

This is the **Higher Separate** version — includes all Higher Tier content (marked ★) and all Separate Science content.

During exercise, the body adjusts several physiological processes to meet the increased energy demands of working muscles.

**Required Practical: Investigating the effect of exercise on pulse rate and breathing rate — record before, during and after exercise. Repeat at different intensities.**

- Heart rate increases: delivers more O<sub>2</sub> and glucose to muscles via blood, and removes CO<sub>2</sub> and lactic acid faster.
  - Breathing rate and depth increase: takes in more O<sub>2</sub> and removes more CO<sub>2</sub>.
  - Vasodilation of blood vessels supplying muscles: increases blood flow to working muscles.
  - At low-moderate intensity: aerobic respiration meets energy demands.
  - At high intensity: aerobic respiration cannot supply O<sub>2</sub> fast enough → muscles switch to anaerobic respiration → lactic acid builds up.
  - After exercise: heart rate and breathing rate remain elevated until oxygen debt is repaid and lactic acid is broken down.
- ★ **HT Fitter individuals:** recover faster (return to resting heart rate more quickly), have lower resting heart rate, larger stroke volume (cardiac output same at lower heart rate).

### Key Terms

<b>Vasodilation</b>	Widening of blood vessels — increases blood flow to muscles during exercise
<b>Stroke volume</b>	Volume of blood pumped per heartbeat — increases with fitness
<b>Cardiac output</b>	Volume of blood pumped per minute = heart rate × stroke volume

■ **Exam Tip:** When asked to explain why heart rate increases during exercise: 1) muscles use more O<sub>2</sub> for respiration; 2) CO<sub>2</sub> and lactic acid build up; 3) heart rate increases to deliver more O<sub>2</sub> and remove CO<sub>2</sub>/lactic acid faster. Give the REASON, not just the observation.