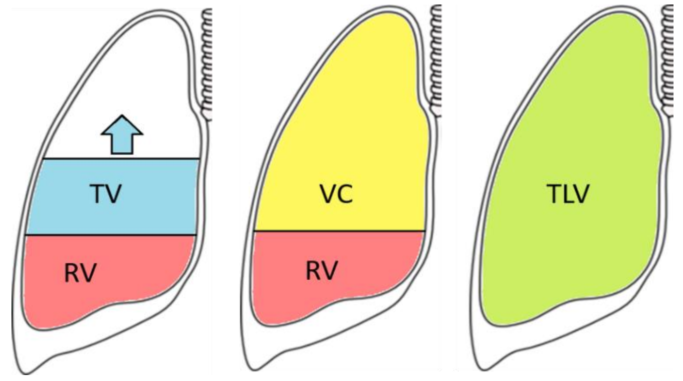
*During exercise exhalation becomes an **active** process.
The internal intercostal muscles contract to pull the rib cage down.




## LUNG VOLUMES

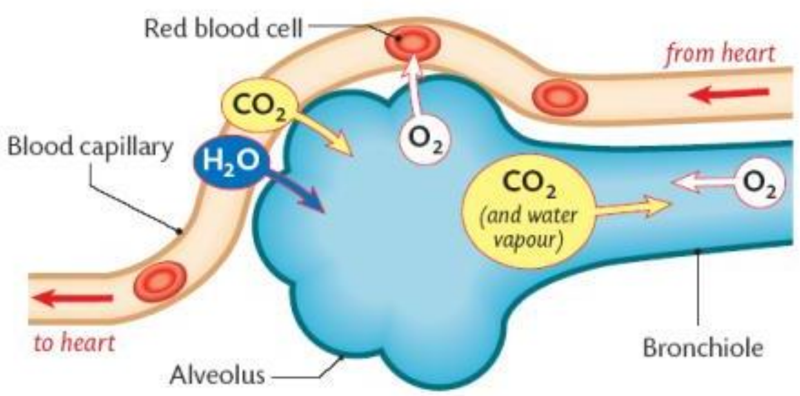
| Lung Volume | Definition |
|---|---|
| **Tidal Volume** | Total air inhaled/exhaled in one breath under resting conditions* |
| **Vital Capacity** | Maximum amount of air that can be expired after a maximum inhalation |
| **Residual Volume** | Amount of air remaining in the lungs after a forced exhalation |
| **Total Lung Volume** | Maximum amount of air in the lungs after a maximum inspiration |
| **Pulmonary 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 Pulmonary Ventilation (VE). TV x RR = VE




## GASEOUS EXCHANGE

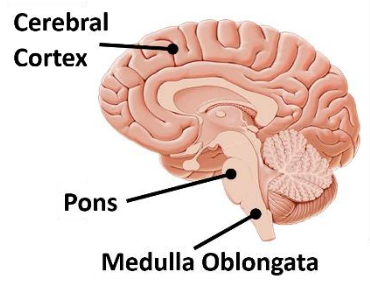
This is where the respiratory and cardiovascular systems meet.



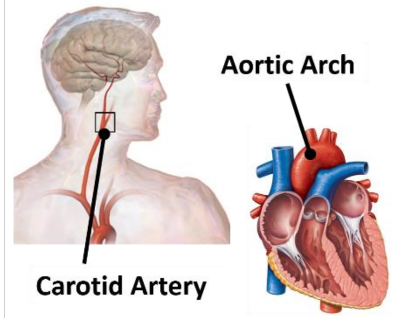

1. Inspired oxygen arrives at the alveoli
2. Oxygen dissolves in the moist alveolar membrane
3. Oxygen diffuses through the membrane
4. Each alveolus is surrounded by capillaries
5. Oxygen is taken up by the red blood cells

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**<br>Breathing is controlled automatically by the respiratory control centre (the Medulla Oblongata and Pons)<br><br>**Voluntary Control**<br>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…<br><br>**Detect change in blood CO2 concentration**<br>• Exercise means CO2 concentration goes up<br>• Breathing rate is increased<br>• CO2 removal speeds up<br><br>**Detect change in pH (acidity)**<br>• Exercise means blood lactate (acidic) builds up<br>• Breathing rate is increased<br>• Lactate breakdown speeds up |




## RESPONSES TO EXERCISE (Short Term)

6. Increase in breathing rate
7. Increased tidal volume

## ADAPTATIONS TO EXERCISE (Long Term)

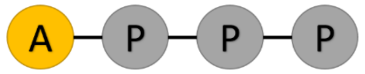
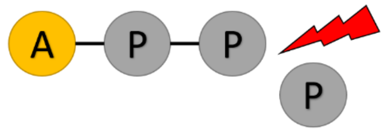
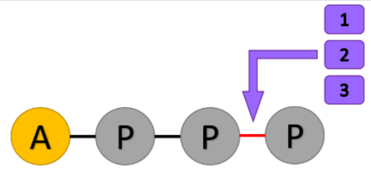
8. Increased vital capacity
9. Increased strength of the respiratory muscles
10. Increase in oxygen and carbon dioxide diffusion rates

## ADDITIONAL FACTORS

4. Asthma
5. Effects of altitude/partial pressure on the respiratory system

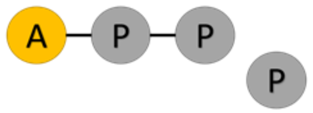
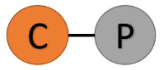
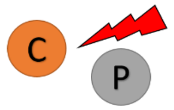
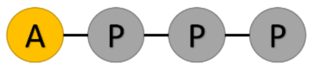
Made by Mike Tyler @MikeTylerSport

## THE ROLE OF ATP IN EXERCISE

| 1. ATP Availability | 2. ATP Structure | 3. ATP Breakdown | 4. ATP Resynthesis |
|---|---|---|---|
|  |  |  |  |
| ATP is stored in the muscles.<br>It is readily available to be broken down.<br>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.<br>Energy is now available for muscular contraction.<br>ADP is left. | Resynthesis of ATP from ADP occurs via 3 pathways.<br>The pathway used will be determined by intensity/duration, fuel source & availability of oxygen. |

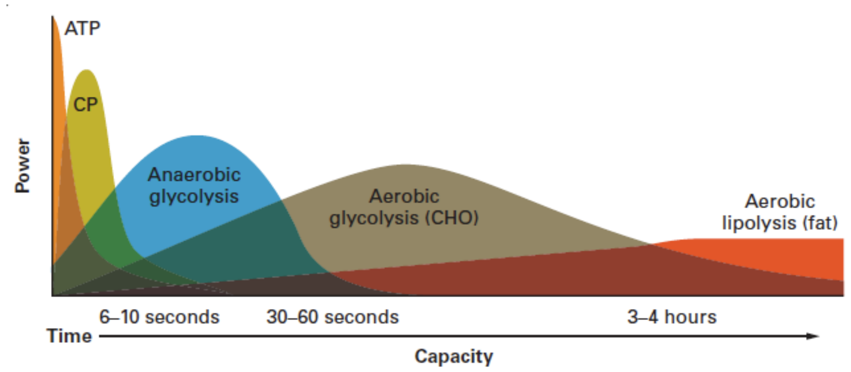
## 1. THE ATP-PC (ALACTIC) ENERGY SYSTEM

**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.** |

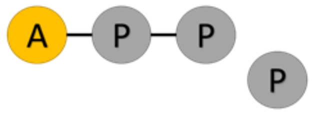
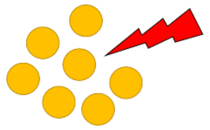
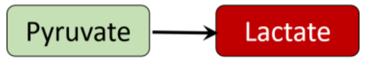
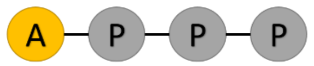
## ENERGY CONTINUUM

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




## 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.<br>Glucose is present in the bloodstream |
| 3 |  | Glucose/Glycogen is broken down to provide the energy required.<br>Enzymes speed up the process. |
| 4 |  | Pyruvate is also produced.<br>Since no oxygen is available this is converted into lactate. |
| 5 |  | **1 Glycogen molecule produces 3 new ATP molecules.** |

## ADAPTATIONS TO EXERCISE (Long Term)

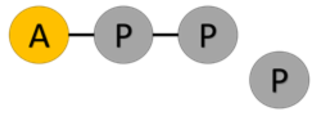
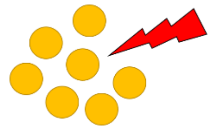
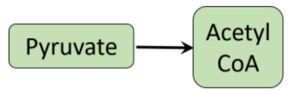
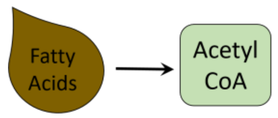
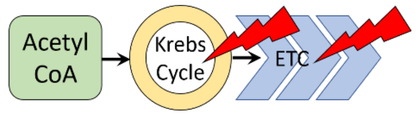
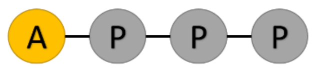
**ATP-PC (alactic) energy system**
1. Increased creatine stores.

**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.

## 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.<br>Glucose is present in the bloodstream |
| 3 |  | Glucose/Glycogen is broken down to provide the energy required.<br>Enzymes speed up the process. |
| 4 |  | Pyruvate is also produced.<br>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)<br>By products include CO2, O2 and H2O.<br>More energy is produced here. |
| 7 |  | **1 Glycogen molecule produces about 34 new ATP molecules.** |

## ADDITIONAL FACTORS

6. Diabetes (hypoglycaemic attack)
7. Children's lack of a lactate system

Made by Mike Tyler @MikeTylerSport