The onset & rate of development of *fatigue* depends on the:

- **Type** of activity being undertaken
- Muscle **fibre type** being used
- Type of muscular contraction occurring:
  - *Isotonic*
  - *Isometric*
  - *Isokinetic*
- **Intensity & duration** of the activity being undertaken
- Level of fitness or training adaptations possessed by the individual
Fatigue is multifactorial—many factors contribute to fatigue, with one contributing more to decrements in performance than the others.

Fatigue is caused by one or more of the following events:

- Fuel Depletion
- Accumulation of metabolic by-products
- Neuromuscular interruption
- Elevated body temperature
Fuel Depletion

- When working at **maximal intensity**, depletion of **ATP** and then **PC** are the most common causes of fatigue.

- **Glycogen depletion** becomes a significant fatiguing factor for events lasting over one hour. (e.g. Football)

- **Muscle glycogen** is used first, then glycogen stored at the liver. Once this runs low, the muscles look to **blood-borne fats** and then **stored fats** as fuel sources.

- The rate at which energy is produced **decreases** markedly when the body switches over to fats as the major fuel source.

- Players often consume **sports drinks** during competition which are rich in dissolved carbohydrates to “top up” their glucose level.
Metabolic by-products refer to H+ ions in plasma and muscle.

- Most sports scientists agree that performance decrements associated with blood lactate accumulation is due to an increase in hydrogen ions.
- Hydrogen ions, not lactate, makes the muscle acidic, which leads to decreased muscle function.
- The acidic environment will slow down enzyme activity and ultimately the availability of glucose and the need to switch to fats.
Majak Daw of the North Melbourne Kangaroos regains his breath after running his time trial during the Roos pre season training session in 2011.

- During the last stages of the time trail players work about their lactate threshold / lactate inflection point, which sees rapid accumulation of H+ ions

*These cause fatigue by:*
- Interfering with *glycolytic enzymes* and thus reducing availability of glucose as a fuel
- Blocking the nerve signals from the brain to muscles
- Reducing *myosin ATPase activity* and slowing muscle cross bridge recycling
Active recovery: performing the same training/competition activity at low (30-40% max) intensity.

- An active recovery is **twice as fast** as a passive recovery at **removing H+ ions** – in fact, active recoveries see H+ ions removed in **30-60 mins** compared to **60-120 mins** for passive recoveries.

- Prevent **venous pooling/promote blood flow** to and from working muscles

- Keep oxygen levels in the vascular system higher than experienced with passive recoveries assisting oxidation & removal of H+ ions

- Extend **EPOC / oxygen debt** to facilitate removal of metabolic by-products

- Associated with reduced muscle spasms and stiffness

- Reduce the severity of **DOMS**
Neuromuscular Factors

When the brain detects fatigue, it sends weaker signals to working muscles in an effort to reduce intensity and slow down the work rate of muscles as a means of self-protection.

Neuromuscular factors of fatigue;

• Less electrical stimulation = less forceful and less frequent muscle contractions

• Nerve fibres don’t connect directly to muscles - there is a gap (neuromuscular junction) across which a neurotransmitter substance (Ach) travels.

• As the intensity of exercise increases, a point is reached where Ach release slows down. This means there is less electrical stimulation crossing the gap – and less muscle stimulation, too.

• The muscles will contract less forcefully (and in some cases, not at all) if the Ach is not given sufficient time to rebuild.
Elevated body temperature: As core temperature rises, sweat rates increase and blood is sent away from working muscles to the skin’s surface in an effort to maximize evaporative cooling caused by sweat.

- This leads to less blood, oxygen and fuels flowing to working muscles

- Increased sweat rates cause decreases in blood plasma volumes; to counteract this, the heart rate and cardiac output both increase to maintain the blood supply to working muscles
Ted Richards takes a drink during a Sydney Swans training session in the Kurnell sand dunes at Wanda Reserve in Sydney, 2010

**Why is it important to hydrate during training, rather than waiting for it to finish?**

- Drinking cooled water and sports drinks can assist reducing core body temperatures

- **Hypotonic drinks** are absorbed by the body quicker than water

- **Hypertonic drinks** are absorbed slower than water but are high in carbohydrates

- **Sports drinks** containing **electrolytes** importantly replace sodium and potassium which are vital to neural transmission and muscle stimulation
Former Port Adelaide coach Matthew Primus addresses his players in a **cool room** at quarter time during the AFL Round 16 match between the Western Bulldogs and Port Adelaide Power.

- Counters elevated body temperatures.
- Body returns to **“normal core temperatures”** at a faster rate.
- Muscle function is **less impaired**
- Less blood is transported away from working muscles
Ice is often used by players to cool their bodies and ice-vests are quite commonly worn during breaks in play when temperatures are above 25 degrees Celsius.

Ice is used during recovery to:

- Decrease blood flow to area being iced
- Reduce muscle damage and reduce inflammation
- Reduce muscle spasms
- Lessen the loss of force generation due to inflammation
- Provide an analgesic effect and thus reduce perceptions of pain
Compression garments are very useful when worn after training or competition and assist recovery by:

- Reducing **venous pooling**

- Increasing blood flow via a muscle pump and thus improved delivery of oxygen and nutrients & waste removal

- Reducing **muscle oedema**

- Reducing the severity of **DOMS**
Massage assists recovery by;

- **Promoting blood flow** to working muscles which carries **oxygen and nutrients**.
- Removal of metabolic by-products.
- Decreasing athlete’s perception of **tightness, pain & fatigue**.
- Decreasing muscle **oedema**
- Reducing the impact of **DOMS**
- Increasing the **joint range of motion**
AFL players often complete *pool / beach* recovery sessions following their matches.

- Water / *hydrostatic pressure* creates an inward and upward displacement of body fluids which creates a form of compression

- *The compression effect improves recovery by:*
  - Increasing blood flow and supply of nutrients to working muscles
  - Increasing removal rates of waste products from muscles
  - Squeezing capillaries around injured sites - thus minimising cellular damage