

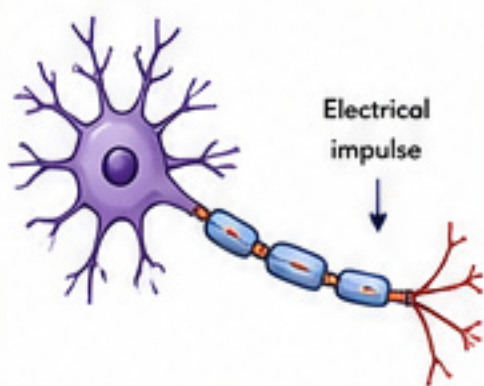
- CNS integrates information and coordinates responses
- PNS = **somatic** (voluntary) and **autonomic** (involuntary)
- Endocrine system: hormones travel in blood
- Negative feedback is the main control mechanism
- Coordination enables rapid and long-term regulation
- ANS: sympathetic (fight or flight) vs parasympathetic (rest & digest)

1. THE COMMUNICATION SYSTEMS

The body uses two systems to communicate.

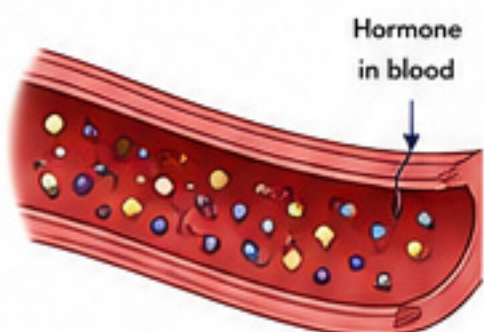
NERVOUS SYSTEM (FAST)

- Electrical impulses travel along neurones
- Very rapid responses (milliseconds)
- Short-lived effects
- Precise and localised



ENDOCRINE SYSTEM (SLOWER)

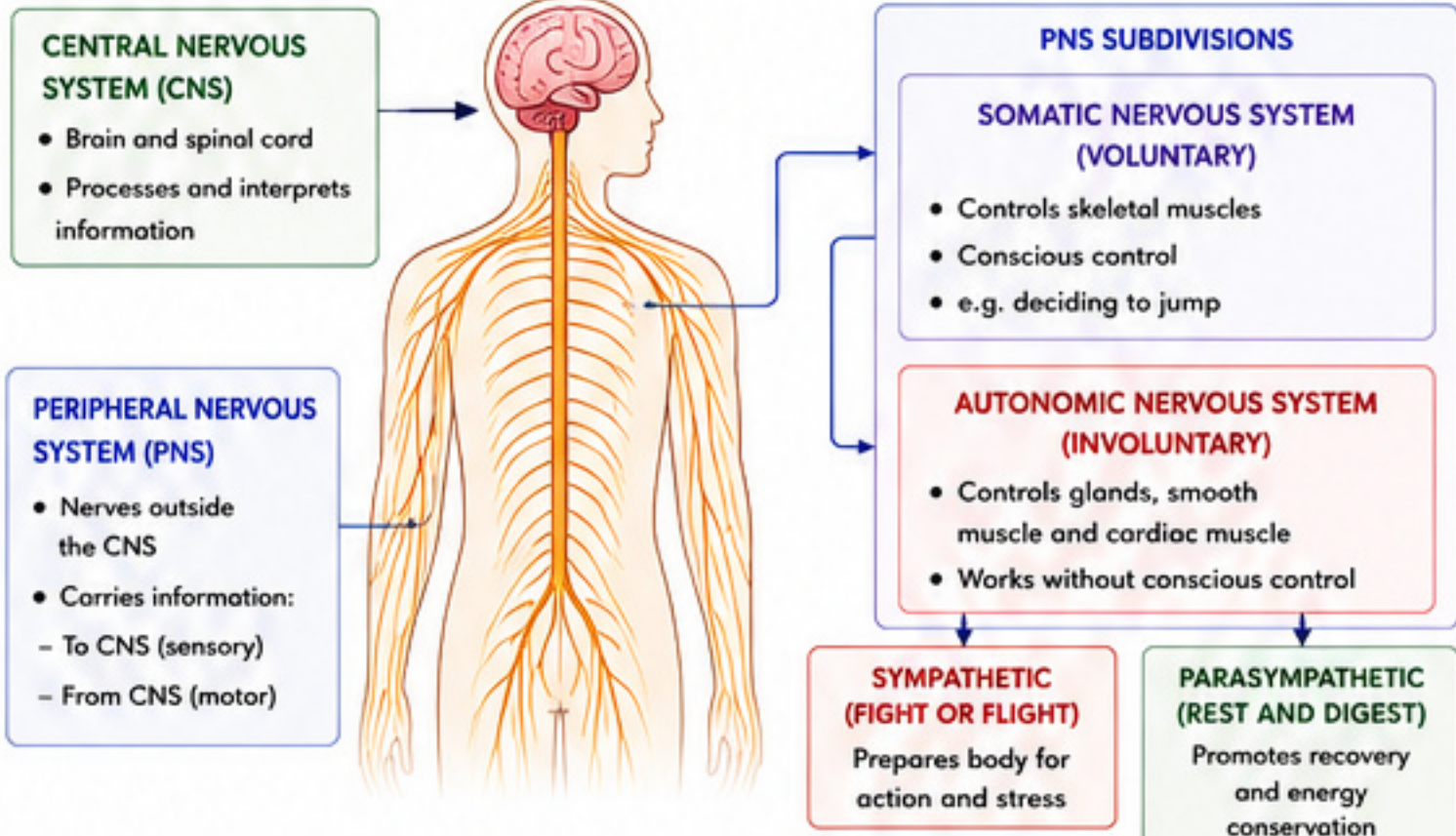
- Hormones released from endocrine glands
- Travel in bloodstream
- Slower responses (seconds to days)
- Longer-lasting effects
- Widespread actions



★ Both systems work together to maintain homeostasis.

2. OVERVIEW OF THE NERVOUS SYSTEM

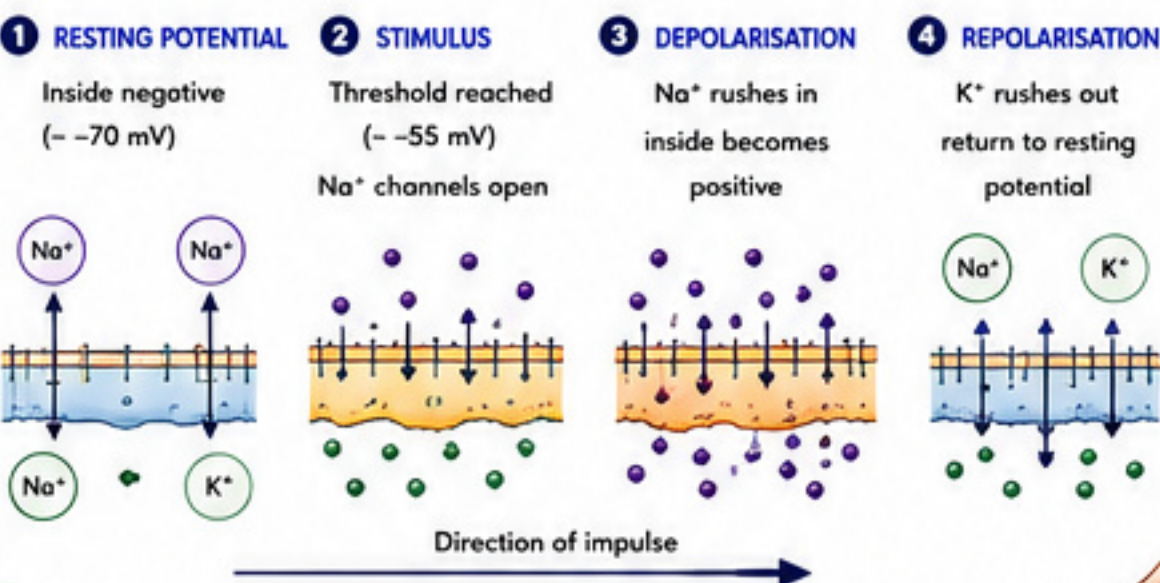
The nervous system is divided into the central and peripheral systems.



★ The PNS links the CNS to the body and has two main pathways.

3. HOW A NERVE IMPULSE TRAVELS

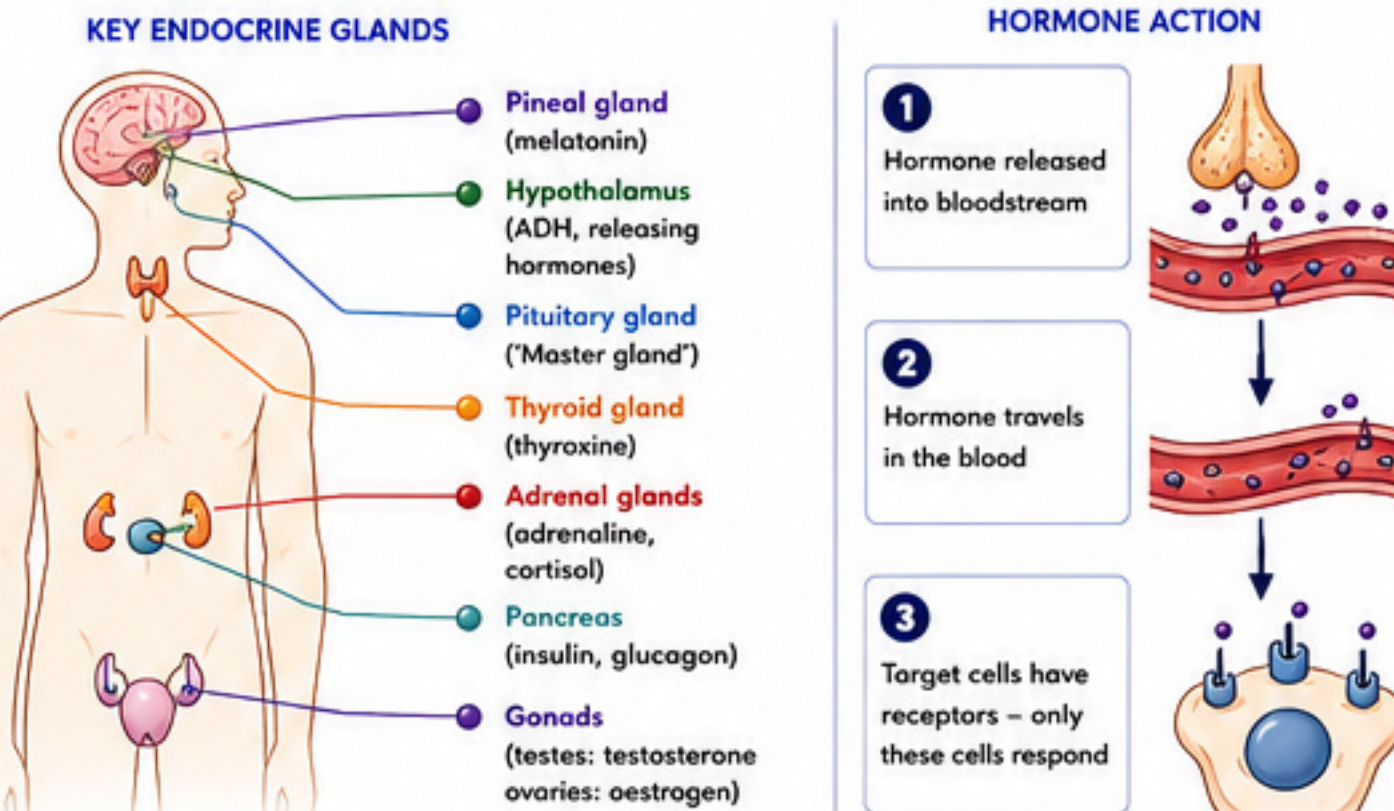
Electrical impulses are transmitted along neurones to send messages quickly.



★ Myelin increases the speed of impulse conduction.

4. OVERVIEW OF THE ENDOCRINE SYSTEM

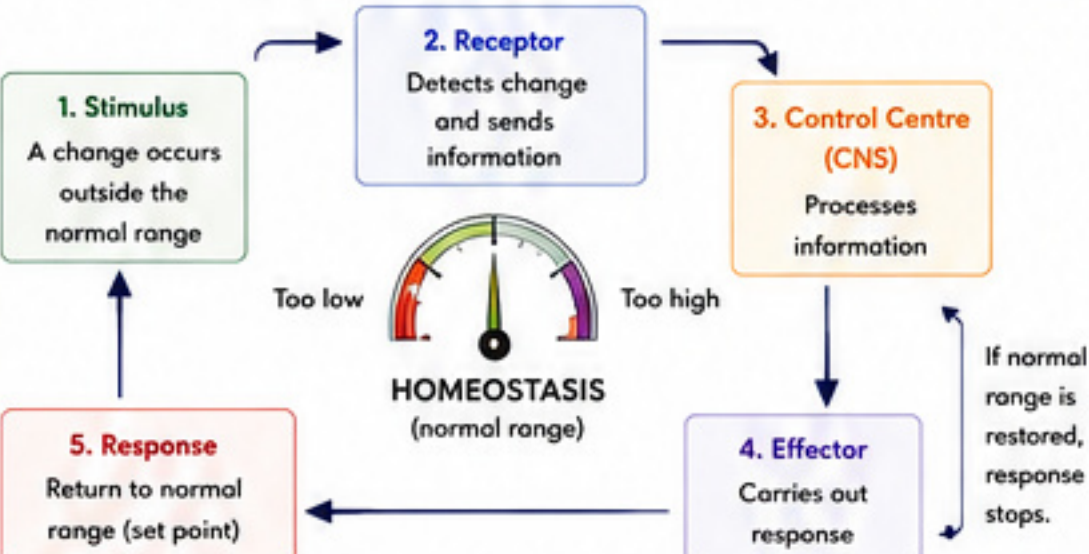
Hormones are chemical messengers released into the blood.



★ Hormones act on target cells with specific receptors.

5. NEGATIVE FEEDBACK – MAINTAINING HOMEOSTASIS

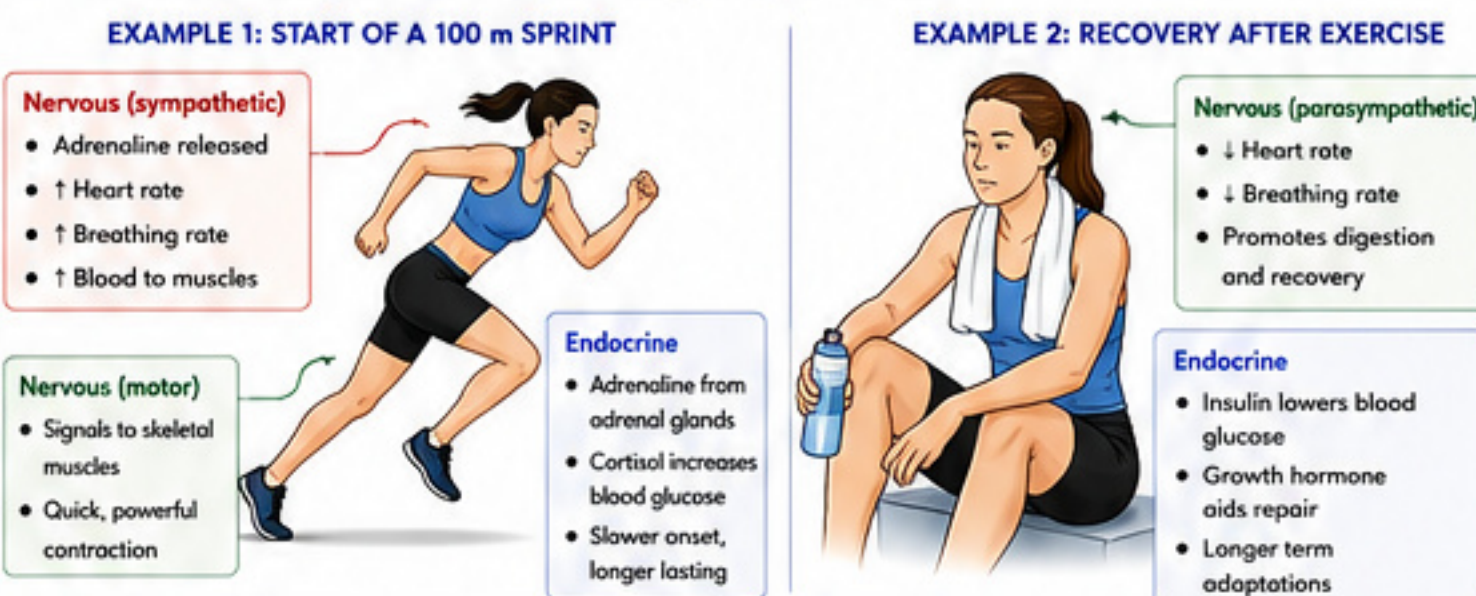
Most body control is by negative feedback loops.



★ Negative feedback keeps internal conditions within narrow limits.

6. EXAMPLES OF COORDINATION IN SPORT

Nervous and endocrine systems work together to optimise performance.



★ Effective coordination allows rapid responses and long-term adaptation.

SPORT APPLICATION

- Good coordination improves performance and safety.
- Maintains homeostasis – keeps temperature, fluids and energy stable during activity.
- Recovery and adaptation – enables training adaptations and reduces fatigue over time.

DO NOT OVERLEARN

You are not required to know:

- Names of all hormones
- Exact hormone concentrations
- Detailed structure of neurones
- All pathways of the ANS
- Drug effects on hormones
- Disorders of glands
- Hormone half-lives

KEY LINKS

- Links to A.1.2 (Intra-system communication) – communication within systems.
- Links to A.2.1 (Water & electrolyte balance) – ADH is an endocrine hormone controlling water.
- Links to A.2.2 (Energy systems) – adrenaline & insulin regulate energy availability.
- Links to A.3 (Cardiovascular, Respiratory, Muscular) – all under nervous & endocrine control.

QUICK CHECK

1. Name the two main systems that communicate within the body.
2. Differentiate between the somatic and autonomic nervous systems.
3. What is the difference between the sympathetic and parasympathetic divisions?
4. Describe the steps of a negative feedback loop.
5. Give one sporting example where both nervous and endocrine systems are involved.



A.1.2 INTRA-SYSTEM COMMUNICATION

Organ systems working together

GUIDING QUESTION: How do organ systems work together within the body to support performance and homeostasis?

★ EXAM PRIORITY – MUST KNOW

- Organ systems are interdependent
- Systems communicate via nervous and endocrine pathways
- Feedback loops maintain homeostasis
- Integration ensures efficient performance and survival
- Examples: thermoregulation, blood glucose regulation, fight or flight response

1. ORGAN SYSTEMS – WORKING TOGETHER

Major body systems interact continuously to maintain homeostasis and support performance.

NERVOUS SYSTEM	ENDOCRINE SYSTEM	CARDIOVASCULAR SYSTEM	RESPIRATORY SYSTEM	MUSCULAR SYSTEM	EXCRETORY SYSTEM
					
Fast communication (rapid responses)	Chemical messengers (hormones) (slower, longer-lasting)	Transports O ₂ , nutrients, hormones and removes waste	Gas exchange: O ₂ in, CO ₂ out	Produces movement and heat	Removes metabolic waste and excess water

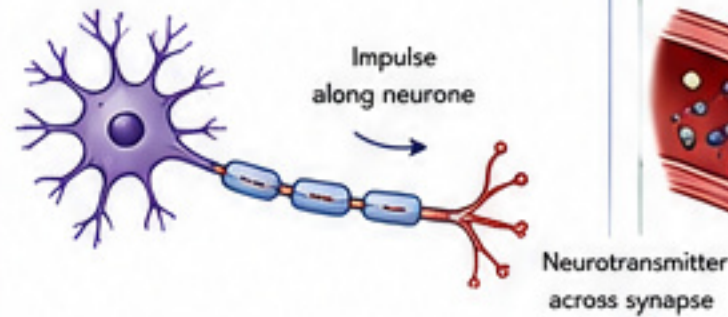
★ No system works in isolation – integration is essential for survival and performance.

2. COMMUNICATION BETWEEN SYSTEMS

Systems communicate using two main pathways.

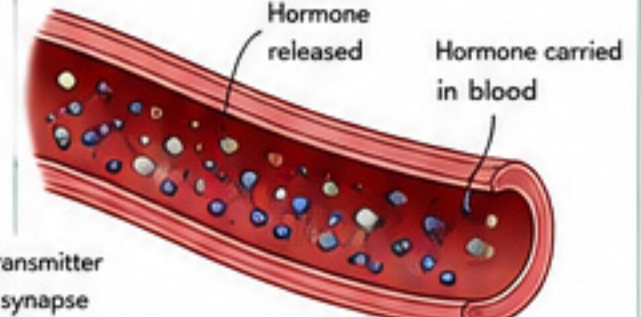
Nervous pathway (FAST)

- Electrical impulses travel along neurones
- Neurotransmitters pass messages across synapses
- Very fast (milliseconds)
- Short-lived effects



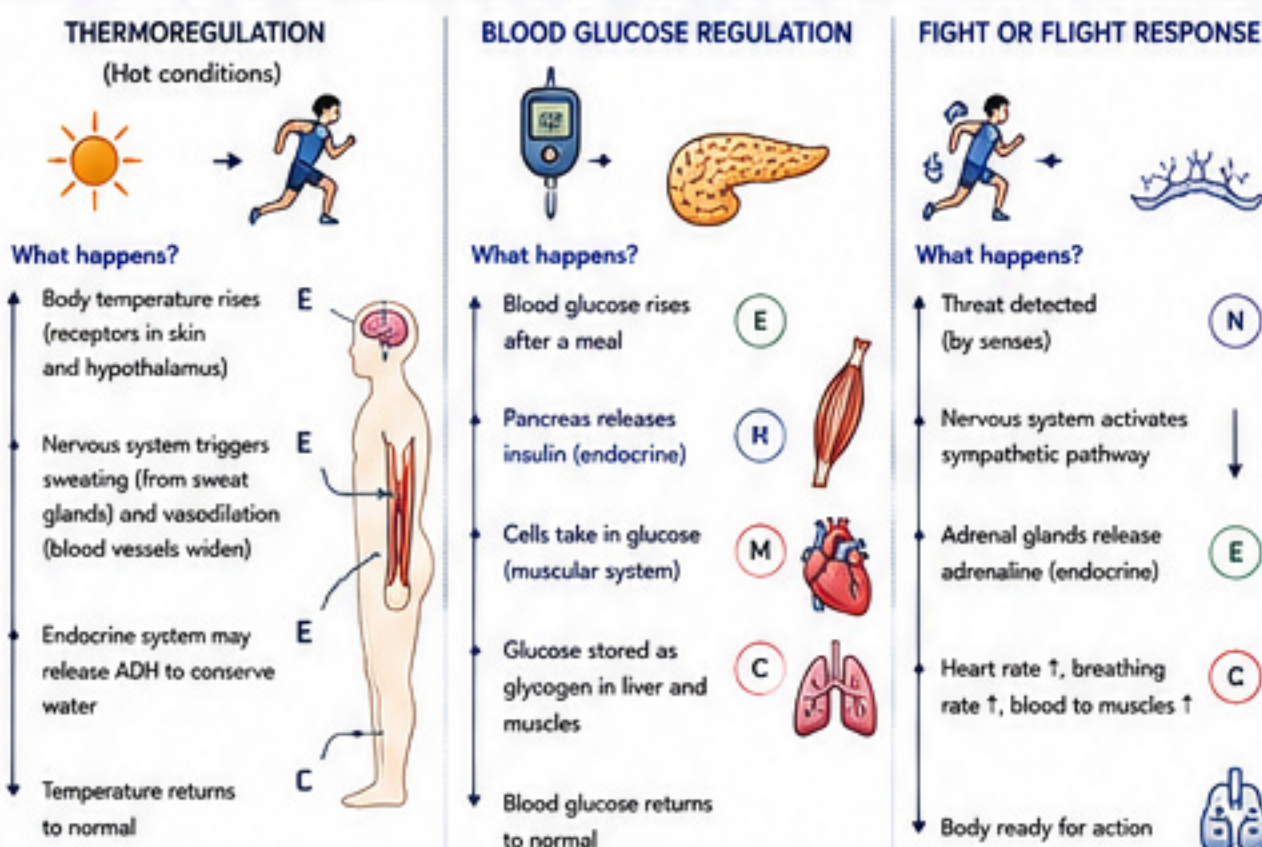
Endocrine pathway (SLOWER)

- Hormones released by glands into the bloodstream
- Travel to target organs/cells
- Slower (seconds to days)
- Longer-lasting effects



★ Both pathways work together to coordinate body functions.

3. EXAMPLES OF SYSTEMS WORKING TOGETHER

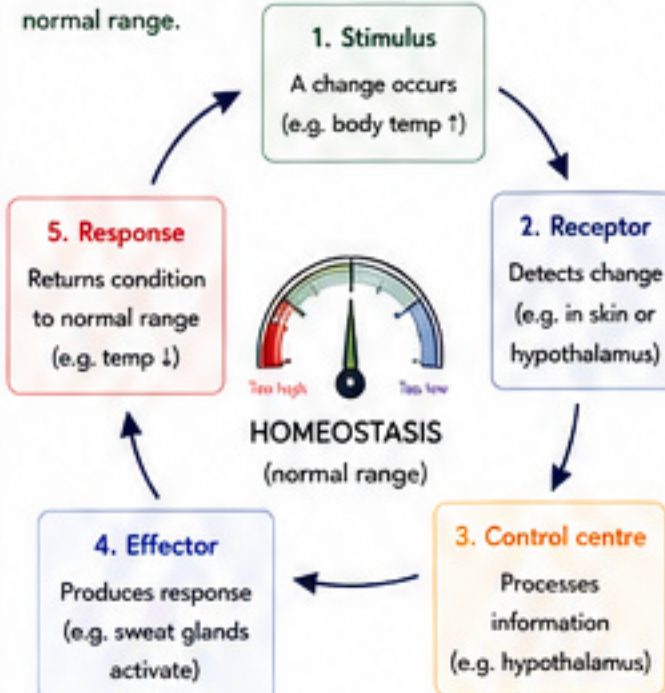


4. FEEDBACK LOOPS – MAINTAINING HOMEOSTASIS

Most body control occurs through feedback loops.

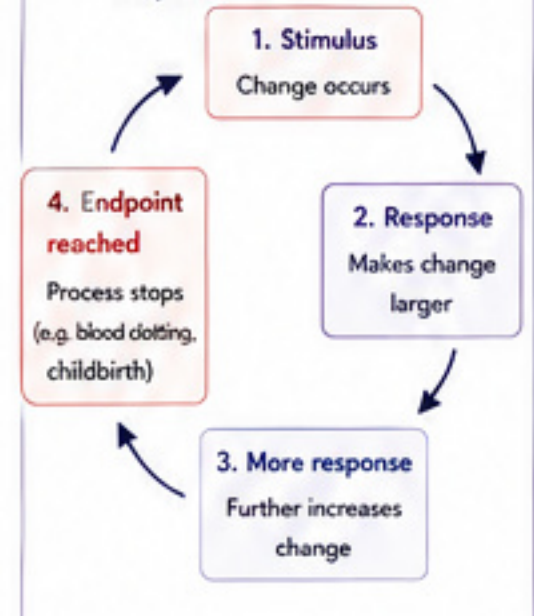
NEGATIVE FEEDBACK (most common)

Returns conditions to normal range.



POSITIVE FEEDBACK (rare)

Amplifies change until a specific endpoint.



★ Negative feedback keeps us stable; positive feedback drives processes to completion.

5. INTEGRATION DURING EXERCISE

During exercise, multiple systems work together to meet increased demands.



★ Integration ensures efficiency, prevents fatigue and maintains homeostasis.

6. KEY POINTS TO REMEMBER

- ✓ Organ systems are interdependent and communicate constantly.
- ✓ Nervous system = fast, short-term responses.
- ✓ Endocrine system = slower, longer-lasting responses.
- ✓ Feedback loops maintain stable internal conditions.
- ✓ Effective integration is essential for performance and survival.

EXAM TIP

Use real-life and sporting examples when answering questions.

Examples:

- Thermoregulation during a hot football match
- Blood glucose control after eating
- Fight or flight at the start of a race
- Systems working together during training

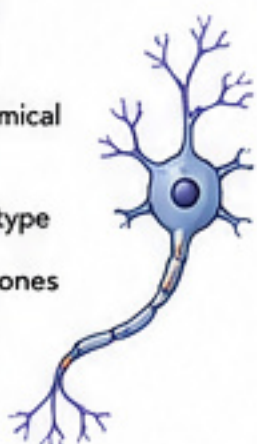
SPORT APPLICATION

- Good integration improves performance and safety.
- Maintains homeostasis – keeps temperature, fluids and energy stable during activity.
- Recovery and adaptation – enables training adaptations and reduces fatigue over time.

DO NOT OVERLEARN

You are not required to know:

- Exact hormone concentrations
- Detailed biochemical pathways
- Every receptor type
- All minor hormones
- Rare disorders



KEY LINKS

- Links to A.1.1 (Inter-system communication) – how systems communicate.
- Links to A.2.2 (Energy systems) – energy is supplied to working organs.
- Links to B.1 (Body composition) – systems affected by body composition.
- Links to C.2 (Motivation) – behaviour influences system function.

QUICK CHECK

1. What are the two main pathways of communication between organ systems?
2. Give one example of systems working together and explain how.
3. What is the difference between negative and positive feedback?
4. Why is integration of systems important during exercise?
5. Give one sporting example where multiple systems work together.



A.1.3 INTER-SYSTEM COMMUNICATION

Nervous and endocrine control of movement

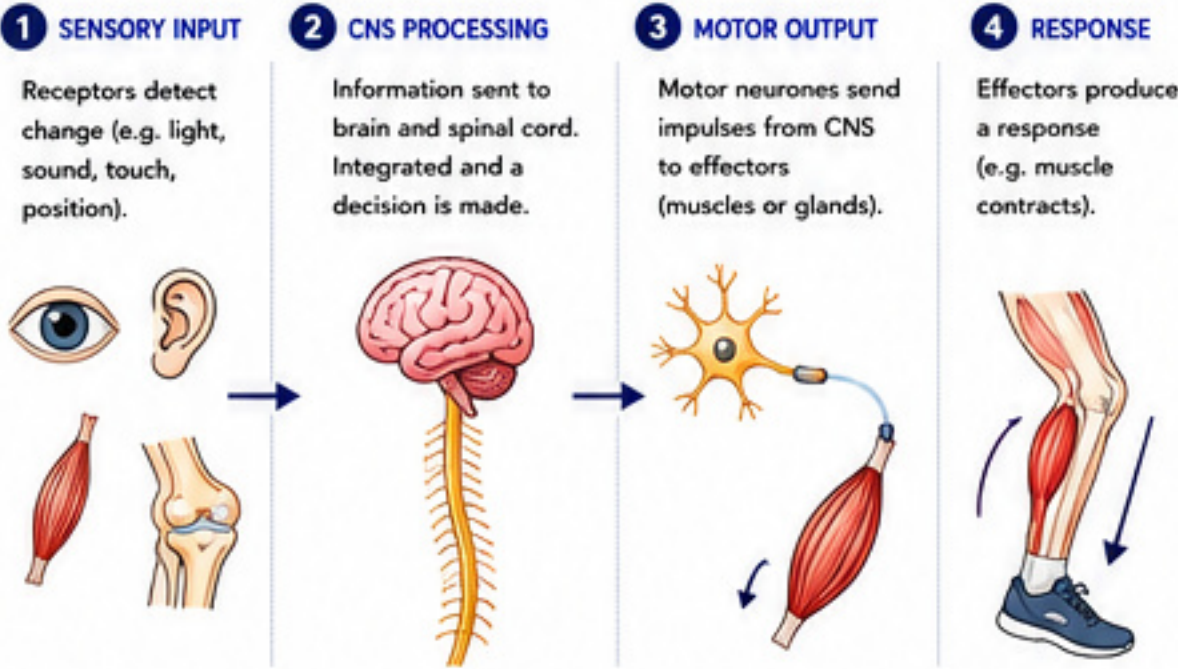
GUIDING QUESTION: How do the nervous and endocrine systems control movement and physical performance?

★ EXAM PRIORITY – MUST KNOW

- CNS plans, initiates and coordinates movement
- PNS carries sensory information to CNS and motor commands to effectors
- Endocrine hormones influence neuromuscular function and energy availability
- Systems work together for efficient, safe and effective movement
- Examples: start of a sprint, reaction time, strength performance

1. THE NERVOUS SYSTEM CONTROLS MOVEMENT

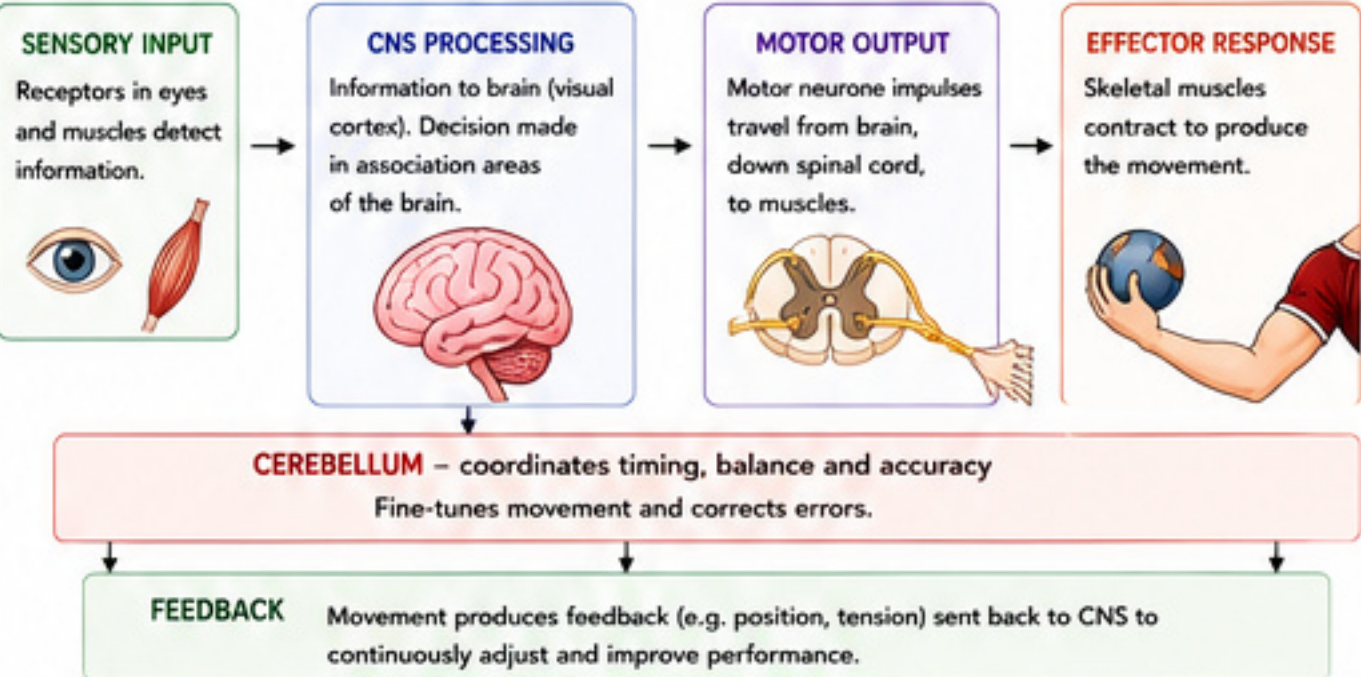
The CNS processes information and sends motor commands.



★ Reaction time = time from stimulus to start of movement.

2. SOMATIC (VOLUNTARY) MOVEMENT PATHWAY

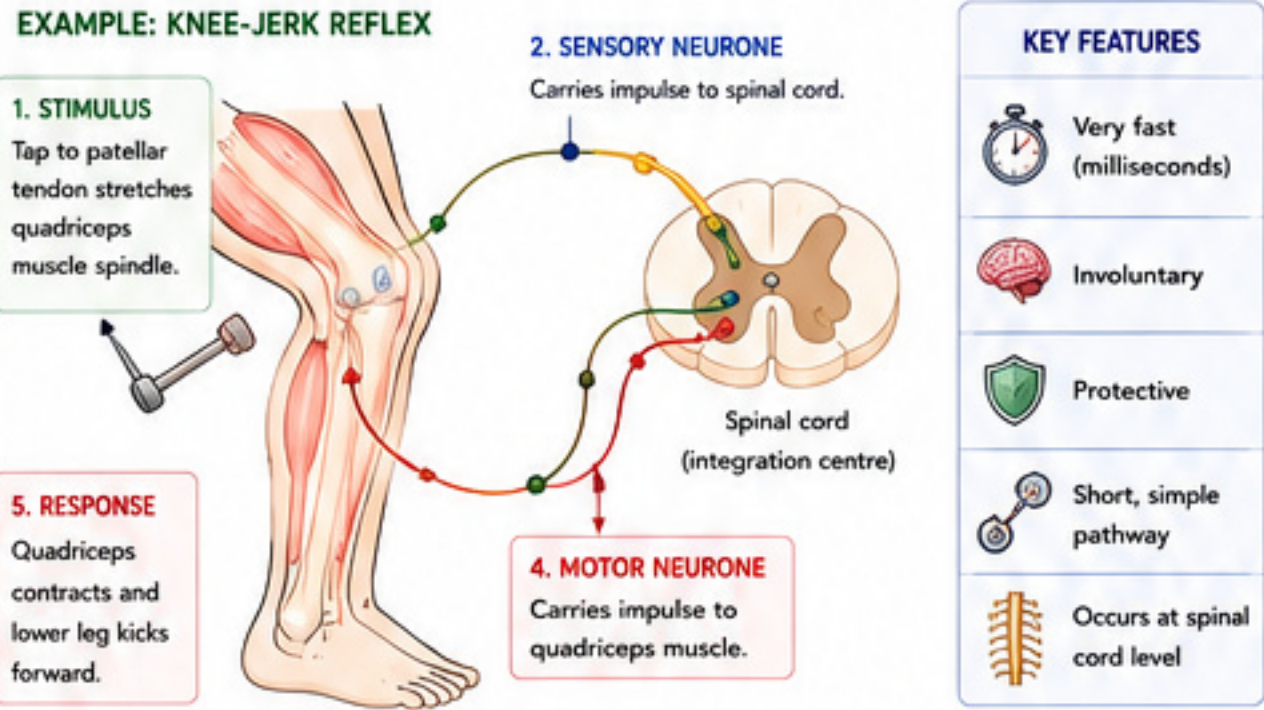
Step-by-step pathway for a voluntary movement (e.g. passing a ball).



★ Efficient pathways allow fast, accurate and coordinated movement.

3. REFLEX ACTIONS – QUICK, AUTOMATIC RESPONSES

Reflexes protect the body and occur without conscious thought.



★ Reflexes free the brain to focus on more important tasks.

4. HORMONAL INFLUENCES ON MOVEMENT

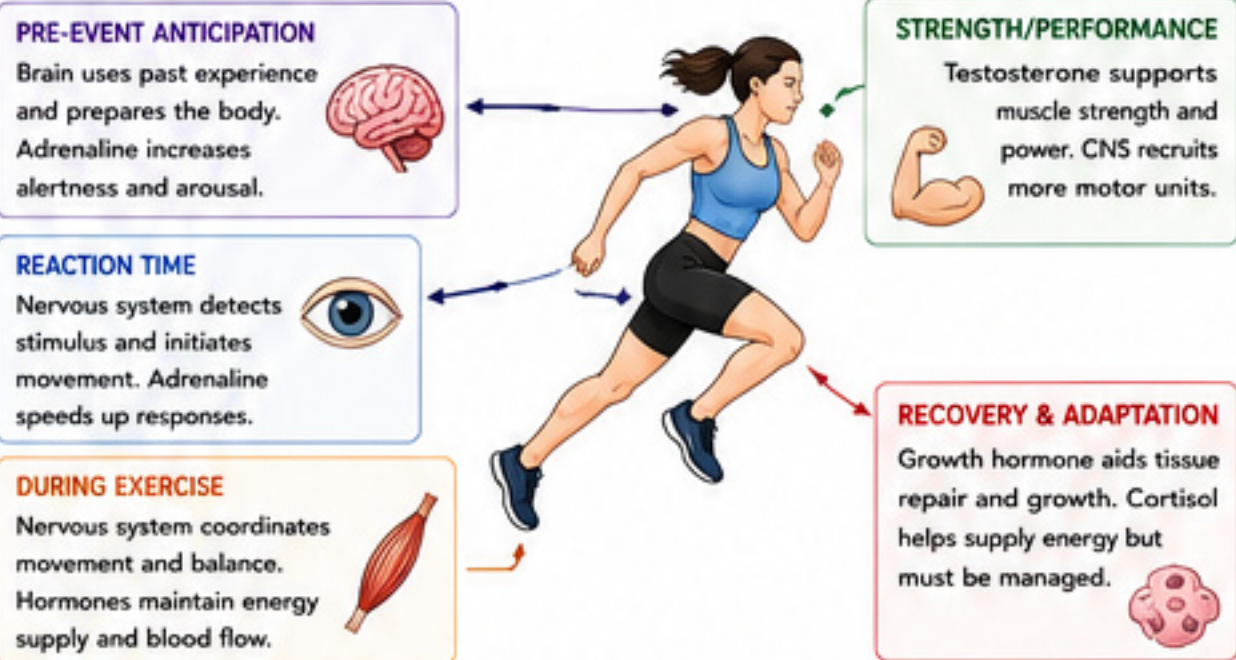
Hormones modify neuromuscular function and energy systems.

HORMONE	SOURCE	MAIN FUNCTIONS (related to movement)	EXAMPLE
ADRENALINE (epinephrine)	Adrenal glands (adrenal medulla) 	- Increases heart rate - Increases breathing rate - Redirects blood to muscles - Mobilises glucose	Start of a 100 m sprint
TESTOSTERONE	Testes 	- Increases muscle protein synthesis - Increases strength and power - Enhances recovery	Strength training adaptations
GROWTH HORMONE (HGH)	Pituitary gland (anterior) 	- Promotes growth of bone and muscle - Aids tissue repair	Recovery from injury
CORTISOL	Adrenal cortex 	- Increases blood glucose - Protein breakdown (long term) - Anti-inflammatory	Prolonged endurance exercise

★ Hormones influence readiness, performance and recovery.

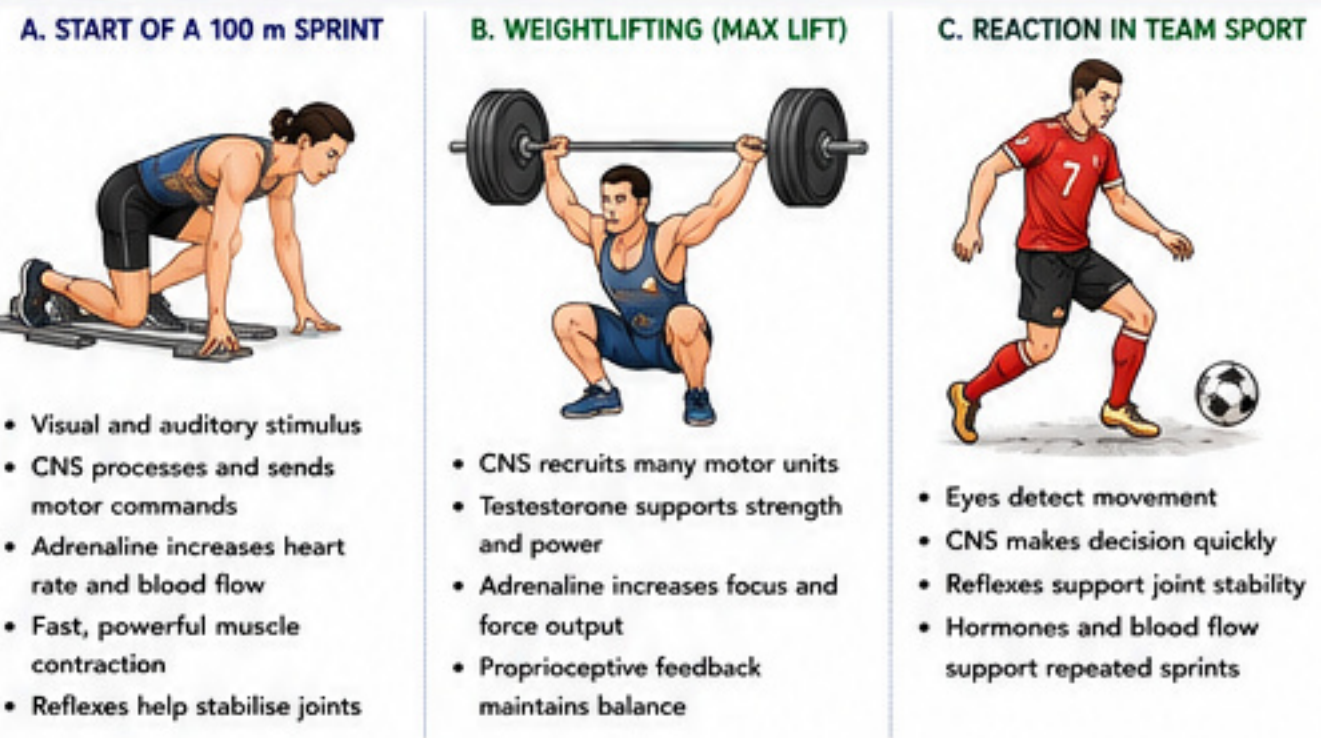
5. NERVOUS AND ENDOCRINE CONTROL IN PERFORMANCE

Both systems interact to optimise performance.



★ Optimal performance depends on the integration of both systems.

6. APPLIED EXAMPLES IN SPORT



★ Different sports demand different combinations of nervous and hormonal control.

SPORT APPLICATION



Efficient communication = better coordination, quicker reactions and improved performance.



Warm up to prepare nervous system and increase hormone levels.



Fatigue slows nerve conduction and reduces hormone effectiveness.



Recovery strategies (sleep, nutrition, hydration) support both systems.



DO NOT OVERLEARN

You are not required to know:

- Exact neuron speeds (m/s)
- All hormone half-lives
- Detailed molecular pathways
- Rare disorders
- Uncommon hormones



KEY LINKS

- Links to A.1.1 (Inter-system communication) – main systems and pathways
- Links to A.1.2 (Intra-system communication) – how each system works internally
- Links to A.2.1 (Water & electrolyte balance) – supports nerve and muscle function
- Links to B.1 (Body composition) – affects hormone levels and performance
- Links to C.1 (Goal setting) – motivation influences system activation



QUICK CHECK

- What is the role of the CNS in voluntary movement?
- What is the difference between a reflex action and a voluntary action?
- Give two hormones that influence movement and one function of each.
- How do feedback loops help maintain homeostasis during exercise?
- Give one sporting example where both nervous and endocrine systems are working together.



A.2.1 WATER AND ELECTROLYTE BALANCE

Maintaining fluid balance for performance

GUIDING QUESTION: How do water and electrolytes maintain health and support performance?

★ EXAM PRIORITY – MUST KNOW

- Water is essential for performance and thermoregulation
- Electrolytes maintain fluid balance and nerve/muscle function
- Intake must match losses to maintain homeostasis
- Dehydration impairs performance and health
- ADH regulates water reabsorption in the kidneys
- Monitor body mass, urine colour and osmolality
- Cardiovascular drift occurs in prolonged exercise (heat)

1. IMPORTANCE OF WATER AND ELECTROLYTES

WATER – KEY ROLES

- Regulates body temperature (sweating)
- Transports nutrients and wastes
- Lubricates joints and tissues
- Maintains blood volume and pressure
- Essential for chemical reactions and metabolism

TOTAL BODY WATER

The average adult



~60%
of body mass
is water

ELECTROLYTES – KEY ROLES

- Maintain fluid balance and osmotic pressure
- Enable nerve impulses
- Support muscle contraction
- Help maintain blood pH
- Essential for heart rhythm and performance

MAJOR ELECTROLYTES

Electrolyte	Symbol	Main role	Where found
Sodium	Na ⁺	Fluid balance, nerve function	Blood, sweat, extracellular fluid
Potassium	K ⁺	Muscle contraction, heart rhythm	Cells, intracellular fluid
Chloride	Cl ⁻	Fluid balance, acid–base balance	Blood, sweat, extracellular fluid

★ Adequate water and electrolytes are essential for health and performance.

2. WATER INTAKE AND LOSSES – THE BALANCE

DAILY FLUID BALANCE

INTAKE

- Drinks (fluids)
- Food (moisture)
- Metabolic water (produced in the body)

Total intake

FLUID BALANCE (= HOMEOSTASIS)

Intake
=
Losses

LOSSES

- Sweat
- Urine
- Respiration (water vapour)
- Faeces

Total losses



EXERCISE IN HEAT INCREASES LOSSES

- Sweat rate can be 0.5–2.0 L per hour
- Sodium lost in sweat: 300–1000 mg per hour
- Greater fluid loss → greater dehydration risk

★ Match intake to losses to maintain body water and electrolyte balance.

3. IMBALANCE – CONSEQUENCES OF FLUID DISRUPTION

DEHYDRATION (WATER DEFICIT)

Loss of body water (>2%)

Effects

- Thirst
- Reduced blood volume
- ↑ Heart rate
- ↑ Core temperature
- Fatigue, reduced concentration
- Poor performance
- Heat illness risk



HYPERNATREMIA (Too much sodium)

High blood sodium
(>145 mmol · L⁻¹)

Causes

- Excessive sweating with low fluid intake
- Too much sodium intake
- Inadequate water replacement

Effects

- Thirst
- Headache
- Confusion
- Irritability
- Severe: seizures, coma



HYPONATREMIA (Low sodium)

Low blood sodium
(<135 mmol · L⁻¹)

Causes

- Excessive fluid intake
- Replacement with water only
- Prolonged sweating without sodium

Effects

- Nausea
- Headache
- Muscle cramps
- Confusion
- Severe: seizures, coma



★ Too little or too much sodium, or too little water, can be dangerous.

4. MONITORING HYDRATION STATUS

BODY MASS

Weigh before and after exercise (naked or in minimal clothing).

Guideline

Lose ≤2% of body mass during exercise.

>2% = dehydration and performance impairment.



URINE COLOUR

Simple and practical hydration check.

1	Very pale (hydrated)
2	Pale
3	Light yellow
4	Yellow
5	Dark yellow (mildly dehydrated)
6	Amber
7	Dark amber
8	Brown (severely dehydrated)

↑ HYDRATED

↓ DEHYDRATED

URINE OSMOLARITY (mOsm · kg⁻¹)

Laboratory measure of concentration.

Interpretation

< 300	Well hydrated
300–600	Adequate
600–800	Concentrated
> 800	Dehydrated



★ Use multiple indicators – no single method is perfect on its own.

5. REGULATION – ADH AND FLUID BALANCE

HYPOTHALAMUS–PITUITARY–KIDNEY CONTROL

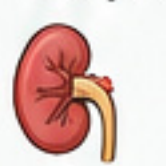
1. Osmoreceptors in hypothalamus detect ↑ plasma osmolality (or ↓ blood volume)



2. Posterior pituitary releases ADH (antidiuretic hormone) into the blood



3. Kidneys
ADH increases water reabsorption in the collecting ducts



4. Result
More water retained
Less dilute urine
↓ Plasma osmolality
Restores balance



ADH NEGATIVE FEEDBACK LOOP

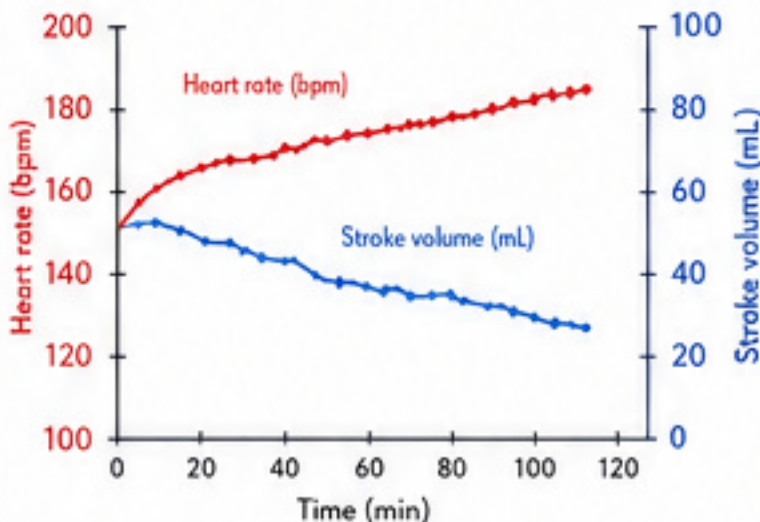


★ ADH conserves water and maintains fluid balance.

6. CARDIOVASCULAR DRIFT IN PROLONGED EXERCISE (HEAT)

WHAT IS CARDIOVASCULAR DRIFT?

A gradual ↑ in heart rate and ↓ in stroke volume at a constant workload during prolonged exercise in the heat.



CAUSES

- Dehydration reduces plasma volume
- More blood directed to skin for cooling
- Less blood available to working muscles
- Heart rate increases to maintain cardiac output

EFFECTS

- Higher heart rate
- Earlier fatigue
- Reduced performance

★ Stay hydrated and cool to reduce cardiovascular drift.

SPORT APPLICATION

Endurance sports in the heat increase sweat and sodium loss.

Plan ahead:

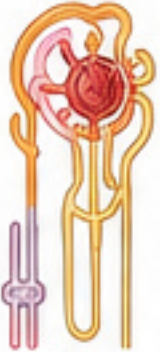
- ✓ Start well hydrated
- ✓ Drink regularly
- ✓ Replace sodium
- ✓ Monitor body mass
- ✓ Adjust strategy as needed



DO NOT OVERLEARN

You are not required to know:

- Detailed kidney/nephron structure
- All hormone pathways
- Exact urine osmolality mechanisms
- Rare electrolyte disorders and treatments



KEY LINKS

- Links to A.1.1 (Nervous system) – hypothalamus and ADH control
- Links to A.1.3 (Energy systems) – hydration affects performance and heat stress
- Links to A.2.2 (Energy systems) – fluid intake supports recovery and adaptation
- Links to A.2.3 (Cardiovascular, Respiratory, Muscular) – blood volume and cardiac output



QUICK CHECK

1. Why is water essential for performance?
2. Name the main routes of fluid intake and loss.
3. What are the signs and risks of dehydration?
4. How can you monitor your hydration status?
5. How does ADH help maintain fluid balance?
6. What causes cardiovascular drift?
7. How can athletes reduce the impact of cardiovascular drift?



A.2.2 FUELLING FOR HEALTH AND PERFORMANCE

Eating for health, energy and performance

GUIDING QUESTION: How can nutrition support health, exercise and recovery?

★ EXAM PRIORITY – MUST KNOW

- Carbohydrate, protein and lipid roles
- How needs vary with body composition, age, sex differences and activity
- Pre- and during-exercise fuelling
- Gastrointestinal comfort
- Low energy availability and RED-S
- HL: iron, calcium, sodium, potassium, vitamins and gut microbiome

1. ROLES OF CARBOHYDRATE, PROTEIN AND LIPID

Each macronutrient has a key role in health, exercise and recovery.

CARBOHYDRATE

- Primary fuel for high-intensity exercise
- Spares protein
- Replenishes muscle glycogen
- Supports brain function

GOOD SOURCES

Wholegrains, fruit, veg, rice, pasta, potatoes, cereals



PROTEIN

- Builds and repairs muscle and tissues
- Supports immune function
- Enzymes, hormones and transport proteins

GOOD SOURCES

Meat, fish, eggs, dairy, beans, lentils, tofu, nuts



LIPID (FAT)

- Concentrated energy source
- Supports hormone production
- Protects organs
- Helps absorb vitamins A, D, E and K

GOOD SOURCES

Oils, nuts, seeds, avocado, oily fish, dairy



★ All three are needed in the right amounts for health and performance.

2. HOW CONTRIBUTION VARIES

Nutrition needs differ according to several individual factors.

AGE

- Children & adolescents: growth and development: ↑ energy, protein, Ca, Fe
- Adults: maintenance and performance
- Older adults: maintain muscle and bone health



SEX DIFFERENCES



- Generally lower energy needs and body size
- Higher risk of iron deficiency
- Menstruation increases iron requirements



- Generally higher energy and protein needs due to greater lean mass and size

BODY COMPOSITION

- Higher muscle mass = higher energy and protein needs
- Higher body fat = lower energy needs



PHYSICAL ACTIVITY



LOW

HIGH

- As activity amount and intensity increase, so do energy, carbohydrate and fluid needs
- Recovery nutrition becomes more important

★ Nutrition is individual – there is no one-size-fits-all.

3. PRE- AND DURING-EXERCISE STRATEGIES

Plan fuelling to perform well and feel good.

PRE-EXERCISE FUELLING

Aim: top up energy stores and optimise performance.

- Eat 1–4 hours before exercise
- Focus on carbohydrate with some protein
- Low in fat and fibre
- Hydrate well
- Train the gut in training

EXAMPLES

- 3 h: pasta + chicken + veg
- 1–2 h: bagel + banana + yogurt
- 30–60 min: sports drink, banana, jelly sweets

DURING-EXERCISE FUELLING

Aim: maintain blood glucose, delay fatigue and replace fluid.

- For >60 min or high intensity: consume carbohydrate
- 30–60 g carbohydrate per hour
- Sip fluids regularly (150–250 ml every 15–20 min)
- Include sodium if >60 min (300–600 mg per hour)

EXAMPLES

- Sports drink
- Energy gels
- Chews / jelly sweets
- Banana / dried fruit

GASTROINTESTINAL COMFORT TIMELINE



★ Practise fuelling in training to find what works for you.

4. LOW ENERGY AVAILABILITY TO RED-S PATHWAY

Low energy availability (LEA) occurs when energy intake is too low for health and daily function after exercise energy expenditure.



Possible consequences across body systems

Metabolic	Menstrual	Bone	Immunity	Cardiovascular	Psychological	Growth & Development
↓ metabolism ↑ risk of fatigue	Menstrual dysfunction (amenorrhoea)	↓ Bone mineral density ↑ Fracture risk	↑ Illness ↓ Recovery	↓ Heart rate ↓ Blood pressure	↑ Irritability ↓ Mood ↑ Stress	Impaired growth and maturation in adolescents

Who is at risk?

- Athletes in aesthetic, weight-class or endurance sports
- Quick weight loss practices and chronic under-eating
- Female athletes (higher risk of menstrual dysfunction)
- Anyone with poor fuelling and high training load

Prevention & management

- Eat enough energy – all foods fit
- Monitor health and training
- Support from coaches, parents and health professionals

★ Energy availability first – health and performance depend on it.

5. KEY MICRONUTRIENTS (HL)

Key roles in oxygen transport, bone health, fluid balance, nerve function and immunity.

IRON (Fe)

Forms haemoglobin to carry oxygen. Supports energy production.

FOUND IN
Red meat, poultry, fish, legumes, leafy greens, fortified cerealsNEED ↑
Females, adolescents, endurance sports

CALCIUM (Ca)

Builds and maintains strong bones and teeth. Needed for muscle contraction.

FOUND IN
Dairy, fortified plant milks, tofu, almonds, leafy greensNEED ↑
Adolescents, females, impact sports

SODIUM (Na)

Maintains fluid balance and blood volume. Supports nerve and muscle function.

FOUND IN
Salt, bread, cheese, soups, sauces, processed foodsNEED ↑
Heavy sweaters, endurance sports, hot environments

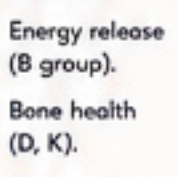
POTASSIUM (K)

Maintains fluid balance. Supports nerve and muscle function.

FOUND IN
Banana, potatoes, beans, leafy greens, yogurtNEED ↑
Heavy sweaters, endurance sports

VITAMINS (HL)

Key antioxidant and immune functions. Energy release (B group). Bone health (D, K).

FOUND IN
Fruit, veg, wholegrains, dairy, eggs, fortified foods

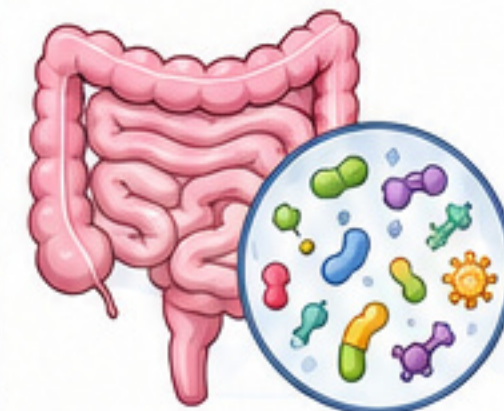
★ A varied, balanced diet usually meets micronutrient needs.

6. GUT MICROBIOME (HL)

Trillions of microbes in the gut influence digestion, immunity and overall health.

WHAT INFLUENCES THE GUT MICROBIOME?

- Genetics
- Diet
- Medications (e.g., antibiotics)
- Lifestyle (sleep, stress, activity)



EFFECTS ON HEALTH AND PERFORMANCE

- Improves digestion and nutrient absorption
- Supports immune function
- Produces short-chain fatty acids (energy for gut cells)
- May influence mood and recovery
- Protects against harmful pathogens

★ Feed your gut: eat a variety of fibre-rich foods and stay healthy.

SPORT APPLICATION

Good nutrition improves training quality, performance, recovery and long-term health.

Practise pre- and during-exercise fuelling in training.

Monitor energy availability – fuel enough to perform and stay healthy.

DO NOT OVERLEARN

You are not expected to know:

- Detailed functions of every vitamin and mineral
- Exact universal meal plans
- Complex biochemical pathways of the gut microbiome



KEY LINKS

- Links to A.2.1 (Energy systems) – Nutrition provides energy for all systems.
- Links to A.2.3 (Training principles) – Nutrition supports adaptation and recovery.
- Links to A.1.3 (Health) – Good nutrition reduces disease risk and supports wellbeing.
- Links to A.1.1 (Inter-system communication) – Hormones and systems regulate hunger and energy.

QUICK CHECK

1. State one role of carbohydrate, protein and lipid.
2. Why do nutrition needs vary between individuals?
3. List two pre-exercise fuelling guidelines.
4. How much carbohydrate is recommended per hour during exercise?
5. What is RED-S and name two possible consequences.
6. Name two key sources of calcium and iron.
7. What factors influence the gut microbiome?
8. How can good nutrition enhance performance?



A.2.3 ENERGY SYSTEMS

How the body resynthesises ATP

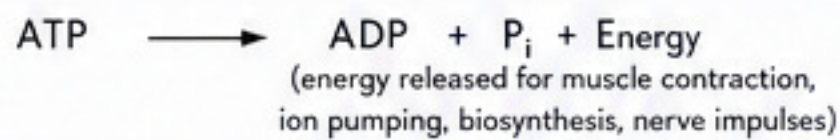
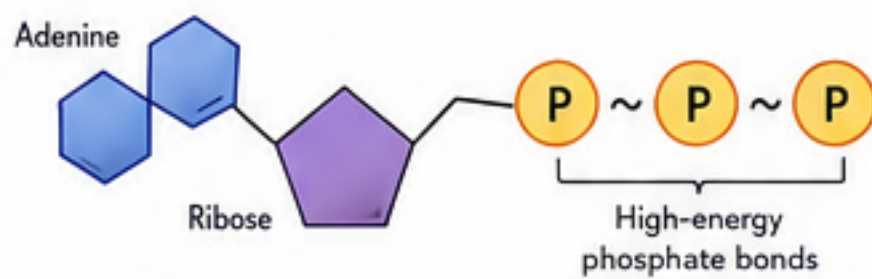
GUIDING QUESTION: How do energy systems supply ATP for physical activity?

★ EXAM PRIORITY – MUST KNOW

- ATP is the immediate energy currency for all body functions
- Three energy systems resynthesise ATP: phosphagen, glycolytic, oxidative
- Systems differ in oxygen need, fuels, ATP supply, duration, intensity & recovery
- Energy continuum – systems work together across all intensities
- VO_2 max & movement economy influence endurance performance
- HL: lactate inflection point (LIP) and EPOC (oxygen deficit, fast & slow)

1. ATP – THE IMMEDIATE ENERGY CURRENCY

ATP (adenosine triphosphate) stores energy in its bonds.



★ ATP is resynthesised continuously by the energy systems.

2. THE THREE ENERGY SYSTEMS

The body uses three main systems to resynthesise ATP.

PHOSPHAGEN SYSTEM (ATP-PCr SYSTEM)



- Very fast ATP resynthesis
- Small ATP supply
- No oxygen required

GLYCOLYTIC SYSTEM (ANAEROBIC)



- Fast ATP resynthesis
- Medium ATP supply
- No oxygen required
- Produces lactate & H^+

OXIDATIVE SYSTEM (AEROBIC)



- Slower ATP resynthesis
- Large ATP supply
- Requires oxygen

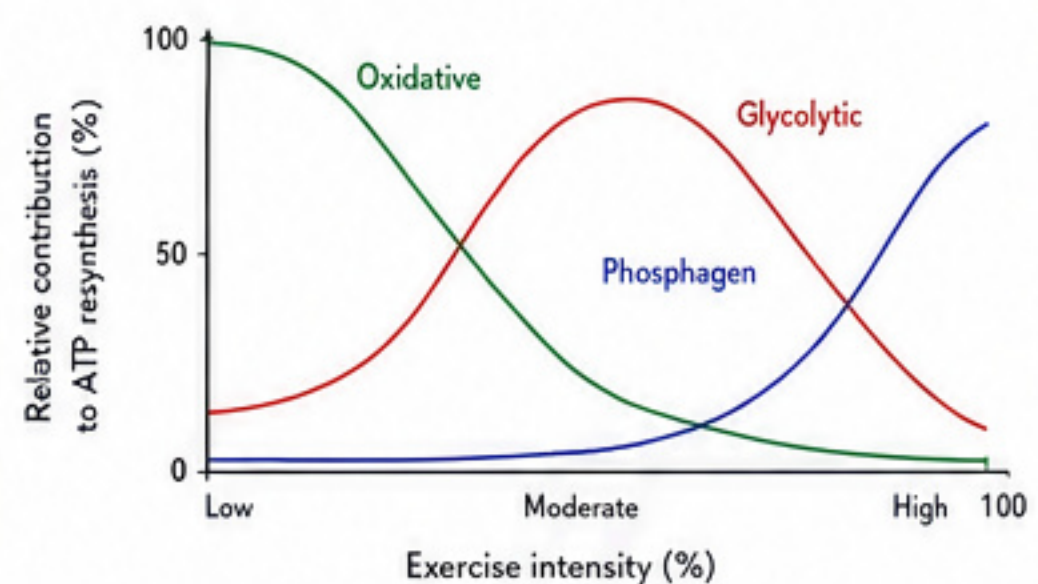
★ All three systems work together – the contribution depends on intensity and duration.

3. COMPARING THE THREE ENERGY SYSTEMS

Feature	PHOSPHAGEN (ATP-PCr)	GLYCOLYTIC (ANAEROBIC)	OXIDATIVE (AEROBIC)
Oxygen requirement	None	None	Required
Main fuels	ATP & phosphocreatine (PCr)	Carbohydrate (glucose / glycogen)	Carbohydrate (glycogen), fat, protein
ATP supply	Very small ($\approx 1-10$ seconds)	Small-moderate (≈ 30 sec – 2 min)	Very large (minutes to hours)
Duration	0–10 seconds	30 seconds – 2 minutes	2 minutes – many hours
Best at	Very high intensity	High intensity	Low to moderate intensity
Recovery time	Very fast (full in 2–3 min)	Moderate (several minutes)	Fast (as long as oxygen available)
Benefits	Explosive power, starts, jumps, throws	High power output, short intense efforts	Endurance, sustain prolonged activity, uses fat – spares glycogen
Limitations	Very small ATP store, fatigues in seconds	Lactate & H^+ cause fatigue, limited duration	Slower ATP resynthesis, limited at very high intensities

4. ENERGY CONTINUUM

Systems overlap and their contribution changes with intensity.



★ At any intensity, all three systems contribute to ATP resynthesis.

5. FROM SYSTEMS TO PERFORMANCE

Energy systems underpin different types of physical activity.

SPRINT / EXPLOSIVE (0–10 sec)



Main system: Phosphagen

- Maximum power
- Very short duration
- Examples: 100 m sprint, long jump, shot put

REPEATED SPRINTS / HIA (10 sec – 2 min)



Main system: Glycolytic

- High intensity efforts
- Short duration / repeated
- Examples: 400 m, 200 m repeats, HIIT

ENDURANCE (> 2 min)



Main system: Oxidative

- Lower intensity
- Longer duration
- Examples: 1500 m, 10 km run, cycling, rowing

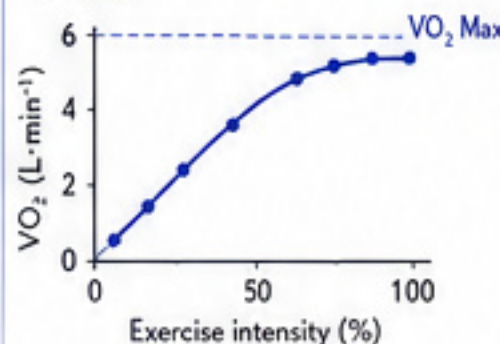
★ Train the right systems for the performance goal.

6. KEY PHYSIOLOGICAL CONCEPTS (HL)

VO_2 MAX & MOVEMENT ECONOMY

VO_2 Max

Maximum rate of oxygen uptake. Higher VO_2 max = greater aerobic capacity.



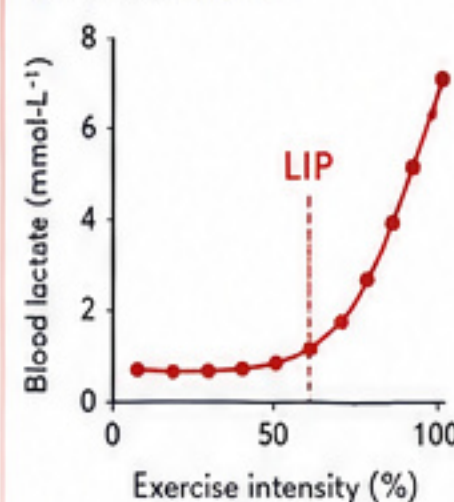
Movement economy

Oxygen cost of a given submaximal speed. Better economy = less O_2 needed = improved endurance.



LACTATE INFLECTION POINT (LIP)

The point where lactate begins to rise above baseline.

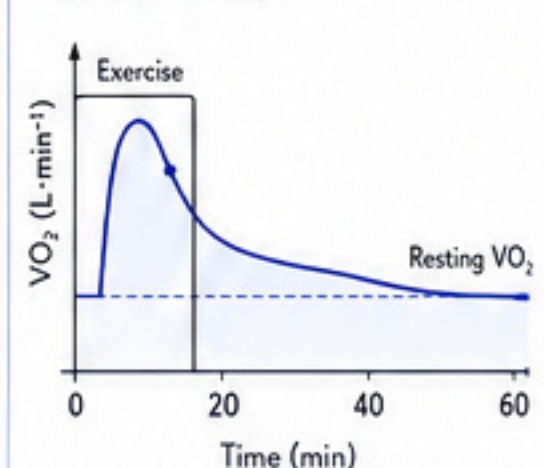


Intensity below LIP = mostly aerobic.

Intensity above LIP = increasing anaerobic contribution.

EPOC – OXYGEN DEFICIT

Extra oxygen needed after exercise to restore the body.



Fast component (0–2 min)

- Restore ATP-PCr
- Remove O_2 debt
- Clear lactate

Slow component (> 2 min)

- Restore O_2 stores
- Repair tissue
- Thermoregulation

★ These concepts explain why training and pacing affect performance.

SPORT APPLICATION



Match training to energy system demands of your sport.



Improve VO_2 max and movement economy for better endurance.



Use intervals, tempo and recovery strategies to target LIP and delay fatigue.



DO NOT OVERLEARN

You are not required to know:

- Detailed Krebs cycle
- Electron transport chain
- Exact number of molecules in each step
- Detailed enzyme names



KEY LINKS

- Links to A.1.1 (Nervous & Endocrine Systems) – control & coordination
- Links to A.2.2 (Intra-system Communication) – energy availability
- Links to A.2.1 (Water & Electrolyte Balance) – impacts performance
- Links to C.1.2 (Health Priorities) – physical activity & health



QUICK CHECK

1. What is ATP and why is it important?
2. Compare the three energy systems.
3. How do the systems work together?
4. What is VO_2 max and why does it matter?
5. What is the lactate inflection point?
6. What is EPOC and its two components?
7. Give a sporting example for each system.



THEME

A

A.3.1

QUALITIES OF TRAINING

Designing safe and effective training

GUIDING QUESTION: How should training be planned to improve performance safely?

★ EXAM PRIORITY – MUST KNOW

- Specificity – training must be specific to the sport and goal
- Progressive overload – gradually increase training stress
- Recovery/rest – allows adaptation and prevents fatigue
- Variety – prevents boredom and performance plateaus
- Reversibility – fitness is lost if training stops
- Periodization – plan training across time for peak performance

1. THE SIX QUALITIES OF TRAINING

Effective training is safe, planned and leads to improvement.

1. Specificity

Training is specific to the sport, position and goal.

2. Progressive Overload

Gradually increase training load to stimulate adaptation.

3. Recovery/Rest

Rest allows the body to repair, adapt and get stronger.

4. Variety

Change training methods, exercises or environment to maintain motivation and reduce plateaus.

5. Reversibility

Fitness gains are lost if training stops or is reduced.

6. Periodization

Plan training in cycles to peak at the right time.

FITT PRINCIPLE + PROGRESSIVE OVERLOAD

F Frequency (How often)

I Intensity (How hard)

T Time (How long)

T Type (What type)

How many training sessions per week?

How hard is the training?

How long is each session?

What training method is used?

PROGRESSIVE OVERLOAD

Small, gradual increases over time.

Start

+5%

+5%

+5%

Goal

★ Apply the six qualities using FITT and progressive overload.

2. PLANNING TRAINING PROGRAMMES

Use FITT, measure progress and plan across time.

SETTING TRAINING VARIABLES (FITT)

Frequency

How often will you train?

Intensity

How hard will you train?

Time (Duration)

How long will you train for?

Type

What type/method of training will you do?

BASELINE MEASUREMENT & MONITORING

Test, measure and monitor to guide training.

Set a baseline

Measure key fitness components at the start.

Monitor regularly

Track performance and response to training.

Adjust training

Use data to make informed decisions.

Review & record

Keep accurate records of tests and training.

ADAPTATION CURVE

Performance level

Training stimulus

Fatigue

Recovery

Adaptation (improvement)

New improved performance

Time

★ Measure, monitor and adjust to train smart and improve safely.

3. PERIODIZATION – PLANNING OVER TIME

Periodization structures training to peak at the right time.

MACROCYCLE (Season / Year)

Long-term plan (usually 6–12 months)

Includes pre-season, competition season and off-season.

MESOCYCLE (Phase / Block)

Medium-term plan (usually 3–6 weeks)

Focuses on a specific goal or training outcome.

MICROCYCLE (Week)

Short-term plan (7 days)

Daily training sessions.

EXAMPLE PERIODIZATION PLAN (ANNUAL CALENDAR)

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Preparation (General)	Preparation (Specific)	Competition 1	Transition (Active Rest)	Competition 2	Transition (Active Rest)	Preparation (General)					

Preparation – build fitness and skills

Competition – perform and peak

Transition – rest and recover

★ Plan training in cycles to peak for key competitions.

4. INDIVIDUALISATION – TRAINING FOR THE INDIVIDUAL

Training must be adapted to the needs of the individual.

Current Fitness Level

Match training load to the individual's starting point.

Age

Children, adolescents, adults and older adults respond differently.

Sex & Reproductive Status

Training needs may differ between males and females.

Menstrual-Cycle Changes

Hormonal fluctuations can affect energy, strength and recovery.

Genetics & Responders

Some people are high responders, others low responders to the same training.

Macrocycle Phase

Training focus changes across preparation, competition and transition phases.

★ Individualisation improves performance and reduces injury risk.

5. OVERREACHING vs OVERTRAINING

More is not always better.

FUNCTIONAL OVERREACHING (PLANNED)

- Short-term increase in training load
- Performance temporarily drops
- Increased fatigue
- Recovery period restores fitness
- Leads to supercompensation
- Improves performance

OVERTRAINING (NOT PLANNED)

- Very high training load for too long
- Performance keeps declining
- Chronic fatigue, no recovery
- Increased risk of illness & injury
- Mood disturbances, poor sleep
- Decreased performance

Increase training load

Fatigue

Planned rest/recovery

Supercompensation (improvement)

Excessive training load

Prolonged fatigue

Overtraining

★ Aim for functional overreaching – avoid overtraining.

6. MONITOR, ADAPT AND REVIEW

Continuous monitoring and review ensure safe, effective training.

TRAINING DATA

Load, volume, intensity, RPE

WELLBEING

Sleep, mood, stress, motivation

PERFORMANCE TESTS

Fitness, skills, sport-specific tests

MONITOR ADAPT REVIEW

ANALYSE

What is working? What is not?

ADAPT

Adjust training variables and load

REVIEW

Plan ahead and set new goals

★ Monitor, adapt and review for continuous improvement.

SPORT APPLICATION

Well-planned training improves performance and reduces injury risk.

Use the six qualities and periodization to peak at the right time.

Recovery and individualisation are essential for long-term success.

DO NOT OVERLEARN

You are not required to know:

- Exact training loads or % increases
- Detailed training programmes
- Exact testing protocols
- Genetic markers or tests
- Medical treatment for overtraining

KEY LINKS

- Link to A.1.2 (Intra-system communication) – nervous and endocrine systems respond to training.
- Link to A.2.1 (Movement Analysis) – technique and efficiency in training.
- Link to A.2.2 (Energy Systems) – training targets energy systems.
- Link to A.3.2 (Injury Prevention) – safe training reduces injury risk.

QUICK CHECK

- What are the six qualities of training?
- Define FITT and progressive overload.
- Why is recovery/rest essential?
- What is periodization? Explain macro, meso and microcycles.
- How do you individualise training?
- Difference between overreaching and overtraining?

IB SPORTS, EXERCISE AND HEALTH SCIENCE – VISUAL REVISION GUIDE

THEME A • A.3.1 QUALITIES OF TRAINING

1

A.3.2 BENEFITS TO HEALTH OF BEING ACTIVE

Physical activity and health

GUIDING QUESTION: How does physical activity influence health across different populations?

★ EXAM PRIORITY – MUST KNOW

- Regular activity improves health across all life stages
- Energy balance = intake vs expenditure
- Muscular, skeletal and immune benefits
- Reduces risk of non-communicable diseases (NCDs)
- Exercise prescription varies by population (HL detail)
- Progressive overload reduces injury risk and supports physical and mental health

1. ACTIVE LIFESTYLE VARIES WITH AGE AND SEX DIFFERENCES

VARIES WITH AGE

- | Age Group | Benefits |
|----------------------------|--|
| Children (5–12) | <ul style="list-style-type: none"> Builds fundamental movement skills Supports growth and development |
| Adolescents (13–19) | <ul style="list-style-type: none"> Improves fitness and body composition Supports mental well-being |
| Adults (20–64) | <ul style="list-style-type: none"> Maintains health and performance Prevents chronic disease |
| Older adults (65+) | <ul style="list-style-type: none"> Maintains independence and functional ability Reduces risk of frailty |

SEX DIFFERENCES

- | Sex | Characteristics |
|------------------|--|
| Females ♀ | <ul style="list-style-type: none"> Higher body fat % Lower muscle mass Greater risk of iron deficiency Hormonal cycles affect energy and performance |
| Males ♂ | <ul style="list-style-type: none"> Higher muscle mass and strength Higher VO₂ max (on average) Higher risk-taking behaviour Different responses to training |
- ★ Activity recommendations must consider age, sex and individual needs.

2. ENERGY INTAKE, CONSUMPTION AND STORAGE

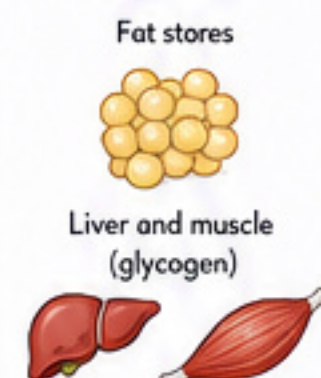
ENERGY INTAKE (CALORIES IN)



ENERGY CONSUMPTION (CALORIES OUT)



ENERGY STORED (SURPLUS)



ENERGY DEFICIT (Intake < Expenditure)



Weight loss
Improved body composition

ENERGY BALANCE (Intake = Expenditure)



Weight stable
Optimal function

ENERGY SURPLUS (Intake > Expenditure)



Weight gain
Increased fat stores

★ Sustained energy balance supports health and performance.

3. POSITIVE AND NEGATIVE EFFECTS ON BODY SYSTEMS

POSITIVE EFFECTS

- | System | Effects |
|-----------------|--|
| Muscular | <ul style="list-style-type: none"> Increased strength and endurance Improved power and function |
| Immune | <ul style="list-style-type: none"> Stronger immune response Reduced incidence of illness |
| Mental | <ul style="list-style-type: none"> Reduced stress and anxiety Improved mood, sleep and self-esteem |

NEGATIVE EFFECTS (if overdone or poor choices)

- | System | Effects |
|-----------------|---|
| Muscular | <ul style="list-style-type: none"> Overuse injuries Muscle fatigue, soreness Decreased performance |
| Immune | <ul style="list-style-type: none"> Suppressed immune function Increased risk of illness |
| Mental | <ul style="list-style-type: none"> Increased stress Poor mood Burnout |

★ Balance, recovery and variety maximise benefits and minimise harm.

4. REDUCED RISK OF CHRONIC DISEASES

Regular physical activity lowers the risk of developing non-communicable diseases.

OSTEOPOROSIS



- Weight-bearing activity increases bone density
- Stronger bones
- Reduced fracture risk



OBESITY



- Increases energy expenditure
- Improves body composition
- Reduces body fat



HYPERTENSION



- Lowers resting blood pressure
- Improves blood vessel function
- Reduces strain on the heart



CARDIOVASCULAR DISEASE



- Improves heart function
- Lowers cholesterol and triglycerides
- Reduces risk of heart attack and stroke



TYPE 2 DIABETES



- Improves insulin sensitivity
- Regulates blood glucose
- Reduces risk of diabetes



★ Being active is a powerful way to prevent chronic disease.

5. HL EXERCISE PRESCRIPTION FOR DIFFERENT POPULATIONS

CHILDREN & ADOLESCENTS (5–18 years)

- | | |
|------------------|--|
| Frequency | ≥60 min/day (moderate-vigorous) |
| Intensity | Moderate to vigorous |
| Type | Aerobic, resistance, bone-loading, skills-based activities |
| Time | ≥60 min/day |
| Notes | Variety, fun and skill development are key |

OLDER ADULTS (65+ years)

- | | |
|------------------|---|
| Frequency | ≥150 min/week (moderate aerobic) |
| Intensity | Moderate |
| Type | Aerobic, balance, resistance, flexibility |
| Time | ≥30 min most days |
| Notes | Focus on balance, strength and independence |

PREGNANT INDIVIDUALS (All trimesters)

- | | |
|------------------|---|
| Frequency | 150 min/week (moderate) |
| Intensity | Moderate |
| Type | Aerobic, strength, pelvic floor, flexibility |
| Time | ≥30 min most days |
| Notes | Avoid supine after 1st trimester; stay hydrated |

★ Prescription must be individualised and adjusted as needs change.

6. PROGRESSIVE INTENSITY TO SUPPORT HEALTH AND REDUCE INJURY RISK

Gradually increasing workload builds fitness safely and supports long-term health.

PROGRESSIVE OVERLOAD PRINCIPLES

- Increase gradually (time, intensity, frequency or type)
- Allow recovery and adaptation
- Monitor fatigue and performance
- Avoid sudden large increases

HEALTH BENEFITS OF PROGRESSIVE TRAINING

PHYSICAL

- Stronger heart and lungs
- Increased strength and endurance
- Stronger bones and joints
- Better movement and posture
- Stronger immune function

MENTAL

- Reduced stress and anxiety
- Improved mood and energy
- Better sleep quality
- Increased confidence
- Greater focus and resilience

★ Progress smart. Train for life.

SPORT APPLICATION

- Regular training improves performance and recovery.
- Maintains homeostasis – keeps body systems functioning efficiently.
- Stronger body and mind lead to better performance under pressure.

DO NOT OVERLEARN

- You are not required to know:
- Ossification stages in detail
 - Osteoblast and osteoclast mechanisms
 - Detailed bone remodelling processes



KEY LINKS

- Links to A.1.2 (Intra-system communication) – hormones regulate energy and responses
- Links to A.2.1 (Water & electrolyte balance) – hydration supports performance and health
- Links to A.2.2 (Energy systems) – fuel for activity and adaptation
- Links to A.3.1 (Components of physical fitness) – fitness underpins health outcomes
- Links to A.3.3 (Health choices) – activity is a key healthy choice



QUICK CHECK

- Why does active lifestyle need to vary with age and sex?
- Explain energy balance and its outcomes.
- Give two positive and two negative effects of physical activity.
- Name five chronic diseases reduced by regular activity.
- How should exercise be prescribed for different populations? Why is progressive overload important?



A.3.3 FATIGUE AND RECOVERY (HL ONLY)

Restoring readiness for training and performance.

GUIDING QUESTION: Why does fatigue develop and how can recovery be supported?

★ EXAM PRIORITY – MUST KNOW

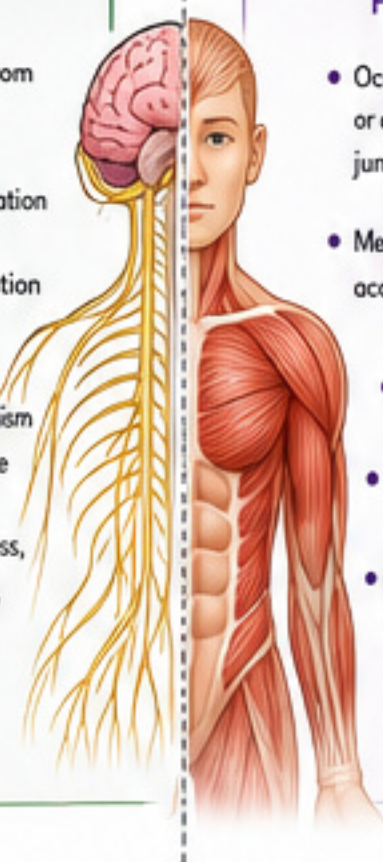
- Fatigue can be central (CNS) or peripheral (outside CNS)
- Peripheral fatigue is influenced by several biochemical factors
- Recovery is multi-dimensional: physiological, symptomatic, psychological
- Recovery nutrition and strategies restore readiness
- Sleep and travel disruption impair recovery and performance

1. CENTRAL VS PERIPHERAL FATIGUE

Fatigue can originate in the brain or within the muscles.

CENTRAL (CNS) FATIGUE

- Reduced drive from the brain
- Decreased motivation
- Increased perception of effort
- Protective mechanism to prevent damage
- Influenced by stress, sleep loss, illness, and overtraining



PERIPHERAL (MUSCLE) FATIGUE

- Occurs in muscles or at the neuromuscular junction
- Metabolic by-products accumulate
- Ion imbalance
- Depleted fuel stores
- Impaired excitation-contraction coupling

★ Both central and peripheral fatigue can limit performance.

2. PERIPHERAL CONTRIBUTORS TO FATIGUE

Biochemical changes in muscles affect force production.

pH (ACIDOSIS)

H⁺ ions accumulate from intense exercise, inhibiting enzyme activity and contraction.



HYDRATION

Dehydration reduces plasma volume, impairs temperature regulation and increases effort.

POTASSIUM (K⁺)

K⁺ accumulation outside cells reduces membrane excitability and nerve impulse conduction.



FATIGUE CAUSES

FUEL (GLYCOGEN)

Low muscle glycogen limits ATP resynthesis and prolongs fatigue.

SODIUM (Na⁺)

Loss of Na⁺ through sweat can impair nociception and neuromuscular function.

CALCIUM (Ca²⁺)

Reduced Ca²⁺ release or reuptake impairs cross-bridge cycling and force production.

★ Multiple peripheral factors interact to cause fatigue.

3. RECOVERY INDICATORS

Recovery is more than just feeling less tired.



PHYSIOLOGICAL

- Resting heart rate returns to baseline
- Heart rate variability improves
- Muscle soreness decreases
- Inflammatory markers reduce
- Sleep quality improves



SYMPTOMATIC

- Reduced fatigue and heaviness
- Better muscle function and power
- Decreased perceived exertion (RPE)
- Less pain and stiffness
- Improved appetite



PSYCHOLOGICAL

- Better mood and motivation
- Greater confidence
- Reduced stress and irritability
- Improved concentration
- Renewed desire to train

★ Monitor multiple indicators for a full picture of recovery.

4. RECOVERY NUTRITION

Nutrition after exercise restores, repairs and adapts.

KEY NUTRIENTS AND THEIR ROLES



CARBOHYDRATE

Replenishes muscle glycogen stores.



PROTEIN

Provides amino acids for muscle repair and adaptation.



WATER

Rehydrates the body and maintains blood volume.



CREATINE MONOHYDRATE

Restores phosphocreatine stores to resynthesize ATP for high-intensity efforts.



POLYPHENOL-RICH FOODS

(e.g., berries, tart cherry, green tea) Reduce inflammation and oxidative stress.

RECOVERY NUTRITION TIMELINE

Target the early window for maximum benefit.



0–30 MINUTES

Refuel & Rehydrate



30–120 MINUTES

Repair & Restock



2–4 HOURS

Restore & Refuel



DAILY

Support Adaptation

★ Timing, quality and total daily intake all matter.

5. RECOVERY METHODS

Evidence-informed strategies speed recovery.



MYOFASCIAL RELEASE

- Foam rolling or massage reduces muscle tension
- Improves blood flow and mobility
- May reduce soreness and improve range of motion



COMPRESSION GARMENTS

- May improve venous return and circulation
- Can reduce perceived muscle soreness
- Useful during travel and between sessions



THERMOTHERAPY

COLD

- Ice baths / cold showers
- Reduce inflammation
- Numb pain and soreness
- Best for short-term relief

HEAT



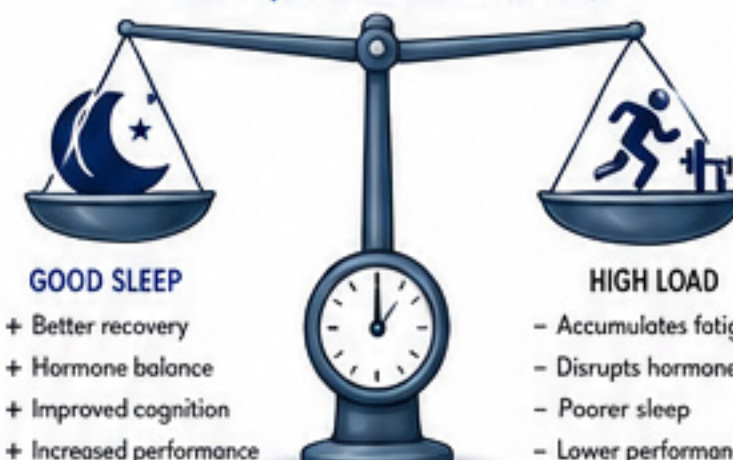
- Hot baths / sauna
- Increase blood flow
- Relax muscles
- Aid long-term recovery

★ Use methods that suit the goal, timing and athlete.

6. SLEEP QUALITY, LOAD & TRAVEL

Sleep and travel strongly influence recovery.

SLEEP QUALITY & TRAINING LOAD



Aim for balance: manage load and prioritise quality sleep.

TRAVEL & TIME-ZONE DISRUPTION

EFFECTS

- Circadian rhythm misalignment
- Poor sleep quality
- Increased fatigue
- Reduced performance
- GI upset and dehydration



MANAGEMENT

- ✓ Adjust sleep schedule before travel
- ✓ Stay hydrated
- ✓ Expose to light at destination
- ✓ Light movement and mobility
- ✓ Plan nutrition ahead

★ Plan ahead and adapt to reduce disruption.

SPORT APPLICATION



Good recovery improves training quality and performance.



Optimises homeostasis – energy, fluid balance, repair and adaptation.



Recovery strategies reduce injury risk and support long-term success.



DO NOT OVERLEARN

You are not required to know:

- Exact enzyme pathways
- Detailed ion channel mechanisms
- Complex hormone pathways
- Specific supplement brands
- Detailed sleep cycles
- Air travel physiology beyond key effects



KEY LINKS

- Links to A.1.1 (Nervous system) – central fatigue and CNS control.
- Links to A.1.2 (Intra-system communication) – information flow and hormonal responses.
- Links to A.2.1 (Water & electrolyte balance) – hydration, sodium and potassium.
- Links to A.2.2 (Energy systems) – fuel use and restoration.
- Links to A.2.4 (Movement analysis) – performance outcomes.



QUICK CHECK

1. What is the difference between central and peripheral fatigue?
2. List three peripheral factors that contribute to fatigue and explain their effects.
3. What are three physiological indicators of recovery?
4. Name three key nutrients for recovery and explain their roles.
5. Give three recovery strategies and explain how they help.
6. How can sleep and travel disruption impact recovery?



B.1.1

ANATOMICAL POSITION,
PLANES AND MOVEMENT

Understanding the body and its movement

GUIDING QUESTION: How can precise anatomical language describe human movement?

★ EXAM PRIORITY – MUST KNOW

- Anatomical position = standard reference position
- Planes divide the body; axes run perpendicular to planes
- Movement terms describe specific actions at joints
- Applies to analysis, coaching, training and injury prevention
- HL: anthropometry (equipment sizing & design)
- HL: ergonomics (efficiency & reducing risk)

1. AXIAL VS APPENDICULAR SKELETON

The skeleton is divided into two main parts.

AXIAL SKELETON
(central axis)

- Skull
- Vertebral column
- Rib cage
- Sternum

APPENDICULAR SKELETON
(limbs & girdles)

- Pectoral (shoulder) girdle
- Upper limbs
- Pelvic (hip) girdle
- Lower limbs

Skull
Rib cage
Sternum
Vertebral column

Shoulder girdle
Humerus
Pelvic (hip) girdle
Femur
Tibia
Fibula

★ The axial skeleton protects vital organs; the appendicular skeleton enables movement.

2. ANATOMICAL POSITION & POSITIONAL TERMS

Anatomical position is the standard reference position.

SUPERIOR
Above; towards the head

INFERIOR
Below; towards the feet

ANTERIOR
Towards the front

POSTERIOR
Towards the back

MEDIAL
Towards the midline

LATERAL
Away from the midline

INTERMEDIATE
Between medial and lateral

PROXIMAL
Nearer to the point of origin

DISTAL
Further from the point of origin

Anatomical position:

- Standing upright, facing forward
- Head level, eyes forward
- Arms at sides, palms facing forward
- Feet flat, toes pointing forward

★ These terms are used to describe the position of structures and the direction of movement.

3. PLANES AND AXES OF MOVEMENT

Planes divide the body; axes run perpendicular to the plane.

PLANES	AXES (perpendicular)
SAGITTAL PLANE Divides left and right. 	TRANSVERSE AXIS (Right–Left axis) Movement examples: • Flexion, extension
FRONTAL (CORONAL) PLANE Divides front and back. 	ANTEROPosterior AXIS (Front–Back axis) Movement examples: • Abduction, adduction • Lateral flexion
TRANSVERSE (HORIZONTAL) PLANE Divides top and bottom. 	LONGITUDINAL AXIS (Superior–Inferior axis) Movement examples: • Rotation

★ Knowing the plane and axis helps identify and analyse movements precisely.

4. MOVEMENT TERMINOLOGY AT SYNOVIAL JOINTS

Movements occur around the axes and within the planes.

FLEXION
Decrease angle at joint.

EXTENSION
Increase angle at joint.

ABDUCTION
Away from midline.

ADDUCTION
Towards midline.

PRONATION
Forearm rotates so palm faces down.

SUPINATION
Forearm rotates so palm faces up.

PROTRACTION
Scapula moves forward around rib cage.

RETRACTION
Scapula moves back towards spine.

OPPOSITION
Thumb moves across palm to touch fingers.

REPOSITION
Return thumb from opposition to anatomical position.

INVERSION
Sole of foot turns inwards.

EVERSION
Sole of foot turns outwards.

ELEVATION
Move a body part upwards.

DEPRESSION
Move a body part downwards.

CIRCUMDUCTION
Circular motion combining flexion, extension, abduction and adduction.

ROTATION
Bone turns around its long axis.

PLANTARFLEXION
Point foot downwards.

DORSIFLEXION
Lift foot towards shin.

HORIZONTAL FLEXION
Movement in a horizontal plane towards midline.

HORIZONTAL EXTENSION
Movement in a horizontal plane away from midline.

★ Muscles cross joints to produce these movements.

5. HL – ANTHROPOMETRY & EQUIPMENT SIZING / DESIGN

Anthropometry = measuring body dimensions.

KEY MEASUREMENTS

- Stature (height)
- Sitting height
- Arm span
- Limb lengths
- Shoulder width
- Hip width
- Hand span
- Foot length

APPLICATIONS IN SPORT

- Bike frame size
- Rowing seat position
- Shoe / boot sizing
- Helmet fit

DESIGN CONSIDERATIONS

- Fit, comfort and safety
- Performance optimisation
- Reducing injury risk
- Inclusive design for all body types

★ Accurate body measurements lead to better equipment choice, fit and performance.

6. HL – ERGONOMICS & EFFICIENCY IN PERFORMANCE

Ergonomics = designing tasks, equipment and environments to optimise performance and reduce strain.

ERGONOMIC PRINCIPLES

- Neutral spine and joint alignment
- Reduce excessive force and repetition
- Keep frequently used items within easy reach
- Use appropriate tool / equipment sizes
- Maintain good posture and balance

EXAMPLES IN SPORT

WEIGHT TRAINING
Correct technique and bench height reduce lower back strain and improve force production.

CYCLING
Handlebar and saddle position reduce strain and improve power output.

OFFICE / COACHING
Proper chair, desk distance and screen height improve posture and reduce fatigue.

RUNNING
Appropriate footwear and landing mechanics reduce impact forces and injury risk.

★ Good ergonomics improves efficiency, reduces fatigue and helps prevent injury.

SPORT APPLICATION

Precise language improves coaching feedback and skill analysis.

Understanding planes and axes helps in skill execution.

Movement knowledge supports strength and conditioning programme design.

Biomechanical awareness reduces injury risk and aids rehabilitation.

✗ DO NOT OVERLEARN

You are not required to know:

- Every muscle action
- Every joint classification detail
- Biomechanical equations or complex calculations
- Advanced gait analysis metrics
- CAD software specifics

🔗 KEY LINKS

- Links to B.1.2 (Factors affecting movement) – leverage, stability and balance.
- Links to B.2.2 (Exercise and skill analysis) – using biomechanical principles.
- Links to B.3 (Training) – exercises specifically target movements.
- Links to HL Options – biomechanics, ergonomics and performance optimisation.

✓ QUICK CHECK

1. Describe anatomical position.
2. Define and give an example for each plane and its axis.
3. What is the difference between proximal and distal?
4. Explain the difference between pronation and supination.
5. Give an example of how anthropometry influences equipment design.
6. How does ergonomics improve performance?

GUIDING QUESTION: How do connective tissues and joint structures permit movement while maintaining stability?

- Connective tissues: structure and function
- Joint types: fibrous, cartilaginous, synovial
- Synovial joint classes and examples
- Structure–function relationships
- Balance of mobility and stability
- Applications to sport performance and injury

1. CONNECTIVE TISSUES – STRUCTURE, LOCATION & FUNCTION

BONE  Location: Skeletal system Function: • Supports & protects • Levers for movement • Mineral store (Ca, P) • Blood cell formation	LIGAMENT  Location: Bone to bone Function: • Stabilises joints • Limits excessive movement • Guides joint alignment	CARTILAGE  Location: Ends of bones, ribs, nose, ear Function: • Reduces friction • Absorbs shock • Smooth surface for movement
FASCIA  Location: • Around muscles and organs throughout body Function: • Wraps, supports and separates structures • Transmits force • Maintains shape	TENDON  Location: Muscle to bone Function: • Transmits force from muscle to bone • Stores elastic energy	

★ Connective tissues form the body's framework – supporting, linking and transmitting forces.

2. TYPES OF ARTICULATION (BY TISSUE)

Joints are classified by the tissue that connects the bones.

 FIBROUS Examples: • Skull sutures • Distal tibiofibular joint	Tissue: Dense fibrous connective tissue Movement: None (immovable) Function: Provides maximum stability and protection
 CARTILAGINOUS Examples: • Intervertebral discs • Pubic symphysis	Tissue: Cartilage (hyaline) Movement: Slight (limited) Function: Allows small amounts of movement and absorbs shock
 SYNOVIAL Examples: • Knee • Shoulder • Ankle	Tissue: Synovial membrane, capsule, ligaments, cartilage Movement: Freely movable Function: Wide range of movement with stability and low friction

★ Different tissues = different movement potential.

3. SYNOVIAL JOINT CLASSES

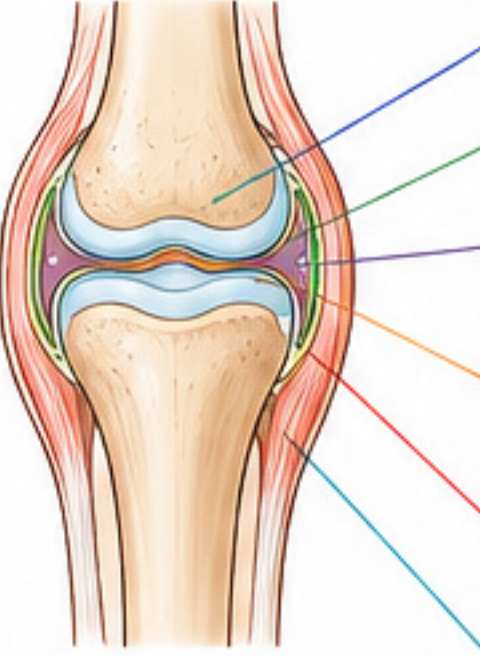
Synovial joints allow the greatest range of movement. Six functional classes:

BALL-AND-SOCKET  Movement: Multi-axial (flex/ext, abd/add, rotation, circum.) Example: Shoulder, hip Sport example: Overarm throw (shoulder)	HINGE  Movement: Uniaxial (flexion and extension) Example: Elbow, knee, ankle Sport example: Knee extension in a kick	PIVOT  Movement: Uniaxial (rotation) Example: Atlas-axis (neck) Sport example: Turning head to track ball	CONDYLOID (ELLIPSOID)  Movement: Bi-axial (flex/ext, abd/add, circumduction) Example: Wrist joint Sport example: Dribbling a ball (wrist control)	SADDLE  Movement: Bi-axial (flex/ext, abd/add, opposition) Example: Thumb CMC joint Sport example: Dripping a bat (thumb action)	PLANE/GLIDING  Movement: Non-axial (sliding) Example: Intercarpal joints, facet joints Sport example: Small glides in spine during run
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★ The shape of the joint surface determines the direction and amount of movement.

4. STRUCTURE–FUNCTION RELATIONSHIPS IN SYNOVIAL JOINTS

Each structure contributes to movement with stability.

	Articular cartilage – smooth, reduces friction and absorbs shock Synovial membrane – produces synovial fluid Synovial fluid – lubricates, nourishes cartilage, removes waste Joint capsule – encloses joint, maintains negative pressure Ligaments – strengthen and stabilise joint, limit excessive movement Tendons (outside capsule) – transmit force from muscle to bone
---	---

★ Integrated structures = smooth movement + joint protection.

5. MOBILITY VERSUS STABILITY

Performance requires the right balance of mobility (movement) and stability (control).

High mobility: • Greater ROM • Better for skill performance • Risk: instability and injury		High stability: • Protects joints • Improves force transfer • Risk: reduced movement efficiency
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★ Optimal performance = appropriate mobility + appropriate stability for the task.

6. EXAM APPLICATION: SPORT & INJURY

APPLYING KNOWLEDGE TO SPORT • Ligaments stabilise joints during cutting, landing and change of direction. • Tendons store and return elastic energy in running and jumping. • Cartilage and synovial fluid reduce impact in high-load sports.	COMMON INJURIES & IMPACT • Ligament sprain/tear (e.g., ACL) – instability, swelling, loss of control • Tendinopathy (e.g., Achilles) – pain, reduced force transfer • Cartilage wear (e.g., OA) – pain, stiffness, reduced ROM
--	---

Training adaptations improve connective tissue strength and joint control (e.g., strength training, plyometrics, mobility work, technique).

★ Understanding tissues and joints helps prevent injury and guides rehabilitation.



SPORT APPLICATION

Good joint health = better results.

- Warm up to increase synovial fluid and tissue elasticity.
- Build strength of muscles, tendons and ligaments.
- Use correct technique to reduce joint stress.
- Recover well – sleep, nutrition, hydration.



DO NOT OVERLEARN

You are not required to know:

- Cellular-level structure of connective tissues (fibroblasts, collagen types, proteoglycans)



KEY LINKS

- Links to A.1.2 (Intra-system communication) – hormones support tissue repair.
- Links to A.2.1 (Water & electrolyte balance) – hydration maintains synovial fluid.
- Links to A.2.3 (Respiratory system) – oxygen needed for tissue recovery.
- Links to A.2.2 (Energy systems) – energy for repair and adaptation.



QUICK CHECK

1. Name and explain the function of the six connective tissues covered.
2. Differentiate between fibrous, cartilaginous and synovial joints.
3. Describe the six classes of synovial joints with examples.
4. Explain how joint structures allow movement while maintaining stability.
5. Give a sporting example of how connective tissues and joints can be injured.



B.1.3 MUSCULAR FUNCTION

Movement and Performance – the muscular and skeletal systems

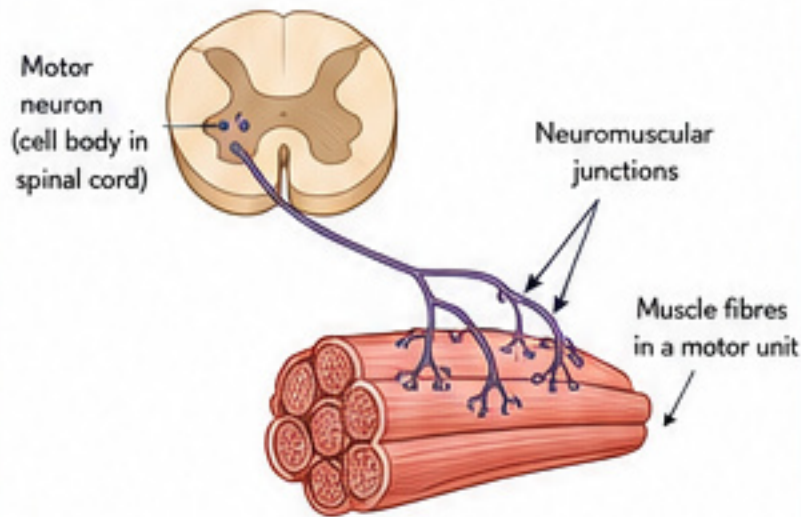
GUIDING QUESTION: How do motor units, fibre types and contractions create force and movement?

★ EXAM PRIORITY – MUST KNOW

- Motor unit = motor neuron + all fibres it innervates
- All-or-none: once stimulated, a muscle fibre contracts fully
- Fibre types differ in twitch speed, fatigue resistance & force
- Recruitment principle: small → large motor units
- Hypertrophy ↑ CSA & force; Atrophy ↓ CSA & force
- Contraction types: isometric, concentric, eccentric, isokinetic
- Agonist & antagonist + reciprocal inhibition enable movement
- ATP needed for cross-bridge cycling and relaxation

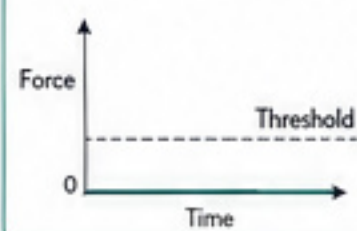
1. MOTOR UNIT & THE ALL-OR-NONE PRINCIPLE

A motor unit is one motor neuron and all the muscle fibres it stimulates.



ALL-OR-NONE PRINCIPLE

1 Below threshold: no contraction



2 At or above threshold: full contraction

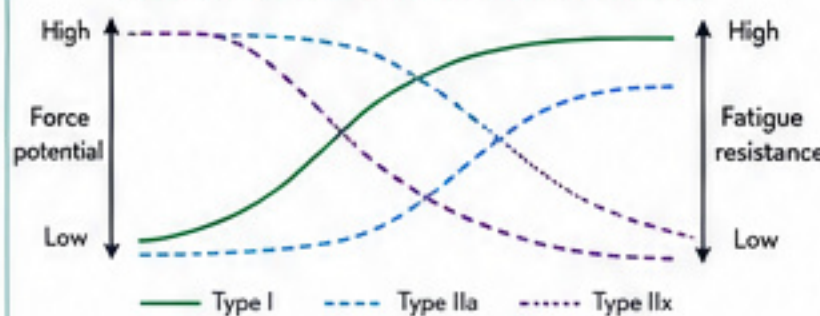


★ Strength comes from recruiting more motor units, not from a stronger contraction of one unit.

2. MUSCLE FIBRE TYPES: TYPE I, IIa & IIx

Feature	TYPE I (Slow Oxidative)	TYPE IIa (Fast Oxidative-Glycolytic)	TYPE IIx (Fast Glycolytic)
Twitch speed	Slow	Fast	Very fast
Force potential	Low	Moderate-high	Very high
Fatigue resistance	High	Moderate	Low
Primary energy systems	Aerobic	Aerobic + Anaerobic (glycolytic)	Anaerobic (glycolytic)
Examples in sport	Marathon, cycling (endurance)	800–1500 m running, team sports	100 m sprint, weightlifting, jumping

RELATIVE FORCE & FATIGUE COMPARISON

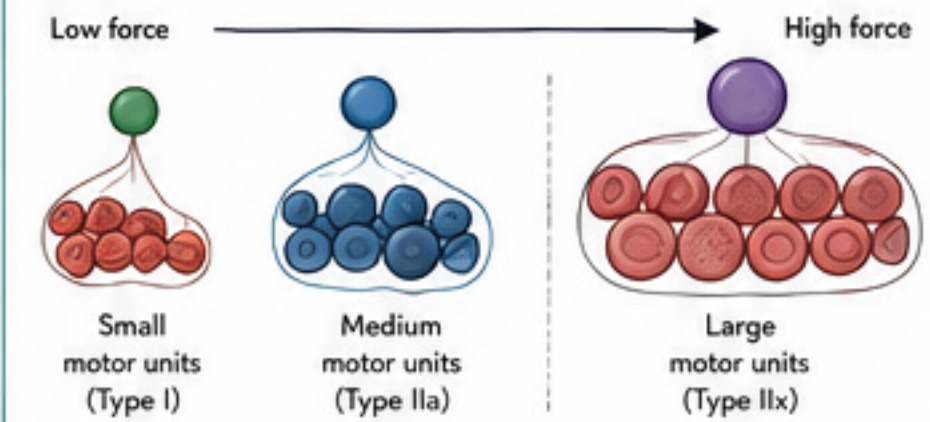


★ Muscle performance depends on the mix of fibre types.

3. RECRUITMENT, HYPERTROPHY & ATROPHY

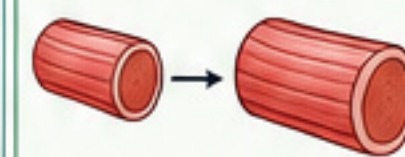
SIZE PRINCIPLE – RECRUITMENT ORDER

Motor units are recruited from smallest to largest as more force is needed.



HYPERTROPHY (Training)

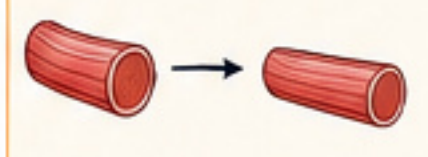
Increase in muscle fibre cross-sectional area (CSA).



- ✓ More contractile proteins
- ✓ Greater CSA
- ✓ More force production

ATROPHY (Detraining/Inactivity)

Decrease in muscle fibre cross-sectional area (CSA).



- ✓ Fewer contractile proteins
- ✓ Smaller CSA
- ✓ Less force production

★ Training stimulus → adaptation → improved performance.

4. TYPES OF MUSCLE CONTRACTION

Muscles can produce force in different ways.

ISOMETRIC (No joint movement)

Muscle produces force but length does not change.

Example: Wall sit, pushing against an immovable object.



CONCENTRIC (Muscle shortens)

Muscle shortens as it overcomes resistance.

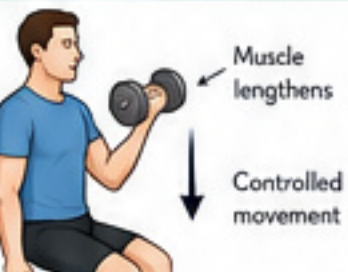
Example: Bicep curl – lifting the weight.



ECCENTRIC (Muscle lengthens)

Muscle lengthens while controlling resistance.

Example: Lowering the weight in a bicep curl.



ISOKINETIC (Constant speed)

Muscle contracts at a constant speed through full ROM.

Example: Rehab or biodex machine.



★ Different contraction types place different demands on muscles.

5. AGONIST, ANTAGONIST & RECIPROCAL INHIBITION

Skeletal muscles work in pairs to create movement.

AGONIST (Prime mover)

Contracts to produce the movement.



FLEXION (BICEP CURL)

Bicep contracts (agonist)

ANTAGONIST

Relaxes to allow the movement.



Tricep relaxes (antagonist)

RECIPROCAL INHIBITION

When the agonist contracts, the CNS inhibits the antagonist to prevent opposing contraction.



ATP REQUIREMENT

- ATP is required for:
- Cross-bridge cycling (contraction)
 - Calcium reuptake (relaxation)

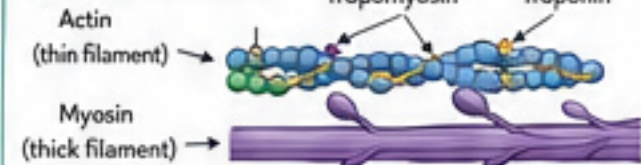
Without ATP, muscles fatigue and can't relax.

★ Coordinated activation and inhibition = smooth movement.

6. SLIDING FILAMENT THEORY (HOW MUSCLES CONTRACT)

Force is produced by interaction of actin and myosin filaments.

1 RESTING STATE



Tropomyosin blocks myosin binding sites on actin. Muscle is relaxed.

2 CALCIUM RELEASE



Calcium (Ca²⁺) binds to troponin, moving tropomyosin away from binding sites.

3 CROSS-BRIDGE FORMATION



Myosin head (with ADP + Pi) binds to actin.

4 POWER STROKE



ADP and Pi released. Myosin head pivots, pulling actin towards the centre.

5 DETACHMENT



ATP binds to myosin → cross-bridge detaches.

6 RE-COCKING



ATP hydrolysis cocks the myosin head, ready to bind again.

★ Cycle repeats while Ca²⁺ and ATP are available.

SPORT APPLICATION

- Sprinters rely more on Type IIx fibres for maximal speed and power.
- Distance runners rely more on Type I fibres for endurance.
- Eccentric training (e.g. slowing phase) improves strength and reduces injury risk.
- Strength training increases hypertrophy → improves performance.
- Detraining leads to atrophy → loss of strength and power.

DO NOT OVERLEARN

You are not required to know:

- Detailed biochemical pathways of ATP production
- Exact molecular structures of actin, myosin, troponin and tropomyosin
- All enzyme names in the cross-bridge cycle
- Precise hormonal control of hypertrophy



KEY LINKS

- Links to B.2.1 (Movement analysis) – muscle actions create joint movement.
- Links to B.2.2 (Energy systems) – ATP supplies the energy for muscle contraction.
- Links to A.1.2 (Cardiovascular system) – oxygen delivery supports aerobic muscle performance.
- Links to A.1.1 (Nervous system) – CNS and PNS control muscle activity.

QUICK CHECK

1. Define a motor unit and the all-or-none principle.
2. Compare Type I, IIa and IIx fibres.
3. Explain the recruitment principle.
4. Describe hypertrophy and atrophy.
5. Describe and give an example of each contraction type.
6. Explain agonist, antagonist and reciprocal inhibition.
7. What is ATP needed for in muscle contraction?
8. Outline the sliding filament theory in six steps.



How the body uses leverage to produce movement.

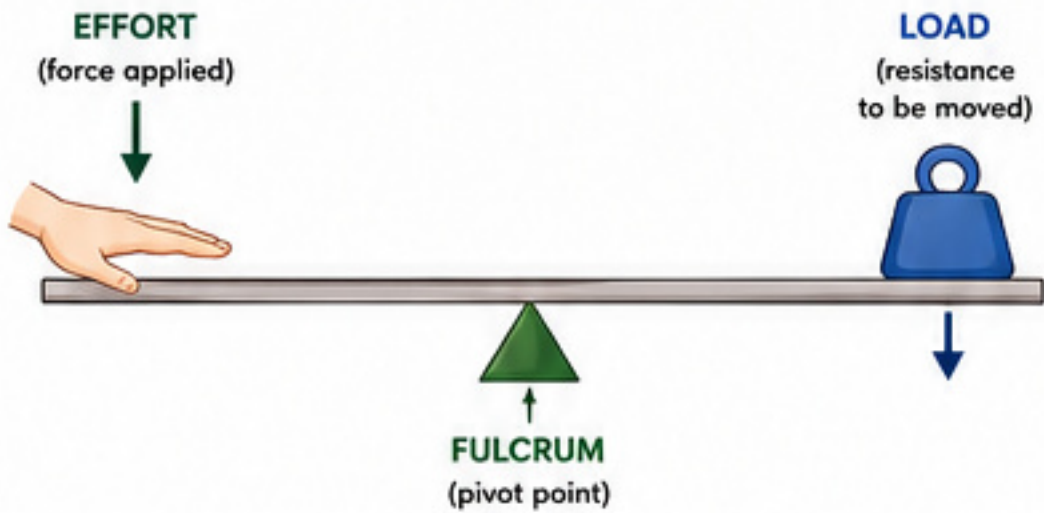
GUIDING QUESTION: How do lever arrangements change force, speed and range of motion?

★ **EXAM PRIORITY – MUST KNOW**

- Levers consist of a fulcrum, effort and load.
- Three classes of levers: first, second and third.
- Lever class affects mechanical advantage, speed and range of motion.
- $MA > 1$ = force advantage (less speed, less ROM).
- $MA < 1$ = speed/ROM advantage (less force).
- External levers (equipment) extend body levers and improve performance.

1. LEVER COMPONENTS

Every lever has three key components.

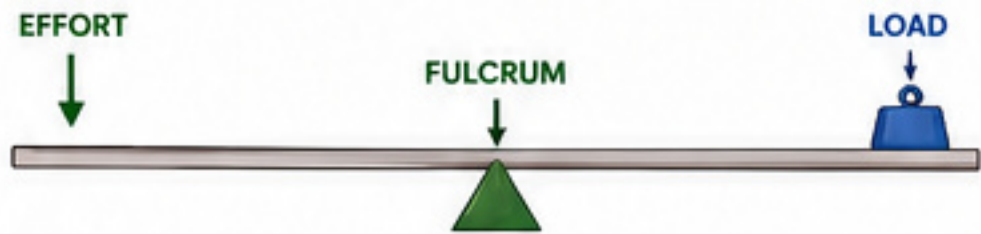


KEY POINTS

- The position of each component determines the lever class.
- Changing the distance between components changes the effect.
- In the body, bones = levers, joints = fulcrums, muscles = effort, body parts/objects = load.

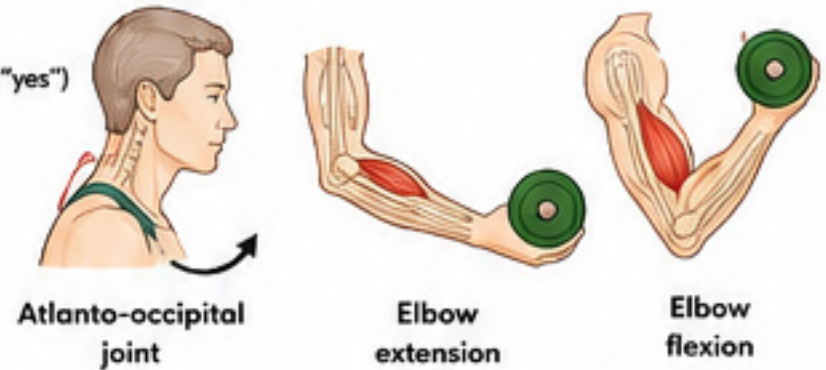
2. FIRST-CLASS LEVER

Fulcrum is between effort and load.



Examples in the body

- Atlanto-occipital joint (nodding "yes")
- Elbow extension (triceps)
- Biceps curl (elbow flexion)



EFFECT

Can produce force in either direction. MA can be $>$, $=$ or $<$ 1 depending on the position of the effort and load.

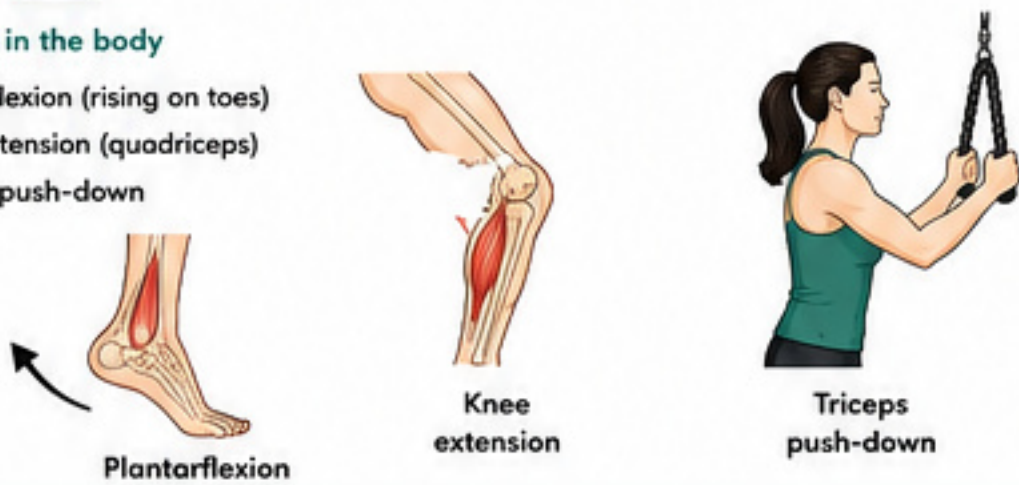
3. SECOND-CLASS LEVER

Load is between fulcrum and effort.



Examples in the body

- Plantarflexion (rising on toes)
- Knee extension (quadriceps)
- Triceps push-down



EFFECT

Always $MA > 1$ (force advantage). Produces more force with less effort, but the load moves a shorter distance and slower.

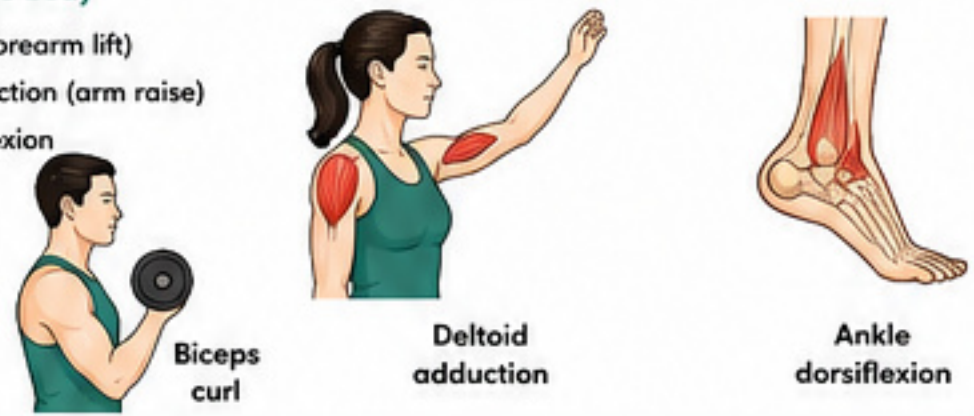
4. THIRD-CLASS LEVER

Effort is between fulcrum and load.



Examples in the body

- Biceps curl (forearm lift)
- Deltoid abduction (arm raise)
- Ankle dorsiflexion



EFFECT

Always $MA < 1$ (speed/ROM advantage). Requires more effort than the load, but produces greater speed and a larger range of motion.

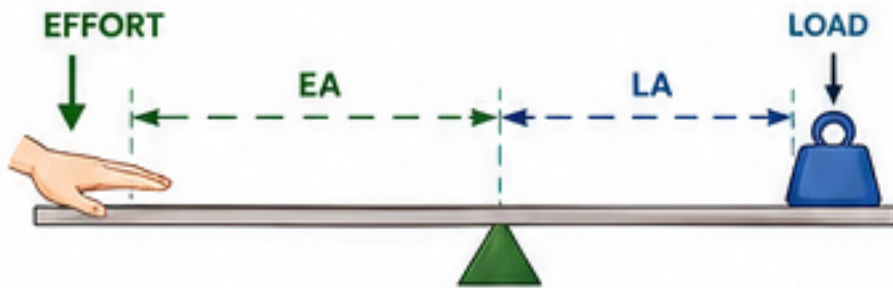
5. MECHANICAL ADVANTAGE, EFFORT ARM & LOAD ARM

The distances from the fulcrum affect the effect.

DEFINITIONS

Effort arm (EA): distance from fulcrum to effort.

Load arm (LA): distance from fulcrum to load.



MECHANICAL ADVANTAGE (MA)

$$MA = EA \div LA$$

INTERPRETING MA

$MA > 1$	Force advantage	More force, less speed/ROM
$MA = 1$	Neutral	Equal force and speed
$MA < 1$	Speed/ROM advantage	Less force, more speed/ROM

HOW TO CHANGE MA

Increase EA = OR Increase MA	Decrease LA = OR Decrease MA (speed/ROM advantage)
Decrease EA OR Increase LA	Decrease EA OR Increase LA

KEY TAKEAWAY

- Levers trade off force for speed and range. The body uses the right lever for the task.

6. EXTERNAL LEVERS IN SPORT

Equipment acts as external levers to increase force, speed or control.

BATS	RACKETS	PADDLES	POLES
PERFORMANCE EFFECTS • Longer bat = longer LA → higher bat speed • Increases power potential at impact	PERFORMANCE EFFECTS • Longer racket = greater swing speed and reach • Improves power and control	PERFORMANCE EFFECTS • Long paddle increases force on water • Improves propulsion and speed	PERFORMANCE EFFECTS • Longer pole stores more elastic energy • Greater height and efficiency

SPORT APPLICATION

- Technique uses the most effective lever for the task.
- Fine-tune positions to change mechanical advantage.
- Develop strength where force is needed; mobility where speed and range are key.

DO NOT OVERLEARN

Focus on understanding, not memorising random examples.

You must be able to identify the lever class from the positions of the:

- ✓ Effort (E)
- ✓ Fulcrum (F)
- ✓ Load (L)

KEY LINKS

- B.1.1 Skeletal system – bones form levers.
- B.1.2 Muscular system – muscles provide effort.
- B.1.3 Movement analysis – lever class affects movement patterns and performance.
- A.1.1 Inter-system communication – coordination optimises lever mechanics.

QUICK CHECK

1. Label the effort, fulcrum and load on any lever.
2. Identify the lever class for each diagram.
3. Which lever class gives the greatest force advantage?
4. Which lever class gives the greatest speed advantage?
5. How can changing EA or LA affect mechanical advantage?



B.2.1 NEWTON'S LAWS OF MOTION

Motion changes when unbalanced forces act.

GUIDING QUESTION: How can forces explain linear and angular movement in sport?

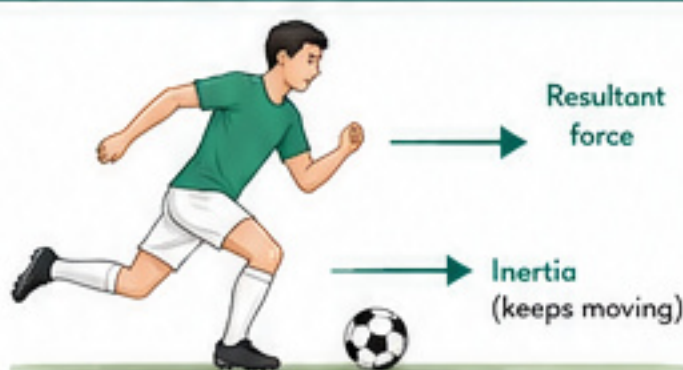
★ EXAM PRIORITY – MUST KNOW

- Newton's three laws explain motion in sport
- Linear and angular variables link forces to performance
- Impulse explains short-duration force-time effects
- Momentum and collisions underpin interactions
- Friction, work and power optimise technique & equipment

1. NEWTON'S THREE LAWS APPLIED TO SPORT

1 FIRST LAW (INERTIA)

An object remains at rest or in uniform straight-line motion unless acted on by a resultant (unbalanced) force.

2 SECOND LAW ($F = ma$)

The resultant force on an object equals its mass $\times$ acceleration.

$$F = ma$$

F = resultant force (N)
 m = mass (kg)
 a = acceleration ($\text{m}\cdot\text{s}^{-2}$)



3 THIRD LAW (ACTION = REACTION)

For every action force there is an equal and opposite reaction force.



★ Laws apply to both linear and angular motion.

2. DESCRIBING MOTION IN SPORT

LINEAR MOTION

Speed (v)
 Distance per unit time.
 $v = \frac{d}{t}$ ($\text{m}\cdot\text{s}^{-1}$)

Linear velocity (v)
 Speed in a given direction.
 $v = \frac{\Delta x}{\Delta t}$ ($\text{m}\cdot\text{s}^{-1}$)

Acceleration (a)
 Rate of change of velocity.
 $a = \frac{\Delta v}{\Delta t}$ ($\text{m}\cdot\text{s}^{-2}$)

Linear momentum (p)
 Quantity of motion.
 $p = mv$ ($\text{kg}\cdot\text{m}\cdot\text{s}^{-1}$)

ANGULAR MOTION

Angular velocity (ω)
 Rate of change of angular displacement.
 $\omega = \frac{\Delta \theta}{\Delta t}$ ($\text{rad}\cdot\text{s}^{-1}$)

Angular acceleration (α)
 Rate of change of angular velocity.
 $\alpha = \frac{\Delta \omega}{\Delta t}$ ($\text{rad}\cdot\text{s}^{-2}$)

Moment of inertia (I)
 Resistance to change in angular motion.
 (Depends on mass distribution)

Torque (τ)
 Turning effect of a force about an axis.
 $\tau = r \times F$ ($\text{N}\cdot\text{m}$)



★ Linear = straight-line motion • Angular = rotation about an axis

3. STABILITY IN SPORT: KEY FACTORS

CENTRE OF MASS (COM)

The point where mass is balanced.



BASE OF SUPPORT (BOS)

Area of contact with the ground.



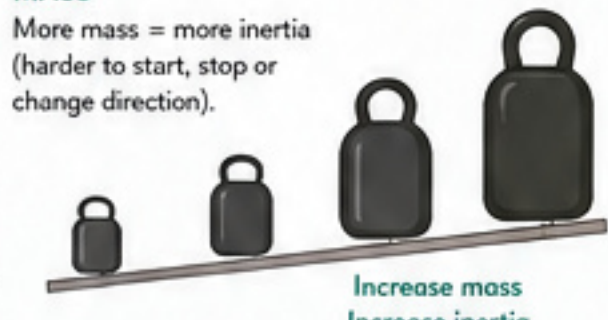
LINE OF GRAVITY (LOG)

Imaginary vertical line from COM towards the ground.



MASS

More mass = more inertia
 (harder to start, stop or change direction).



★ More stable when LOG stays within BOS and COM is low.

4. IMPULSE AND ANGULAR MOTION FROM ECCENTRIC FORCE

LINEAR IMPULSE

Impulse (J) = force $\times$ time.

$$J = F \Delta t \quad (\text{N}\cdot\text{s})$$

Impulse causes a change in momentum.

$$J = \Delta p = m \Delta v$$

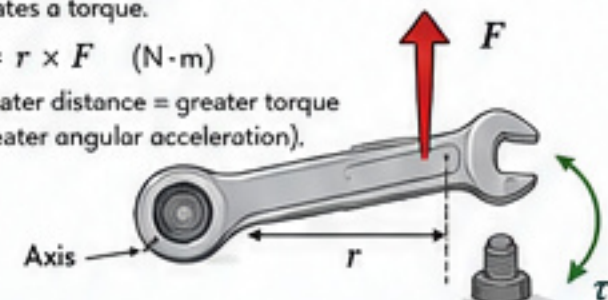


ANGULAR EFFECT OF ECCENTRIC FORCE

A force applied at a distance (r) from the axis creates a torque.

$$\tau = r \times F \quad (\text{N}\cdot\text{m})$$

Greater distance = greater torque
 (greater angular acceleration).



EXAMPLES

Penalty kick

- Foot applies force (F) over time (Δt)
- Impulse changes ball momentum $\rightarrow$ speed and direction



Tennis forehand

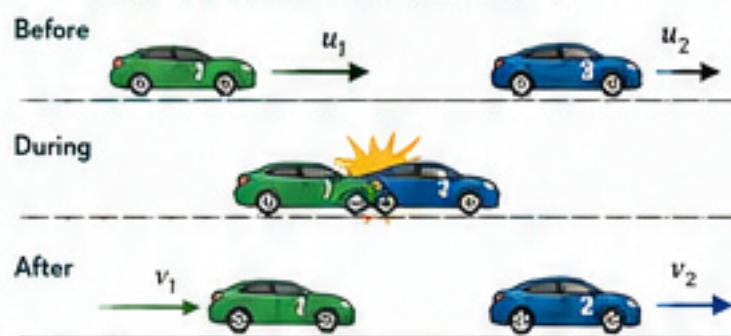
- Racket applies force off the axis (eccentric)
- Torque (τ) increases racket head speed
- Greater spin & pace



★ Impulse = linear change • Torque from eccentric force = angular change

5. HL: COLLISIONS, IMPULSE, MOMENTUM & COEFFICIENT OF RESTITUTION

HEAD-ON COLLISION SEQUENCE (1-D)



KEY EQUATIONS

Impulse: $J = F \Delta t = \Delta p$

Momentum: $p = mv$

Conservation of momentum:
 $m_1 u_1 + m_2 u_2 = m_1 v_1 + m_2 v_2$

Coefficient of restitution (e):

$$e = \frac{v_2 - v_1}{u_1 - u_2}$$

$0 \leq e \leq 1$ ($e = 1$ elastic, $e = 0$ inelastic)

ONE-DIMENSIONAL CALCULATION EXAMPLE

Car 1 ($m_1 = 1000 \text{ kg}$) at $15 \text{ m}\cdot\text{s}^{-1}$ hits stationary car 2 ($m_2 = 1500 \text{ kg}$).
 After collision: $v_1 = 5 \text{ m}\cdot\text{s}^{-1}$, $e = 0.6$. Find v_2 .

Given

$m_1 = 1000 \text{ kg}$
 $u_1 = 15 \text{ m}\cdot\text{s}^{-1}$
 $m_2 = 1500 \text{ kg}$
 $u_2 = 0$
 $v_1 = 5 \text{ m}\cdot\text{s}^{-1}$
 $e = 0.6$
 Find v_2

Step 1 Momentum

$$m_1 u_1 + m_2 u_2 = m_1 v_1 + m_2 v_2$$

$$(1000)(15) + (1500)(0) = (1000)(5) + (1500)v_2$$

$$15000 = 5000 + 1500v_2$$

$$v_2 = 6.67 \text{ m}\cdot\text{s}^{-1}$$

Step 2 Check with e

$$e = \frac{v_2 - v_1}{u_1 - u_2}$$

$$0.6 = \frac{6.67 - 0.5}{15 - 0}$$

$$0.6 = \frac{1.67}{15}$$

✓

★ Use momentum conservation first, then coefficient of restitution to check.

6. HL: FRICTION, WORK AND POWER IN SPORT

FRICTION

Opposes motion between surfaces.

Types: static, kinetic (sliding), rolling, air resistance (drag).



WORK AND POWER

Work (J): $W = F d \cos \theta$
 (Force $\times$ distance in direction of force)

Power (W): $P = \frac{W}{t} = F v \cos \theta$
 (Rate of doing work)

Greater power = more work done in less time.



OPTIMISING POWER IN SPORT

TECHNIQUE

- Reduce unwanted friction
- Optimise force application
- Use correct angles & timing
- Increase effective contact time



EQUIPMENT

- Reduce drag (aero design)
- Reduce rolling resistance
- Improve grip (shoes/ball/racket)
- Improve energy return



★ Minimise resistive forces, maximise useful work and power.

SPORT APPLICATION

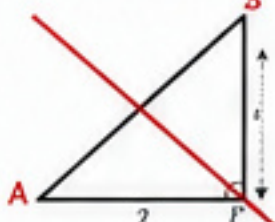
- Explains sprint start, change of direction, tackles and collisions
- Stability critical in balance, landings and cutting
- Impulse in striking, throwing, kicking and blocking
- Power production linked to performance outcomes



DO NOT OVERLEARN

Trigonometry is NOT assessed in SEHS exams.

Focus on understanding forces, equations and application.



KEY LINKS

- B.1.1 Forces
- B.1.2 Measurement of forces
- B.1.3 Equilibrium
- B.1.4 Linear motion
- B.2.2 Projectile motion
- B.2.3 Circular motion
- A.1.2 Communication of data

QUICK CHECK

1. State Newton's three laws and give a sport example.
2. Define linear velocity and angular velocity.
3. What affects stability in sport?
4. Explain how impulse changes momentum.
5. In a collision, what quantities are conserved?
6. How can friction, work and power be optimised?

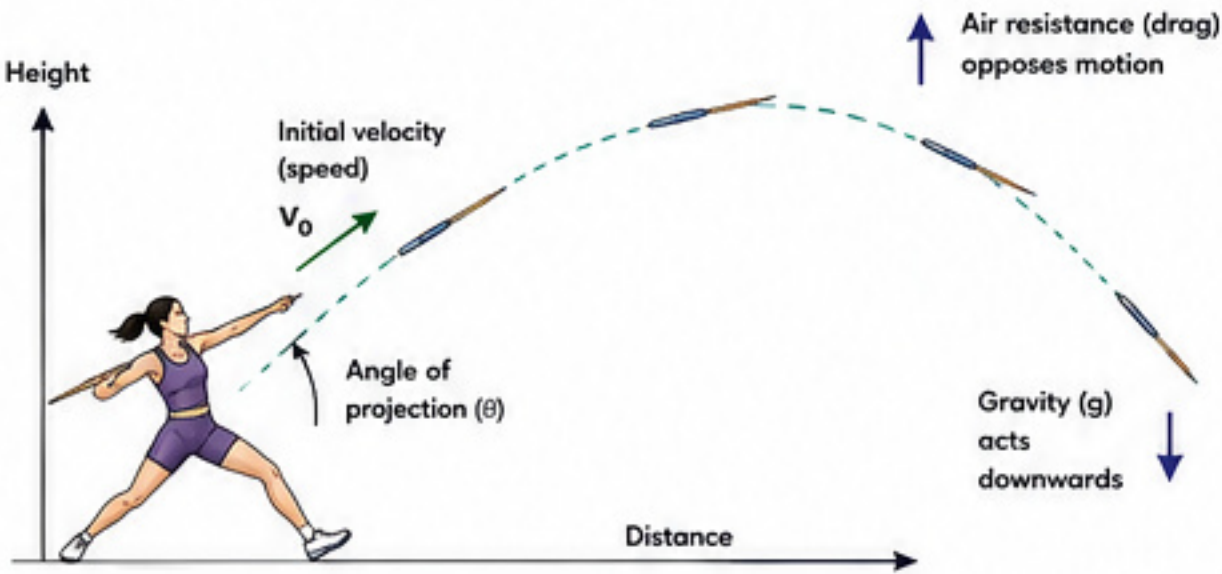


GUIDING QUESTION: How do air and water forces alter projectile and body movement?

- Fluid mechanics explains how forces from fluids (air and water) affect movement and performance.
- Key forces: gravity, drag, lift, buoyancy, thrust.
- Understanding allows optimisation of technique, equipment design and strategy.
- Influenced by environment and individual factors.
- Ethical and environmental responsibility is essential.

1. PROJECTILE FLIGHT DETERMINED BY INITIAL VELOCITY AND ANGLE OF PROJECTION

Projectiles are affected by gravity and air resistance (drag).



↑ Initial velocity and optimal launch angle (≈35°–45° for javelin) increase distance. Drag reduces height and range.

★ Projectiles follow a curved path due to gravity and drag.

2. RELEASE HEIGHT AND WEIGHT-TO-AIR-RESISTANCE RATIO

Greater release height and a higher weight-to-air-resistance ratio increase flight time and distance.

EFFECT OF RELEASE HEIGHT



WEIGHT-TO-AIR-RESISTANCE RATIO

$$\text{Ratio} = \frac{\text{Weight (N)}}{\text{Air resistance (N)}}$$

- ↑ Higher ratio = less slowed by drag (travels farther/maintains speed)
- ↓ Lower ratio = more slowed by drag (shorter flight/less speed)

★ Throw higher and increase the weight-to-air-resistance ratio to improve performance.

3. HL ENVIRONMENTAL CONDITIONS AFFECT FLUID FORCES

Environmental factors change the density of air or water, altering drag, lift and buoyancy.

TEMPERATURE	HUMIDITY	AIR PRESSURE	WIND	WATER SALINITY	ALTITUDE
• Warm air less dense → less drag • Warm water less dense → slightly less buoyancy	• High humidity (more water vapour) → less dense air → less drag	• Low pressure (high altitude) → less dense air → less drag • High pressure → more dense air → more drag	• Headwind ↑ drag • Tailwind ↓ drag	• Salt water more dense → ↑ buoyancy than fresh water	• Higher altitude → less dense air → ↓ drag (but also ↓ oxygen)

★ Environment changes fluid density and therefore the forces acting on the body or object.

4. HL BUOYANCY, LIFT AND DRAG IN WATER AND AIR

Forces act in and around fluids to support, oppose or redirect movement.

IN WATER (e.g., swimmer)



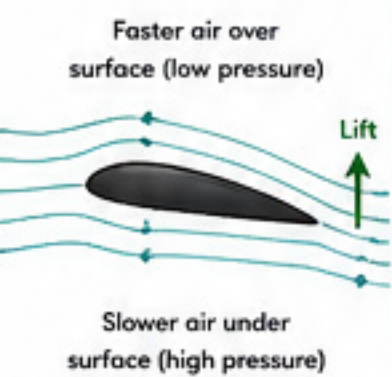
IN AIR (e.g., football)



★ Buoyancy supports. Lift can redirect. Drag opposes. Minimise drag, maximise useful lift.

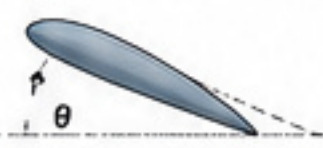
5. HL BERNOULLI PRINCIPLE, ANGLE OF ATTACK AND MAGNUS EFFECT

BERNOULLI PRINCIPLE



ANGLE OF ATTACK

The angle between the object and oncoming flow.



Small angle → stable lift
High angle → stall, loss of lift (more drag)

MAGNUS EFFECT

A spinning ball creates a pressure difference, producing lift.



★ Shape, angle and spin affect pressure differences, producing lift or curved flight.

6. HL SURFACE DRAG, FORM DRAG AND WAVE DRAG + IMPLICATIONS

TYPES OF DRAG

SURFACE DRAG
(skin friction)



FORM DRAG
(pressure drag)



WAVE DRAG
(water/air waves)



IMPLICATIONS IN SPORT



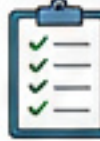
SPORTING

- Better technique reduces drag.
- Equipment designed to be streamlined.
- Performance improved.



ETHICAL

- Fair use of equipment and technology.
- Responsibility to reduce environmental impact.



REGULATORY

- Rules limit equipment advantages (e.g., swimwear thickness).
- Wind readings affect official records in athletics.

★ Understand and manage drag to move faster and more efficiently – with fairness and environmental responsibility.

SPORT APPLICATION



Runners use low body positions to reduce drag.



Cyclists use aero positions and equipment.



Swimmers streamline and steady strokes reduce drag.



Coaches adjust strategies based on environmental conditions.

DO NOT OVERLEARN

You are not required to know:

- Advanced equations for lift/drag coefficients
- Detailed computational fluid dynamics (CFD)
- Complex turbulence models
- Engineering design calculations
- Full meteorological modelling

$$F_D = \frac{1}{2} C_D \rho A v^2$$



KEY LINKS

- Links to B.2.1 (Kinematics) – projectile motion.
- Links to B.2.3 (Energy Systems) – actions influence energy cost.
- Links to A.1.2 (Water & electrolyte balance) – environment affects thermoregulation and fluid balance.
- Links to A.2.2 (Respiratory System) – altitude reduces oxygen availability.
- Links to A.3.1 (Injuries) – technique adjustments can reduce injury risk.

QUICK CHECK

1. What determines the flight of a projectile?
2. How do release height and weight-to-air-resistance ratio affect performance?
3. Name three environmental factors that influence fluid forces.
4. Define buoyancy, lift and drag and give one sporting example of each.
5. How do angle of attack and spin influence lift?
6. Describe three types of drag and their implications.



- Movement analysis breaks skills into phases to understand key events
- Phase analysis improves performance, reduces injury risk and increases inclusion
- Evidence from observation, video and technology informs decisions
- Findings guide coaching, rehab and accessibility adaptations
- Use a continuous improvement loop to monitor and refine

1. MOVEMENT PHASES – DISCRETE SKILLS

Breaking a skill into key phases helps identify what to improve.

EXAMPLE: TENNIS SERVE

1 PREPARATORY

Set up the body and prepare for action

2 FORCE PRODUCTION

Generate maximal force and speed

3 CRITICAL INSTANT

Key event that determines outcome (e.g. ball contact)

4 FOLLOW-THROUGH

Decelerate safely and direct force through the body



★ Each phase has a purpose – master the key events.

2. WHY PHASE ANALYSIS HELPS

Understanding phases leads to better outcomes.



IMPROVES PERFORMANCE

- Focus on key events and sequencing
- Develop power, speed and accuracy
- Refine technique and timing



ENHANCES SAFETY

- Identify risky positions and loads
- Correct technique faults
- Reduce injury risk



INCREASES ACCESSIBILITY

- Adapt technique, equipment or task
- Remove unnecessary barriers
- Support inclusion and participation



GUIDES DECISIONS

- Inform coaching, training and rehab
- Track progress over time
- Make evidence-based adjustments

★ Phase analysis turns information into action.

3. PERFORMANCE DIAGNOSIS LOOP

A continuous cycle of observation, analysis and improvement.



★ Revisit the loop often to keep improving.

4. VIDEO, OBSERVATION AND EVIDENCE SOURCES

Multiple sources provide reliable and valid evidence.



OBSERVATION

- Use checklists and notational analysis
- Note what, when, how often and outcome
- Consider context and environment



VIDEO ANALYSIS

- Slow motion, frame-by-frame review
- Angle, zoom and line/angle tools
- Enables comparison over time



TECHNOLOGY AND MEASURES

- Wearables (e.g. GPS, IMU, HR)
- Force plates, timing gates, jump mats
- Data: speed, force, power, angles, time



ATHLETE FEEDBACK

- RPE, comfort, confidence and goals
- Pain, fatigue and perceived effort
- Supports the full picture

★ Triangulate sources for the most accurate picture.

5. REHABILITATION AND COMPENSATION IDENTIFICATION

Analysis helps find problems and plan solutions.

IDENTIFY COMPENSATIONS

COMMON SIGNS

- Asymmetrical movement
- Reduced range of motion
- Poor timing/sequencing
- Excessive joint load
- Pain or discomfort



POSSIBLE IMPACTS

- Lower performance
- Higher energy cost
- Overuse injuries
- Loss of efficiency

REHABILITATION APPLICATION

ASSESS



Identify limitations and pain

RESTORE



Mobility, strength and control

RE-EDUCATE



Technique and movement patterns

RETURN



Gradual load and sport-specific work

★ Fix the cause, not just the symptom.

6. ACCESSIBILITY – ADAPT TECHNIQUE, EQUIPMENT, TASK

Change the constraints to enable success for all.



TECHNIQUE ADAPTATIONS

- Modify range of motion or stance
- Adjust grip or movement pattern
- Simplify key events



EQUIPMENT ADAPTATIONS

- Lighter rackets or larger handles
- Lower net or softer balls
- Assistive devices and supports



TASK/ENVIRONMENT ADAPTATIONS

- Reduce distance or court size
- Adjust speed, time or repetitions
- Provide clear cues and visuals

★ Adapt the constraints, not the potential.

SPORT APPLICATION – TENNIS SERVE

Using phase analysis to improve performance and reduce injury risk.

1 PREPARATORY

Tip: Balanced stance, consistent toss height
Checks: Toss steady, body coiled

2 FORCE PRODUCTION

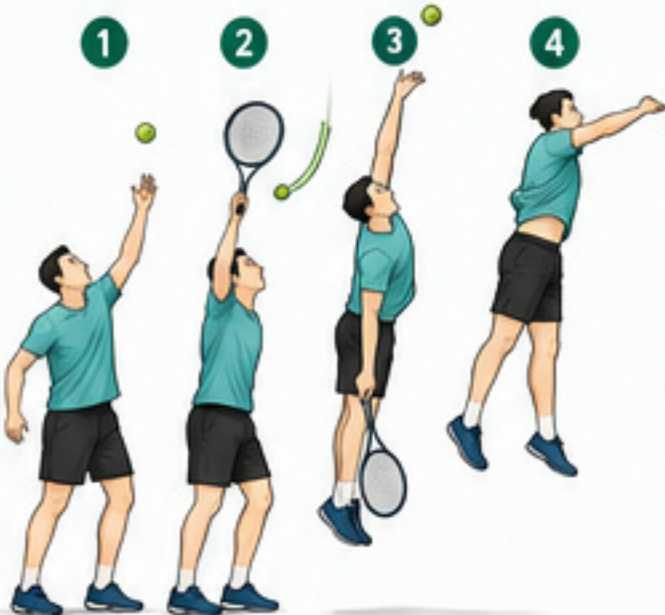
Tip: Drive upward, extend and rotate
Checks: Full extension, racket speed

3 CRITICAL INSTANT

Tip: Contact at highest point in front
Checks: Ball contact out in front, firm wrist

4 FOLLOW-THROUGH

Tip: Let racket decelerate across body
Checks: Finish balanced, no abrupt stop



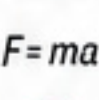
★ Small improvements in each phase create a big difference.



DO NOT OVERLEARN

You are not required to know:

- Exact joint angles or detailed kinetics
- Complex statistical procedures
- All technology brand specifications
- Biomechanical equations $F = ma$
- Pathological medical diagnoses



KEY LINKS

- Links to A.1.2 (Intra-system communication) – nervous and endocrine control of movement
- Links to A.2.2 (Energy systems) – energy supply for movement
- Links to A.2.1 (Water & electrolyte balance) – hydration and performance
- Links to A.2.3 (Respiration) – oxygen supply during activity
- Links to A.1.3 (Cardiovascular system) – transport of oxygen and nutrients



QUICK CHECK

1. Name the four phases used to analyse a discrete skill.
2. Give two ways phase analysis improves performance.
3. Explain how the analysis loop works.
4. List two sources of evidence used in movement analysis.
5. Give one example of a technique, equipment and task adaptation.



B.3.1 CAUSES OF INJURY

Why do internal and external factors make some athletes more susceptible to injury?

★ EXAM PRIORITY – MUST KNOW

- Injury risk = interaction of internal + external factors and exposure
- Can be acute (sudden) or overuse (gradual)
- Not all risk factors cause injury – they increase the likelihood
- Control what you can control!

1. INTERNAL RISK FACTORS

Factors inside the athlete that can increase susceptibility.

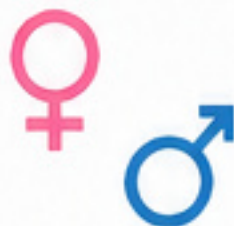
AGE

- Growth spurts can reduce coordination and flexibility
- Bones grow faster than muscles/tendons
- Higher risk in children and adolescents



SEX DIFFERENCES

- Females: wider pelvis, greater Q-angle → knee stress
- More ligament laxity (e.g. ACL)
- Hormonal fluctuations may affect tissue stability



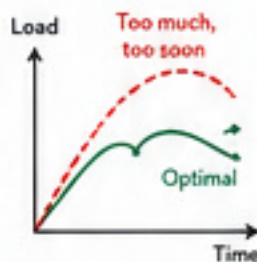
PREGNANCY

- Hormonal changes increase ligament laxity
- Postural changes increase load on back, hips, knees
- Reduced balance and core stability



TRAINING EFFECTS

- Too much, too soon (sudden ↑ volume/intensity)
- Inadequate rest & recovery
- Poor periodisation
- Poor technique or fatigue increases injury risk



CONGENITAL FACTORS

- Structural variations (e.g. limb length, alignment)
- Joint laxity
- Weak connective tissue
- Foot posture (e.g. flat feet)



PREVIOUS INJURY

- Scar tissue and altered mechanics
- Reduced strength, balance or proprioception
- Higher chance of re-injury



★ You can't change all internal factors, but you can manage the risks.

2. EXTERNAL RISK FACTORS

Factors outside the athlete that increase injury risk.

PPE (PERSONAL PROTECTIVE EQUIPMENT)

- Absence, incorrect fit or poor quality increases risk
- Examples: mouthguards, helmets, shin pads, ankle supports, gloves



SPORTING ENVIRONMENT

- Weather: heat, cold, rain, wind
- Playing surface: hard, uneven, slippery
- Facilities: poor lighting, crowding, unsafe equipment
- Travel and long fixtures increase fatigue



★ Poor environments and inadequate PPE increase exposure to risk.

3. ACUTE TRAUMA (SUDDEN INJURY)

Injury caused by a sudden, excessive or unexpected force.

COMMON MECHANISMS

- Collision or contact
- Fall
- Twisting/pivoting
- Overstretching
- Struck by object



KEY POINTS



Happens in one moment



Force is greater than tissue can tolerate



Damage may be immediate and sometimes severe



Examples: fractures, ligament tears, muscle tears, dislocations, contusions

★ Acute injuries are often visible and require immediate management.

4. CUMULATIVE TRAUMA (OVERUSE INJURY)

Injury caused by repeated force over time without adequate recovery.

WHY IT HAPPENS

- Repetitive loading
- Small tissue damage builds up
- Inadequate rest & recovery
- Poor technique or training errors



COMMON EXAMPLES



★ Overuse injuries develop gradually and can be prevented.

5. TISSUES AFFECTED BY INJURY

Different tissues have different functions and are injured in different ways.

CONNECTIVE TISSUE



Ligaments, tendons, cartilage

Injuries: sprains, strains, tendinopathy, cartilage damage

MUSCLE



Provides force for movement

Injuries: strains, tears, contusions

BONE



Provides structure and protection

Injuries: fractures, stress fractures, bone bruising

SKIN



Protects the body from the environment

Injuries: grazes, blisters, lacerations, burns

BRAIN (FUNCTIONAL INJURY)



Controls and coordinates the body

Injury: concussion (temporary disturbance of normal brain function)

Concussion = a functional injury (no structural damage visible). Symptoms may include headache, dizziness, confusion, nausea, sensitivity to light. Must be managed correctly.

★ Know the tissue → know the injury → know the management.

6. OVERUSE / CHRONIC INJURY (HL)

Long-term injuries linked to technique and biomechanical maladaptation.

CONTRIBUTING FACTORS

- Poor technique
- Muscle imbalances or weakness
- Limited mobility/flexibility
- Poor movement patterns
- Incorrect equipment
- Inadequate load management



BIOMECHANICAL MALADAPTATION

When the body adapts to poor movement patterns → abnormal stress on tissues.

Example: Overstriding in running increases stress on knees and shins.



OUTCOMES

- Persistent pain
- Reduced performance
- Increased injury risk
- Longer recovery time



★ Good technique + smart training = fewer injuries and better performance.



SPORT APPLICATION

Injury prevention keeps athletes available to train and compete.



Screen, identify, reduce risk, monitor, review.



Healthy athletes perform better for longer.



DO NOT OVERLEARN

You are not required to know:

- Detailed pathology or medical management
- Drug classifications
- Surgical procedures
- Detailed brain anatomy (only know concussion is functional injury)



KEY LINKS

- B.1.2 Musculoskeletal system – structure & function
- B.1.3 Movement analysis – technique and biomechanics
- B.2.1 Training principles – load, overload, recovery
- B.2.2 Energy systems – fatigue increases injury risk
- B.2.3 Injuries – types and management



QUICK CHECK

1. Give two internal and two external risk factors for injury.
2. What is the difference between acute and overuse injuries?
3. Name two tissues commonly injured in sport and one example injury for each.
4. How does poor technique increase injury risk?
5. Why is a previous injury a risk factor?



GUIDING QUESTION: How can injury risk be reduced and recovery managed safely?

- Reduce abnormal force and improve force absorption
- Use appropriate equipment and correct fit
- Prepare the body and use correct technique
- Manage inflammation with PRICE and NSAIDs (short term)
- Heal → rehab → return using progressive stages
- Concussion: stepwise return for brain and body

1. INJURY PREVENTION

Minimising abnormal force and improving force absorption

MINIMISE ABNORMAL FORCE

- Improve strength to resist high forces
- Good movement control and stability
- Appropriate training load (progressive overload)
- Adequate rest and recovery
- Safe playing surfaces and environment

IMPROVE FORCE ABSORPTION

- Strong, flexible muscles
- Good neuromuscular control
- Effective technique to distribute forces
- Shock-absorbing equipment and footwear
- Body composition (healthy range)

ABNORMAL FORCE = HIGH RISK

Too much force on a structure that cannot tolerate it



OPTIMAL FORCE = LOWER RISK

Forces are managed and spread over time and area



★ Reduce the load. Improve control. Absorb the impact.

2. PROTECTIVE EQUIPMENT AND EQUIPMENT FIT

PROTECTIVE EQUIPMENT

- Protects vulnerable body parts
- Reduces severity of impact
- Must be sport- and position-specific
- Check standards and compliance



EQUIPMENT FIT CHECKLIST

- Correct size for body and age
- Snug but comfortable (no movement)
- Does not restrict movement or breathing
- Secure fastenings and good condition
- Reassess as body grows or roles change

★ Right equipment, right fit, right protection.

3. PREPARE, PERFORM AND PLAY SMART

PREPARE THE BODY

- Flexibility maintains range
- Warm-up raises temperature
- Prehabilitation strengthen weak or at-risk areas

CORRECT TECHNIQUE

- Use efficient movement patterns
- Reduces stress on joints and tissues
- Get expert feedback and video analysis

DEVELOPMENTALLY APPROPRIATE RULES & LOAD

- Match rules to age and maturity
- Limit contact and high-risk situations
- Appropriate training volume and intensity
- Progress skills before increasing competition

Examples of injury risk reduction

Football: proper tackling technique and limit heading in younger players.

Gymnastics: teach progressions before advanced skills.

Running: build weekly distance gradually; vary surfaces.

★ Prepare well. Move well. Play smart.

4. INFLAMMATION MANAGEMENT

Using PRICE and NSAIDs – balance healing vs pain relief

PRICE PROTOCOL (first 48–72 h)

- PROTECTION**
Protect from further injury (brace, support, rest)
- REST**
Relative rest – avoid activities that increase pain
- ICE**
Cold packs 15–20 min every 2–3 h
- COMPRESSION**
Elastic bandage to reduce swelling
- ELEVATION**
Raise the injured part above heart level

NSAIDs (short-term use)

- Reduce pain and inflammation
- Help restore movement and function
- Do not speed up tissue healing
- Use lowest effective dose for shortest time
- Follow guidelines and check contraindications (e.g. stomach, kidney, asthma, bleeding risk)

BALANCE



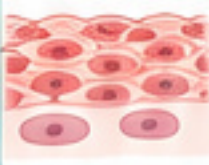
★ Manage pain and swelling early, but do not mask pain to overtrain.

5. HEALING, TREATMENT AND REHABILITATION

From repair to performance

TISSUE HEALING

- Inflammation (days)
- Repair (weeks)
- Remodeling (weeks–months)



SURGERY FOR MAJOR TEARS OR FRACTURES

- For severe damage or instability
- Aims to restore structure
- Follow post-op protocol



THERAPEUTIC MODALITIES

- Assist pain control and tissue recovery
- Examples: heat, ice, ultrasound, TENS, electrical stimulation



PROGRESSIVE REHABILITATION



Key principles: Individualise • Gradual load • Specificity • Monitor response
Quality movement • Patience and consistency

★ Heal the tissue. Restore function. Return to performance.

6. CONCUSSION: STAGED RETURN TO DAILY ACTIVITY, LEARNING AND SPORT

Do not return until symptom-free at each stage.

STAGE	Cognitive / Learning	Physical Activity	Goal
0	Relative rest	Activities of daily living	Recovery
1	Light cognitive activity	Light walk, daily activities	Symptom limited
2	School / work reintroduction	Light aerobic (e.g. stationary bike)	Increase daily tolerance
3	Sport-specific exercise	Running drills, no head impact	Add movement
4	Non-contact training drills	Harder training (no contact)	Increase training load
5	Full-contact practice	Normal training activities	Restore confidence
6	Return to sport competition	Return to normal game play	Performance

RED FLAGS – STOP AND SEEK MEDICAL REVIEW

Worsening headache • Repeated vomiting
Drowsiness • Confusion • Seizure • Neck pain
Weakness/tingling • Slurred speech

★ Step up only when symptom-free. Step back if symptoms return.

SPORT APPLICATION

- Basketball:** strength and landing technique reduce ACL and ankle injuries.
- Rugby:** tackle technique, neck strength and mouthguards lower injury severity.
- Dance:** flexibility, warm-up and load management reduce overuse injuries.
- Swimming:** shoulder stability and gradual volume reduce impingement.

Interventions are specific to the sport, athlete, environment and risk profile.

❌ DO NOT OVERLEARN

You are not required to know:

- Detailed drug classes, doses or side-effects
- Surgical procedures or fixation techniques
- Exact rehab exercises or progressions
- Specialist tests and diagnostic criteria
- Medical management beyond basic principles

Focus on principles, purposes and the sequence of care.

🔗 KEY LINKS

- Links to A.1.2 (Intra-system communication) – nervous and endocrine responses influence injury risk and recovery.
- Links to A.2.1 (Water & electrolyte balance) – hydration supports recovery and tissue repair.
- Links to A.2.2 (Energy systems) – energy availability affects adaptation and healing.
- Links to A.3.1 (Cardiovascular, Respiratory, Muscular) – rehab improves CV fitness, strength and movement capacity safely.
- Links to A.3.2 (Control & regulation) – technique, balance and proprioception reduce injury risk.

✅ QUICK CHECK

1. How can abnormal force be reduced and force absorption improved?
2. What should be considered when selecting and fitting equipment?
3. How do warm-up, prehab and technique reduce injury risk?
4. What are the steps of PRICE and how do NSAIDs fit in?
5. What is the sequence from healing to return to performance?
6. List the concussion return-to-activity stages and their goals.



C.1.1 PERSONALITY

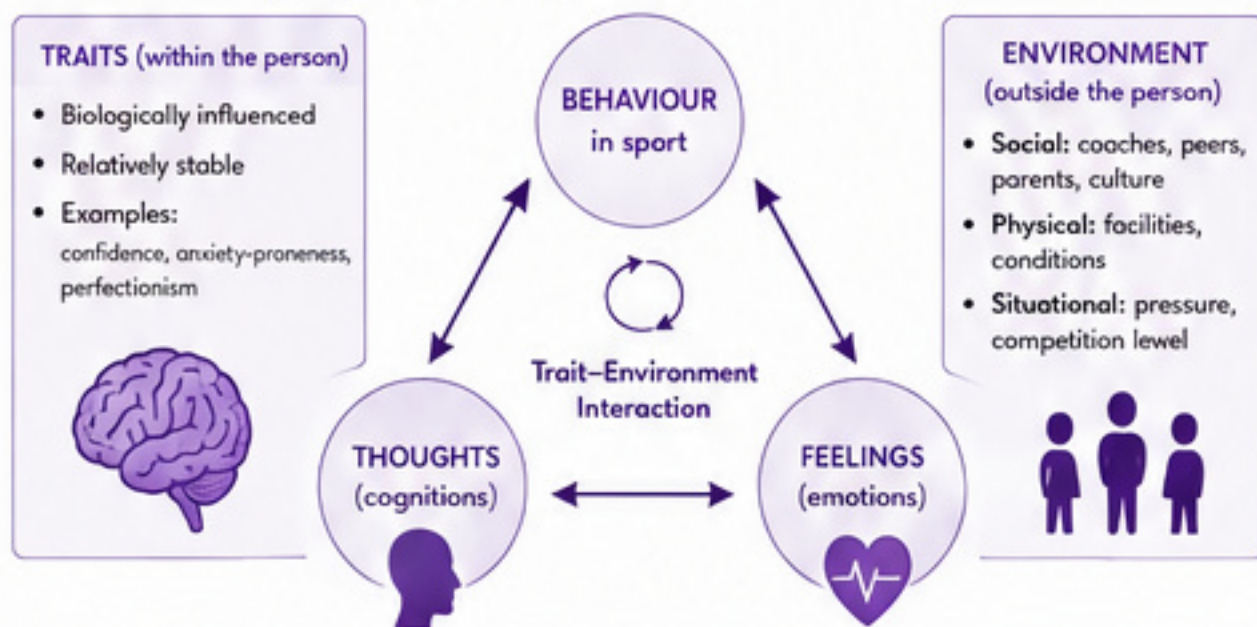
Guiding question: How do stable traits and social experiences shape sporting behaviour?

★ EXAM PRIORITY – MUST KNOW

- Personality = relatively stable patterns of thinking, feeling and behaving.
- Shaped by trait–environment interaction and social learning.
- Measured with validated self-report questionnaires (e.g., Big Five).
- Influences sport behaviour, but does NOT simply predict performance.
- Personality can change across the lifespan.

1. PERSONALITY AS PATTERNS FROM TRAIT–ENVIRONMENT INTERACTION

Personality = relatively stable patterns of thinking, feeling and behaving that influence how people respond in sport and life.



★ Personality is not fixed by traits alone – it emerges from ongoing interaction with the environment.

2. TRAIT APPROACH AND VALIDATED SELF-REPORT QUESTIONNAIRES

TRAIT APPROACH

Assumes personality is made up of relatively stable traits that can be measured and compared between individuals.

HOW IT WORKS

- 1 Identify specific traits
- 2 Create items (statements) to measure each trait
- 3 Respondents rate how much each statement describes them
- 4 Scores indicate the level of the trait

VALIDATED SELF-REPORT QUESTIONNAIRES

- ✓ Standardised administration and scoring
- ✓ Reliability – consistent results (test–retest, internal)
- ✓ Validity – measures what it is intended to measure (content, construct, criterion)
- ✓ Norms – comparison with relevant population

Examples used in sport:

- Big Five Inventory (BFI)
- NEO PI-R
- Sport Personality Scale (SPS)
- Competitive State Anxiety Inventory-2 (CSAI-2)



★ Use questionnaires ethically: informed consent, confidentiality, appropriate use, and feedback that supports development.

3. THE BIG FIVE PERSONALITY TRAITS

The Big Five describes five broad dimensions of personality, each with high and low ends.

TRAIT	HIGH SCORES TEND TO... 😊	LOW SCORES TEND TO... 😞	POTENTIAL SPORT BEHAVIOURS
OPENNESS (to experience)	• Curious, imaginative • Enjoys variety • Open to new ideas	• Prefers routine • Traditional • Less flexible	• Tries new skills & tactics • Adapts to novel situations • Creative problem-solving
CONSCIENTIOUSNESS (duty, self-discipline)	• Organised, reliable • Hard-working • Goal-focused	• Disorganised • Careless • Easily distracted	• Consistent training • Plans & sets goals • Follows coach instructions
EXTRAVERSION (sociability)	• Outgoing, energetic • Enjoys attention • Talkative	• Quiet, reserved • Prefers solitude • Low energy	• Thrives in team settings • Influences teammates • High arousal in competition
AGREEABLENESS (cooperativeness)	• Kind, trusting • Cooperative • Empathetic	• Challenging • Competitive • Skeptical	• Supports teammates • Resolves conflict • Positive team climate
NEUROTICISM / EMOTIONAL STABILITY (anxiety-proneness)	• Calm, secure • Handles stress • Emotionally stable	• Anxious, moody • Easily stressed • Self-doubt	• Coping with pressure • Bounces back from setbacks • Consistent performances

★ Traits exist on continua – most people are somewhere in between.

4. PERSONALITY AND SPORT BEHAVIOUR (NOT SIMPLE PREDICTION)

Personality influences how athletes think, feel and behave in sport, but it does not determine performance.

HOW PERSONALITY INFLUENCES BEHAVIOUR

- 1 **Perception & appraisal**
Interprets situations (e.g., threat vs challenge)
- 2 **Goal setting & motivation**
Sets goals, persists, shows effort
- 3 **Coping & emotion regulation**
Manages stress, anxiety, frustration
- 4 **Decision making & risk taking**
Chooses actions under pressure
- 5 **Interpersonal behaviour**
Communicates, leads, cooperates

IMPORTANCE OF CONTEXT

- Task demands (sport, position)
- Situation (pressure, stakes)
- Development (age, experience)
- Other factors (ability, training, physical, health)

SO...

Personality shapes tendencies and probabilities, not certainties.



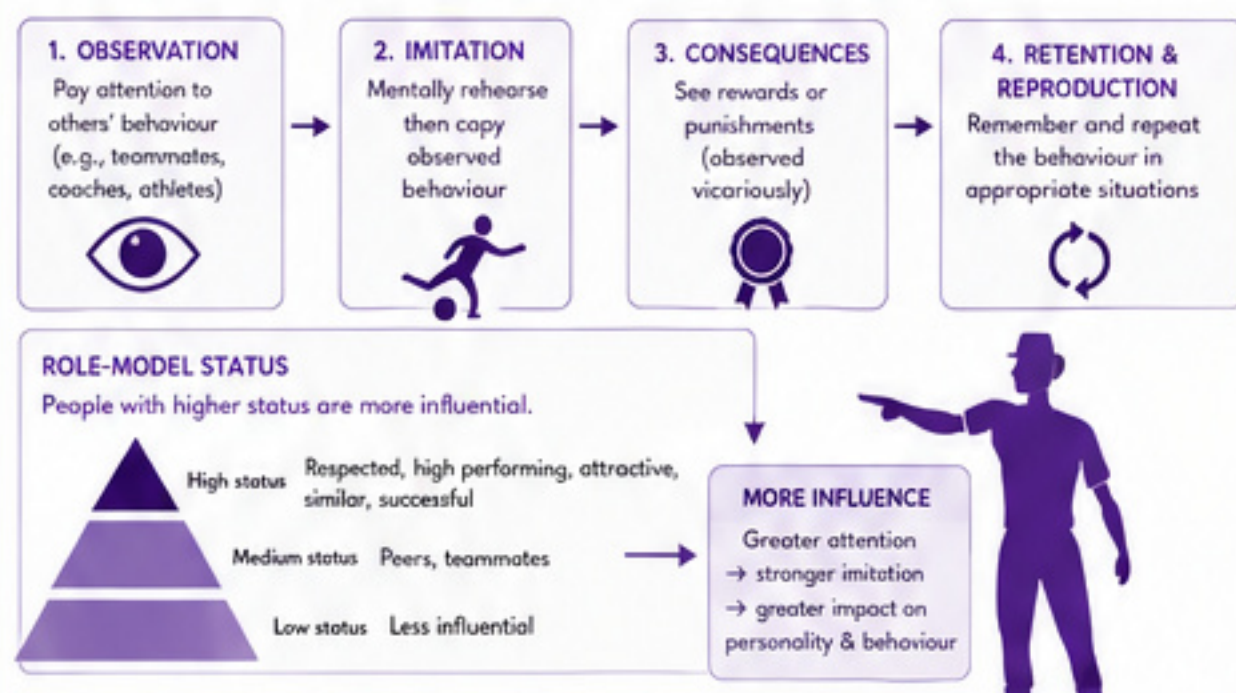
KEY POINT

Two athletes with the same traits may behave differently in different contexts.

★ Use personality insights to support development and environments, not to label or limit athletes.

5. HL: SOCIAL LEARNING THEORY AND PERSONALITY DEVELOPMENT

Bandura's Social Learning Theory explains how social experiences shape personality.



★ Quality role models + positive consequences build adaptive personality and sporting behaviours.

6. HL: PERSONALITY CAN CHANGE OVER TIME

Personality is relatively stable but not fixed.

WHY CHANGE OCCURS

- Maturation & development (biological and cognitive growth)
- Experiences & learning (success, failure, feedback)
- Intentional practice (self-reflection, goal setting)
- Social environment (coaches, peers, culture shifts)
- Life events & transitions (injury, moving teams, etc.)

KEY MESSAGE

- ✓ People can develop new habits, approaches and self-beliefs.
- ✓ Training the mind (e.g., resilience, self-control, optimism) can shift tendencies.
- ✓ Environment can support growth in positive directions.

CRUCIAL EXAM POINT

No single personality profile guarantees sporting success.
High performance = interaction of many factors: physical, technical, tactical, psychological, social.



★ Focus on growth: mindset, habits and environments can change who we are and how we perform.

SPORT APPLICATION

- Know yourself: self-awareness improves strength, choices and wellbeing.
- Build strengths: use traits to your advantage (e.g., conscientiousness for consistent practice).
- Manage challenges: e.g., anxiety—use coping strategies to perform under pressure.
- Develop through environment: seek positive role models and supportive teams.

DO NOT OVERLEARN

- Alternative typologies or stereotypes (e.g., Type A/B, MBTI)
- Fixed "ideal athlete" personality
- Rote memorisation of questionnaire items
- Labels that limit potential
- Deterministic thinking ("traits decide everything")



KEY LINKS

- Links to A.1.3 (Control of movement): traits influence motivation and focus for skill learning.
- Links to A.2.1 (Energy systems): conscientiousness supports effective training and recovery.
- Links to B.2.1 (Health and wellbeing): emotional stability supports mental health and resilience.
- Links to D (Skills & strategies): teamwork (agreeableness) and decision making (openness) support performance.

QUICK CHECK

1. Define personality in your own words.
2. Explain the trait–environment interaction.
3. What are the five Big Five traits?
4. Give one way each trait can influence sport behaviour.
5. How does Social Learning Theory explain personality development?
6. Why can't personality simply predict sporting performance?



THEME

C

C.1.2 MENTAL TOUGHNESS

Performance skills – the mind

GUIDING QUESTION: How do individuals respond differently to pressure and challenge?

★ EXAM PRIORITY – MUST KNOW

- Mental toughness = consistent performance under pressure, adversity and challenge
- Key attributes: challenge appraisal, commitment, confidence, perceived control, resilience (the 5 Cs)
- Can be developed (malleable) through deliberate practice
- Links to persistence, effort, wellbeing and sleep
- Influenced by perceptions, attributions and past experiences

1. THE 5 CORE ATTRIBUTES OF MENTAL TOUGHNESS

Mental toughness is made up of five interconnected attributes.

CHALLENGE APPRAISAL
Sees pressure and challenge as opportunities for growth rather than threats.

SPORT EXAMPLE
A basketball player views a close final quarter as a chance to prove themselves, not something to fear.

COMMITMENT
Sets meaningful goals and stays dedicated to the process, even when it is difficult.

SPORT EXAMPLE
A swimmer sticks to early morning training during winter to reach peak form in summer.

CONFIDENCE
Believes in their abilities and trusts preparation to perform under pressure.

SPORT EXAMPLE
A tennis player trusts their practice and takes on aggressive shots in a deciding set.

PERCEIVED CONTROL
Focuses on controlling what they can (attitude, effort, technique, routines).

SPORT EXAMPLE
A footballer controls their breathing and positioning rather than worrying about the referee.

RESILIENCE
Bounces back from setbacks quickly and learns from adversity.

SPORT EXAMPLE
A volleyball team loses a set but resets, learns and wins the next two.

★ Athletes high in the 5 Cs tend to perform consistently when it matters.

2. MALLEABILITY AND SELF-REPORT MEASUREMENT

Mental toughness is not fixed – it can be developed.

MALLEABLE (DEVELOPABLE)

- Built through experience, reflection and deliberate practice
- Strengthened by setting goals, managing stress and learning coping skills
- Improves with challenge and intentional feedback

SELF-REPORT MEASUREMENT
Most common tool: **Mental Toughness Questionnaire (MTQ48)**

- 48 questions
- Measures the 5 attributes
- Athletes rate how true statements are for them (e.g., 1 = not true, 5 = very true)

EXAMPLE ITEM (MTQ48)	ATTRIBUTE MEASURED
I enjoy challenges.	Challenge appraisal
I am committed to my goals.	Commitment
I am confident I can achieve my goals.	Confidence
I stay focused on what I can control.	Perceived control
I bounce back quickly after setbacks.	Resilience

★ Using tools like the MTQ48 helps athletes identify strengths and areas to improve and track progress over time.

3. HL: SELF-FULFILLING PROPHECY – CONFIDENCE LEADS TO SUCCESS

Believing you can succeed makes you more likely to persist and invest effort, which improves performance.

BELIEF
(High confidence)
I can do this.

BEHAVIOUR
More effort, persistence and use of effective strategies

OUTCOME
Better performance and achievement

REINFORCEMENT
Success increases confidence and belief
I knew I could do it!

★ Positive expectations become self-fulfilling through behaviour.

SPORT EXAMPLE: A gymnast believes they can land a difficult routine, trains hard, commits fully, lands it successfully, and their confidence grows further.

4. HL: LEARNED HELPLESSNESS – PERCEIVED LACK OF CONTROL

When athletes believe they have no control, they may give up, avoid effort and perform poorly.

LACK OF CONTROL
Athlete feels outcomes are out of their control (e.g., “Nothing I do makes a difference”).

LEARNED HELPLESSNESS
Motivation drops. Athlete stops trying or avoids challenge.

POOR PERFORMANCE
Less effort and persistence lead to lower performance and more failure.

CONFIRMS BELIEF
Poor results confirm the belief of helplessness.
There’s no point trying.

★ Breaking the cycle: restore control, set small goals, use positive feedback.

SPORT EXAMPLE: A striker misses several chances, believes they can’t score, stops taking chances and slips further into poor form.

5. HL: HEALTH ASSOCIATIONS

Higher mental toughness is linked to better mental health and recovery.

FEWER DEPRESSIVE & BURNOUT SYMPTOMS

- Better stress management
- Greater sense of purpose and control
- Lower risk of emotional exhaustion and burnout
- More positive mood and wellbeing

IMPROVED SLEEP QUALITY

- Lower worry and rumination before bed
- Better relaxation and routines
- Deeper, more restorative sleep
- Improved recovery and next-day performance

★ Developing mental toughness supports both performance and wellbeing.

SPORT EXAMPLE: A rugby player who manages stress well, maintains routines and stays positive is more likely to sleep well and avoid burnout during a long season.

6. HL: ATTRIBUTION THEORY – LOCUS OF CONTROL & STABILITY

How athletes explain success or failure affects future motivation and performance.

LOCUS OF CONTROL

INTERNAL
Involves personal factors (effort, preparation, skill, attitude)

EXTERNAL
Outside control (luck, referee, weather, other people)

STABILITY

STABLE (Does not change easily over time)	UNSTABLE (Can change with time)
e.g., natural ability	e.g., effort, preparation
e.g., bad luck, poor facilities	e.g., referee decision, weather conditions

EFFECT ON FUTURE MOTIVATION

INTERNAL + UNSTABLE Most adaptive Keeps motivation high (“If I work harder, I can improve.”)	EXTERNAL + STABLE Least adaptive Leads to helplessness (“It’s just bad luck, there’s nothing I can do.”)
---	---

★ Encourage internal and unstable attributions to support learning and persistence.

SPORT EXAMPLE: A player loses a match and thinks, “I didn’t train hard enough” (internal, unstable) – they are more likely to train harder next time.

PRESSURE SPORT EXAMPLES

- Penalty shoot-out in football – challenge appraisal, confidence and perceived control.
- Clutch point in tennis – confidence and commitment.
- Final lap in track – resilience and focus under extreme fatigue.
- Last-minute try in rugby – composure and control of controllables.

KEY LINKS

- Links to A.1.1 (Nervous system): manages arousal under pressure.
- Links to A.1.3 (Skill acquisition): deliberate practice builds competence and confidence.
- Links to B.1.2 (Stress management): coping skills support the 5 Cs.
- Links to B.1.3 (Sleep): better mental toughness supports better sleep, and vice versa.
- Links across topics: mental toughness underpins performance, health and wellbeing.

QUICK CHECK

- Name the five core attributes of mental toughness.
- How is mental toughness measured?
- Explain how self-fulfilling prophecy works.
- What is learned helplessness?
- How is mental toughness linked to mental health and sleep?
- How do internal, unstable attributions help future motivation?

IB SPORTS, EXERCISE AND HEALTH SCIENCE – VISUAL REVISION GUIDE

THEME C • C.1.2 MENTAL TOUGHNESS

1

C.2.1 MOTOR LEARNING PROCESSES

Guiding question: How are skills acquired, practised and perfected?

★ EXAM PRIORITY – MUST KNOW

- Motor learning = relatively permanent change in ability to perform.
- Performance = what we can do right now (can fluctuate).
- Learners move through stages as they develop and practise.
- Learning is influenced by constraints and the environment.
- Transfer helps improve learning in new situations.
- Do not overlearn – stop when skill is consistent and effective.

1. MOTOR LEARNING vs PERFORMANCE

MOTOR LEARNING

- Relatively permanent change in capability.
- Occurs in the brain and nervous system.
- Not directly observable.
- Improved through practice, feedback and experience.

VS

PERFORMANCE

- What we can do right now.
- Affected by fatigue, motivation, stress, environment.
- Varies from day to day.
- The outcome of motor learning in action.



Learning happens inside the learner

Focus: process

Performance happens in the environment

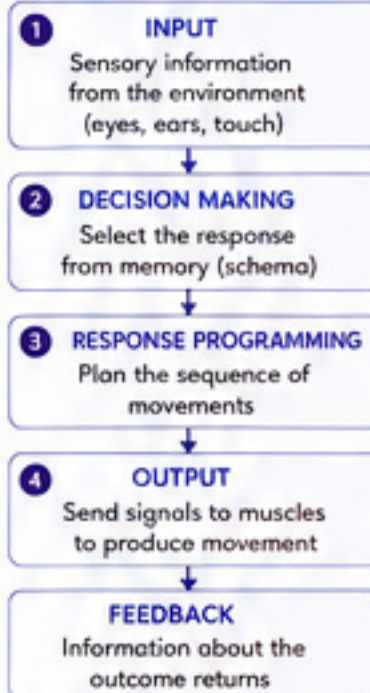
Focus: outcome



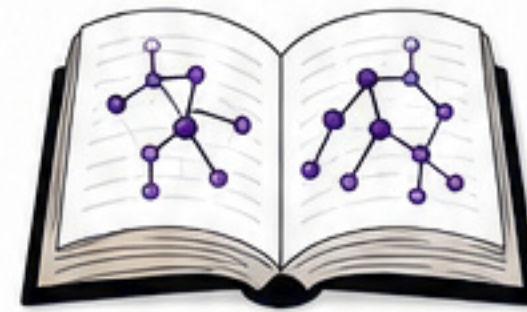
★ Goal: Improve learning so performance is more consistent and effective.

2. INFORMATION-PROCESSING MODEL & SCHEMA THEORY

Learning = processing information through the brain to create a plan for movement.



SCHEMA THEORY



SCHEMA FEATURES

- Generalised – works in many situations
- Flexible – can be adapted
- Efficient – reduces thinking time
- Dynamic – updated with experience

A schema is a generalised memory of a movement.

- Stores essential information about a skill.
- Helps recognise situations.
- Guides selection and programming of responses.
- Developed through practice and experience.



SPORT APPLICATION

A football player uses a schema to decide how to pass, dribble or shoot based on the game situation.

★ Practice builds and refines schemas for faster, better decisions.

3. ECOLOGICAL MODEL & ECOLOGICAL DYNAMICS

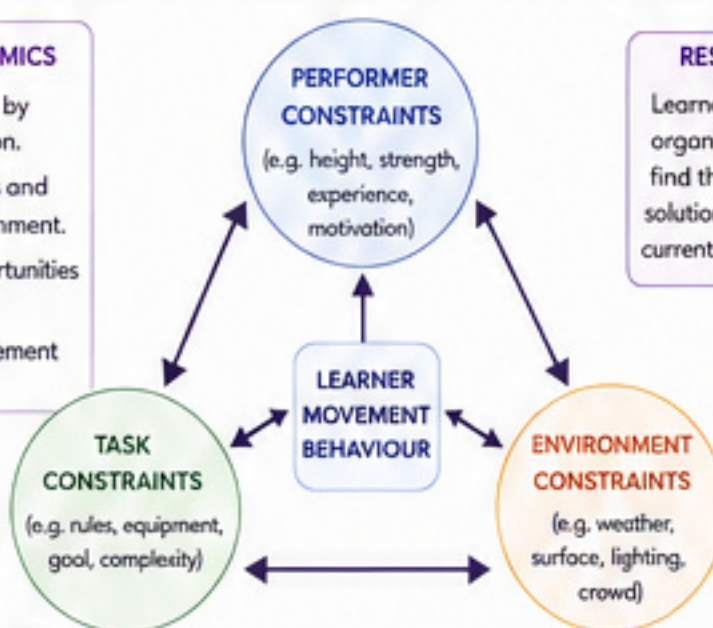
Learning emerges from the interaction between performer, task and environment.

ECOLOGICAL DYNAMICS

- Movement is shaped by continuous interaction.
- The learner explores and adapts to the environment.
- Affordances = opportunities for action.
- Perception and movement are closely linked.

SPORT APPLICATION

A volleyball player adapts their approach based on their ability, the set being played and the conditions.



★ Environment shapes learning: coach designs tasks to guide exploration.

4. NON-LINEAR PEDAGOGY (CONSTRAINTS-LED APPROACH)

Learning is non-linear, adaptive and shaped by constraints.

CONSTRAINTS-LED APPROACH

- Manipulate constraints to guide learning.
- Encourage exploration and discovery.
- Develop adaptable performers.

PERFORMER CONSTRAINTS

- Physical (height, strength)
- Psychological (confidence)
- Physiological (fitness, fatigue)
- Experience (skill level)

TASK CONSTRAINTS

- Rules (e.g. scoring system)
- Equipment (e.g. size, weight)
- Goals (e.g. accuracy, distance)
- Complexity (simple → complex)

ENVIRONMENT CONSTRAINTS

- Physical (weather, surface)
- Social (crowd, teammates)
- Cultural (norms, expectations)



PERCEPTION-ACTION COUPLING

- Seeing and doing are linked.
- Information guides action; action provides new information.
- Enables quick, automatic responses.



SELF-ORGANISATION

- Learners create their own solutions.
- Patterns emerge without direct instruction.
- Leads to adaptable and resilient performance.

★ Design rich practice environments – let learners explore, adapt and succeed.

5. LINEAR PEDAGOGY – TRADITIONAL APPROACH

Skills are taught in a progressive, step-by-step manner.

OPEN-LOOP THEORY

- Learner receives information before the movement.
- Plan is set before action.
- Used for self-paced, predictable skills (e.g. gymnastics).

CLOSED-LOOP THEORY

- Learner uses feedback during and after the movement.
- Adjusts performance in real time.
- Used in dynamic, changing environments (e.g. invasion games).

SCHEMA

- Generalised plan stored in memory.
- Guides performance.
- Refined through practice and feedback.

GENERALISED & SUBORDINATE MOTOR PATTERNS

Generalised Motor Patterns (GMPs)
Fundamental movement patterns (e.g. run, jump, throw)Subordinate Motor Patterns
Refined movements for specific skills (e.g. tennis serve, long jump)

STAGES OF LEARNING (DO NOT OVERLEARN)

1. COGNITIVE STAGE
- Learner understands the skill.
- Lots of errors
 - Slow performance
 - Needs guidance

2. ASSOCIATIVE STAGE
- Learner refines the skill.
- Fewer errors
 - More consistent
 - Needs less feedback

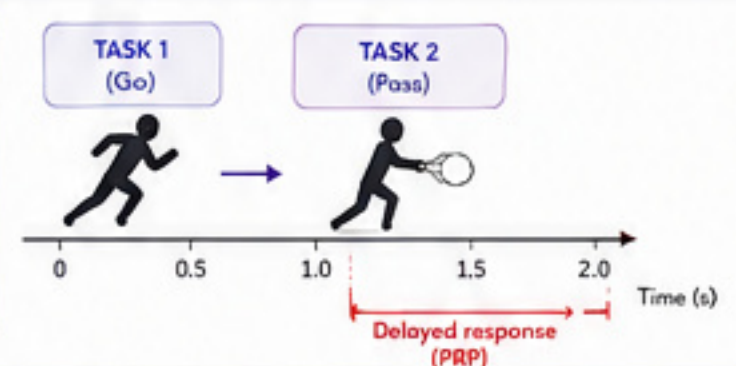
3. AUTONOMOUS STAGE
- Skill becomes automatic.
- Smooth & efficient
 - Consistent under pressure
 - Focus on tactics/strategy

★ Do not overlearn – move on when the skill is effective, not endlessly repeated.

6. PSYCHOLOGICAL REFRACTORY PERIOD & SIX TRANSFER TYPES

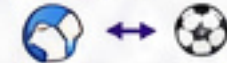
PSYCHOLOGICAL REFRACTORY PERIOD (PRP)

- The brain can focus on only one task at a time.
- If two tasks occur close together, response to the second is slower.
- Caused by information-processing bottleneck.
- Important in sport (e.g. reacting to whistle then passing the ball).



SIX TYPES OF TRANSFER

1. SKILL-TO-SKILL

Learning one skill helps learning another similar skill.
Example: Learning a chest pass helps in a bounce pass.

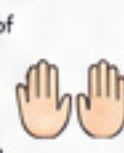
2. PRACTICE-TO-PERFORMANCE

Skills learned in practice improve performance in competition.
Example: Dribbling well in training → better in game.

3. ABILITIES-TO-SKILLS

Underlying abilities help learning new skills.
Example: Good balance helps in gymnastics and surfing.

4. BILATERAL TRANSFER

Learning with one side of the body improves the other side.
Example: Practising with right hand helps left hand.

5. STAGE-TO-STAGE TRANSFER

Skills from earlier stages help in later stages.
Example: Balance (basic) helps in advanced balance moves.

6. PRINCIPLES-TO-SKILLS

Understanding principles helps learning new skills.
Example: Knowing 'keep body low' helps in many sports.

★ Positive transfer improves learning; negative transfer can hinder progress.

KEY LINKS

- C.1.2: Information-processing model underpins decision making.
- C.2.2: Feedback and practice methods support motor learning.
- C.2.3: Guidance and instruction shape learning.
- C.3.1: Skill classification affects how skills are learned.
- C.3.2: Continuum of practice relates to practice design.

QUICK CHECK

1. Differentiate motor learning and performance.
2. Outline the information-processing model.
3. Explain how schemas help performance.
4. Describe the ecological model.
5. What is the constraints-led approach?
6. Compare open-loop and closed-loop theory.
7. List the three stages of learning.
8. Define PRP and give a sporting example.
9. Name and explain the six transfer types.
10. Why should learners avoid overlearning?



SPORT APPLICATION

Effective motor learning comes from appropriate practice, feedback and the right environment.

Coaches should blend structure with exploration to develop adaptable, resilient performers.

DO NOT OVERLEARN

Stop practising when:

- Skill is consistent & effective
- Can perform under pressure
- Focus can shift to tactics and strategies

Overlearning can cause stiffness and reduce adaptability.



GUIDING QUESTION: How does attentional focus influence skilled performance?

- Attentional focus can be internal or external.
- Broad vs narrow focus affects the amount of information processed.
- Distractors can be external (visual/auditory) or internal (cognitions).
- Athletes use strategies to control attention.
- Too much arousal → attentional narrowing → performance ↓.

1. INTERNAL vs EXTERNAL ATTENTION

Where you direct your focus changes performance.

INTERNAL FOCUS (Focus on self)

- Attention on your own body movements and technique.
- Useful for learning new skills and correcting technique.
- Too much internal focus can disrupt automaticity (choking under pressure).



EXTERNAL FOCUS (Focus on the environment)

- Attention on the effect of the movement or a target in the environment.
- Enhances automatic control and fluid performance.
- Linked to better accuracy, speed and consistency.



★ External focus is generally more effective for skilled performance.

PENALTY EXAMPLE



Internal: Thinking "Keep my arms low, step right, push off left foot" → may slow reaction.
External: Thinking "Ball into the bottom left corner" → focuses on outcome → better performance.

2. BROAD vs NARROW ATTENTION

The width of your focus affects what information you process.

BROAD ATTENTION

- Wide focus.
- Processes lots of information (surroundings, teammates, opponents).
- Best for open skills and dynamic environments.



NARROW ATTENTION

- Tight focus.
- Processes very little information.
- Best for closed skills and self-paced tasks.



BROAD vs NARROW MATRIX

	Broad	Narrow
External focus	Best for invasion games, team sports, tactical awareness.	Best for closed skills, set plays, penalty kicks, free throws.
Internal focus	Rarely effective (high cognitive load).	Useful for early learning and technical adjustments.

★ Use the right width of attention for the task and situation.

3. EXTERNAL DISTRACTORS

Irrelevant stimuli in the environment that divert attention.

BROAD ATTENTIONS



- Crowd noise and movement.
- Opposites very little and trash talk.
- Besh photography.
- Moving objects (e.g. flags, reflections, scoreboard).

AUDITORY DISTRACTORS



- Crowd noise and chants.
- Opposition verbal abuse.
- Referee decisions.
- Music or announcements.

PENALTY EXAMPLE

Crowd chanting and moving in the background; opposition players shouting at the penalty taker.



★ Control what you can, ignore what you can't.

4. INTERNAL DISTRACTORS

Thoughts and feelings that take attention away from the task.

NEGATIVE COGNITIONS



- Worry about making mistakes.
- Fear of failure or letting others down.
- Doubting ability.
- Focusing on past errors.

GOAL-IRRELEVANT COGNITIONS



- Thinking about what to eat or plans after the game.
- Replaying a conversation.
- Daydreaming.
- Focusing on fatigue or discomfort.

PENALTY EXAMPLE

Thinking "Don't miss" or "If I miss, the team will lose because of me" → increases anxiety and reduces concentration.



★ Notice negative and goal-irrelevant thoughts early.

5. CONTROLLED DISTRACTION

Deliberately using cues or routines to manage attention.

USEFUL DISTRACTIONS



- Pre-performance routines (e.g. bounce the ball, visualise, tap the post).
- Focus cues (e.g. take a deep breath, look at the target).
- Breathing techniques to reset and refocus.

PENALTY EXAMPLE

The player bounces the ball twice, takes a deep breath and focuses on the bottom left corner.



★ Use controlled distraction to clear the mind and refocus.

6. HIGH AROUSAL & CONTROL STRATEGIES

HIGH AROUSAL → ATTENTIONAL NARROWING

- High stress or anxiety narrows attention automatically.
- Tunnel vision – fewer cues noticed.
- Reduces decision making and skill execution.



SELF-TALK & GOAL SETTING

SELF-TALK

"Calm and focused."

"See the target, trust my technique."

GOAL SETTING

- Set process goals – what you can control.
- Set performance goals – specific and measurable.
- Review and refocus before each attempt.



★ Manage arousal and use strategies to maintain optimal focus.

SPORT APPLICATION



Attention affects accuracy, decision making and consistency.



Train focus in practice using distractions and pressure.



Strong attentional control improves performance when it matters most.



DO NOT OVERLEARN

You are not required to know:

- Detailed attention capacity models.
- All theories of attention.
- Neuroscience of attention.
- All research studies on attention.
- Clinical attention disorders.



KEY LINKS

- Links to C.2.1 (Arousal & performance) – High arousal narrows attention.
- Links to C.2.3 (Stress management) – Stress affects focus and control.
- Links to A.1.1 (Inter-system communication) – CNS controls attention and filters information.
- Links to B.1.4 (Mental skills) – Routines, self-talk, imagery aid attentional control.



QUICK CHECK

1. Define internal and external attention.
2. Give a penalty example of internal and external focus.
3. Explain the difference between broad and narrow attention with examples.
4. Give two external and two internal distractors.
5. How can athletes control attention under pressure?



C.3.1 ACHIEVEMENT MOTIVATION

Achievement motivation influences the choices we make, the effort we give and how we respond to success and failure.

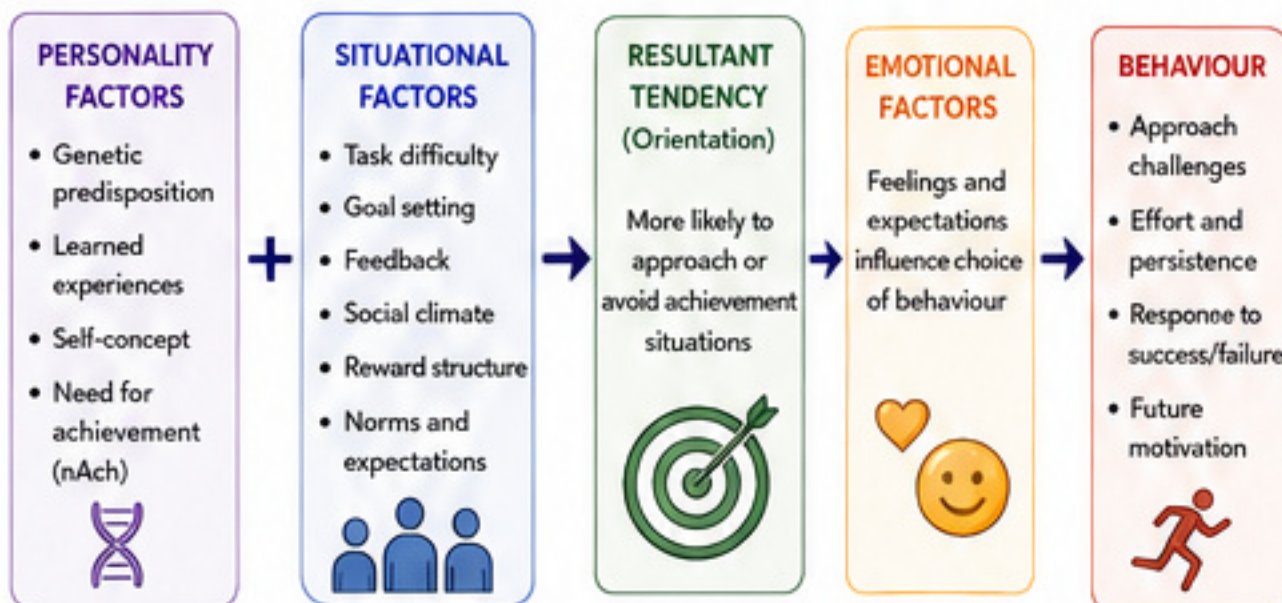
GUIDING QUESTION: Why do some athletes approach achievement challenges while others avoid them?

★ EXAM PRIORITY – MUST KNOW

- Motivation to achieve influences behaviour in sport
- Need Achievement Theory explains achievement motivation
- Two orientations: task (self-referenced) vs ego (other-referenced)
- Perceived ability + situational factors shape orientations
- Task orientation → mastery, effort, persistence, positive emotions
- High ego + low ability → anxiety, dropout risk, excuses, ego protection
- Coaches can manipulate the environment to encourage approach

1. THE NEED ACHIEVEMENT THEORY PATHWAY

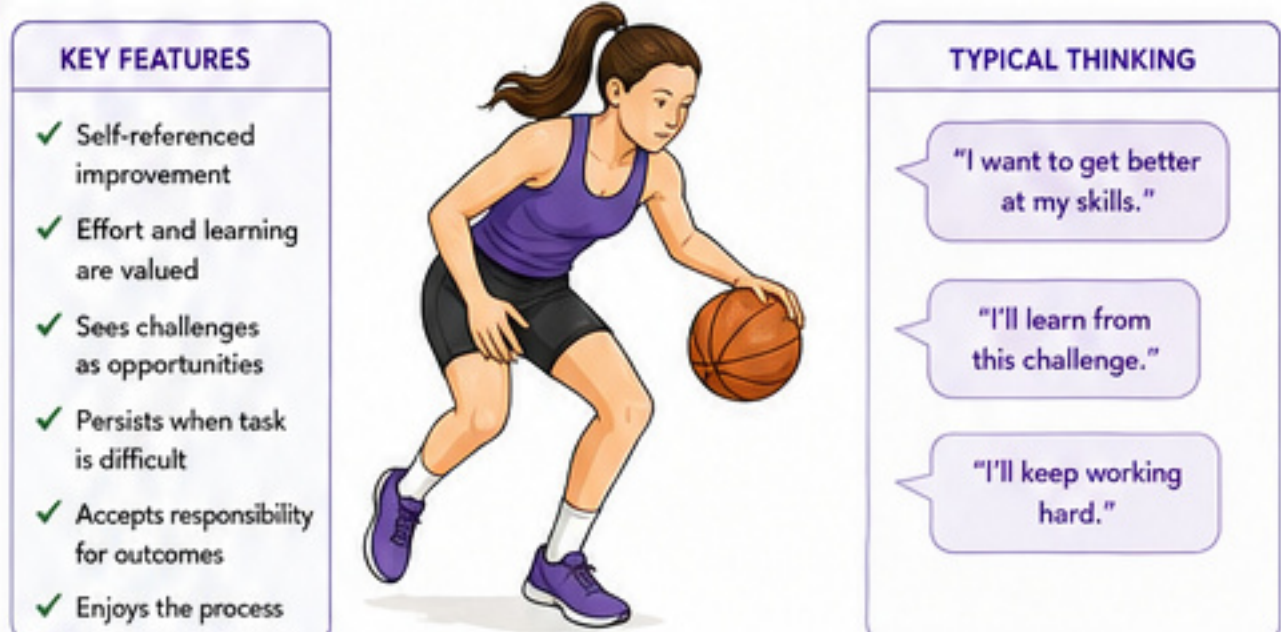
Achievement motivation results from the interaction of key influences.



★ Achievement motivation is not fixed – it changes with situations and experiences.

2. TASK ORIENTATION (MASTERY ORIENTATION)

Focus is on self-improvement, learning and mastery of the task.



★ Leads to approach behaviour, high effort and enjoyment of learning.

3. EGO ORIENTATION (PERFORMANCE ORIENTATION)

Focus is on outperforming others and demonstrating ability.



★ Can lead to pressure, anxiety, low enjoyment and negative behaviours.

4. HIGH TASK ORIENTATION = PERSEVERANCE & EFFORT

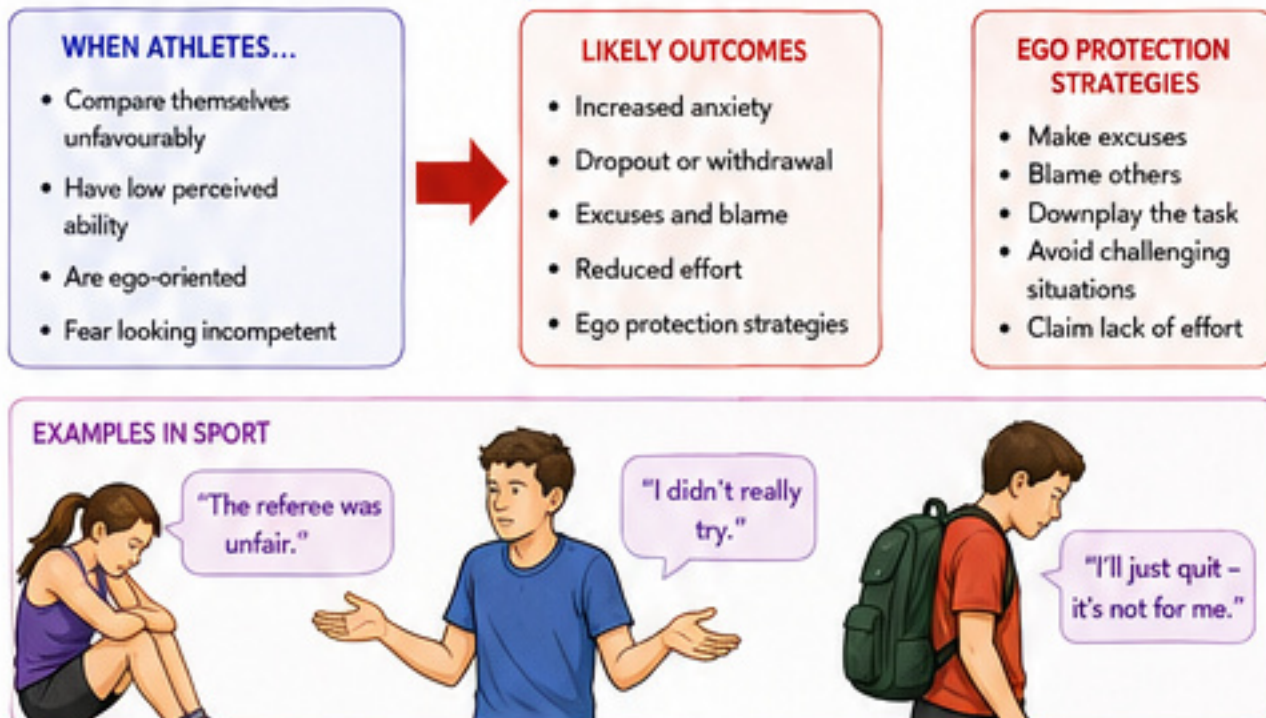
Task orientation encourages athletes to persist and strive for improvement.



★ Athletes are more likely to continue working hard and achieve their potential.

5. HIGH EGO ORIENTATION + LOW PERCEIVED ABILITY

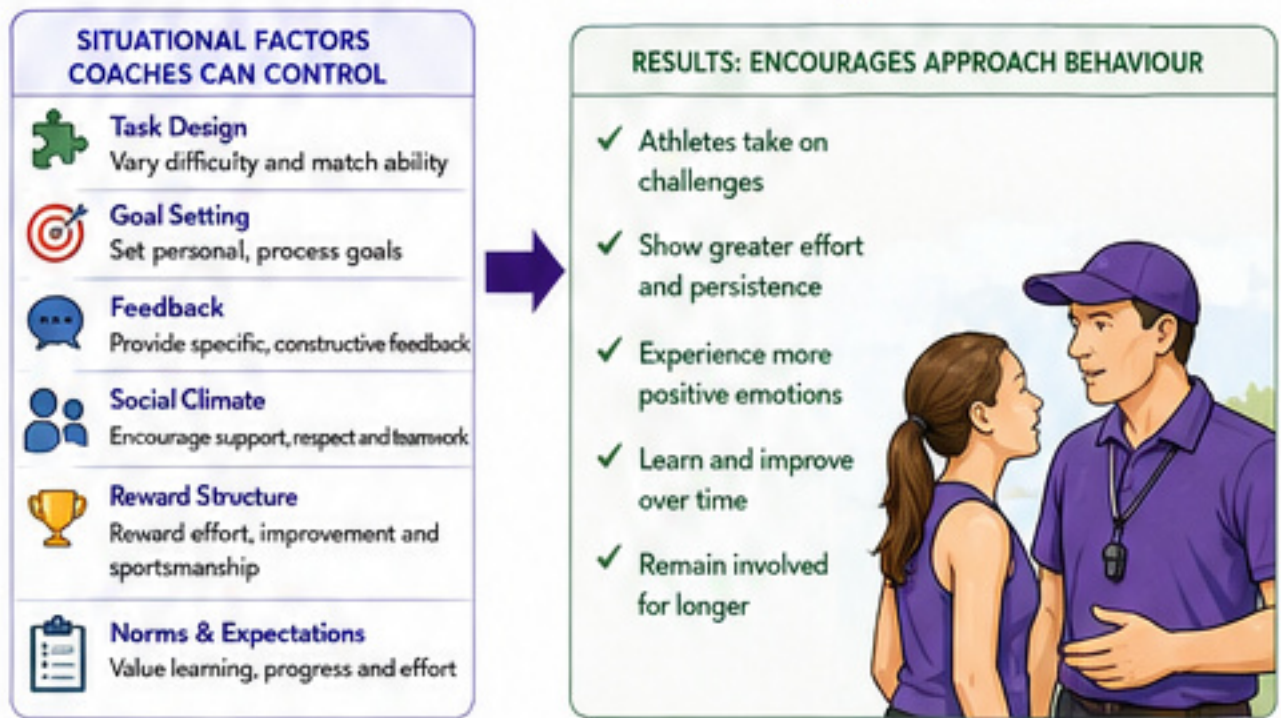
This combination increases risk of negative outcomes.



★ Leads to avoidance of challenges and limits potential.

6. COACHES CAN MANIPULATE SITUATIONAL FACTORS

Create an environment that promotes task orientation and approach behaviour.



★ Small changes in the environment can have a big impact on motivation.

SPORT APPLICATION

- Task-orientated athletes enjoy training and persist through challenges.
- Ego-orientated athletes may experience pressure and fear failure.
- Coaches create climates that encourage effort, learning and personal improvement.
- Outcome:** more motivated athletes who stay in sport and perform better.

❌ DO NOT OVERLEARN

You are not required to know:

- Intrinsic vs extrinsic motivation
- Atkinson's mathematics equation
- Detailed research studies
- Exact statistics

🔗 KEY LINKS

- Links to A.1.2 (Communication) – social climate and feedback affect motivation.
- Links to A.2.1 (Water & electrolyte balance) – fatigue can reduce motivation.
- Links to A.2.2 (Energy systems) – energy availability supports effort.
- Links to A.3.3 (Recovery) – recovery supports long-term motivation and adaptation.

✅ QUICK CHECK

1. What is the guiding question of C.3.1?
2. Name the two orientations and what they focus on.
3. List three features of task orientation.
4. List three features of ego orientation.
5. What outcomes can occur with high ego orientation and low perceived ability?
6. Give two ways coaches can manipulate the environment to encourage approach behaviour.



THEME

C

C.3.2 SELF-DETERMINATION

Motivation, emotions and personality

GUIDING QUESTION: How does satisfaction of psychological needs influence the quality of motivation?

★ EXAM PRIORITY – MUST KNOW

- SDT focuses on the quality (not just quantity) of motivation.
- Three basic psychological needs: autonomy, competence, relatedness.
- Need satisfaction → autonomous motivation → well-being & performance.
- Need frustration → controlled motivation / amotivation → ill-being.
- Six mini-theories explain why and how motivation develops.

1. THE THREE BASIC PSYCHOLOGICAL NEEDS

All people have three universal needs that, when satisfied, support optimal motivation, well-being and performance.

AUTONOMY

Feeling in control of one's behaviour; having choice and volition.

In sport this looks like:

- Choice of drills / roles
- Voice in goal setting
- Freedom to express ideas



COMPETENCE

Feeling effective in one's interactions and able to master challenges.

In sport this looks like:

- Appropriate challenge
- Positive feedback
- Opportunities to improve



RELATEDNESS

Feeling connected, valued and belonging to others.

In sport this looks like:

- Supportive teammates
- Caring coach
- Respect and inclusion



★ Satisfying these needs → higher quality motivation, persistence, enjoyment and mental health.

2. THE SELF-DETERMINATION CONTINUUM

Motivation varies in its level of self-determination from low to high quality.

AMOTIVATION

No intention to act



CONTROLLED MOTIVATION

External Regulation

Behaviour driven by rewards or avoidance of punishment



Introjected Regulation

Behaviour driven by internal pressures (guilt, ego, shame)



AUTONOMOUS MOTIVATION

Identified Regulation

Behaviour personally important



Integrated Regulation

Behaviour personally and socially important



Intrinsic Motivation

Behaviour done for inherent enjoyment and satisfaction



Lower quality
Less self-determined

Higher quality
More self-determined

★ As motivation becomes more self-determined, outcomes improve.

3. CONTROLLED vs AUTONOMOUS & INTRINSIC MOTIVATION

CONTROLLED MOTIVATION

Behaviour is driven by pressure, obligation or rewards. Short-term compliance.

- External regulation (rewards, punishments)
- Introjected regulation (guilt, ego, shame)

Outcomes:

- Lower persistence
- Higher anxiety
- Lower well-being
- Performance depends on pressure



AUTONOMOUS & INTRINSIC MOTIVATION

Behaviour is self-endorsed and aligned with one's values or enjoyment.

- Identified & integrated regulation
- Intrinsic motivation

Outcomes:

- Greater persistence
- Higher enjoyment
- Better well-being
- Higher quality performance



VS.

INTRINSIC MOTIVATION

Doing an activity for its inherent satisfaction and enjoyment.

E.g., playing tennis because it is fun and exciting.

★ Autonomous & intrinsic motivation are more sustainable and beneficial.

4. HL MINI-THEORIES: COGNITIVE EVALUATION & ORGANISMIC INTEGRATION

COGNITIVE EVALUATION THEORY (CET)

Explains how external events influence intrinsic motivation.

Supports intrinsic motivation

- ✓ Autonomy support (choice, rationale)
- ✓ Informational feedback (about task)
- ✓ Optimal challenge

Undermines intrinsic motivation

- ✗ Controlling language (must, should)
- ✗ Tangible rewards (money, prizes)
- ✗ Ego-involving feedback (better than others)

OVERJUSTIFICATION EFFECT (a CET concept)

When external rewards are used for an activity that is already intrinsically motivating, intrinsic motivation can decrease.

Enjoy activity for fun

External reward introduced

Focus shifts to reward

Intrinsic motivation drops

ORGANISMIC INTEGRATION THEORY (OIT)

Explains how people internalise regulations over time.

The internalisation process

External regulation (non self-determined)

Introjected regulation (partly internalised)

Identified regulation (valued and accepted)

Integrated regulation (aligned with self)

Intrinsic motivation (full self-determined)

More self-determined

Less self-determined

★ CET shows what affects intrinsic motivation; OIT shows how motivation develops.

5. HL MINI-THEORY: FOUR TYPES OF EXTRINSIC REGULATION

Different forms of extrinsic motivation reflect varying levels of self-determination.

TYPE	FOCUS	DRIVEN BY	EXAMPLE IN SPORT	I FEEL...
1. EXTERNAL REGULATION	Consequences outside self	Rewards & punishments	Train hard to get selected / avoid being dropped	I MUST
2. INTROJECTED REGULATION	Consequences partly internal	Guilt, ego, approval	Train to avoid guilt from letting the team down	I SHOULD
3. IDENTIFIED REGULATION	Personally important	Personal importance	Train to improve fitness because it helps performance	I WANT (to achieve)
4. INTEGRATED REGULATION	Aligned with values & identity	Values, sense of self	Train because it reflects who I am and what I value	I WANT (because it matches my values)

★ Moving from MUST → SHOULD → WANT → VALUES = more self-determined.

6. ALL SIX SDT MINI-THEORIES AT A GLANCE

MINI-THEORY	FOCUS	KEY IDEA	EXAMPLE IN SPORT
1. Cognitive Evaluation Theory (CET)	How context affects intrinsic motivation	Supportive contexts increase IM; controlling contexts decrease IM.	Coach gives choice & positive feedback → more enjoyment in practice.
2. Organismic Integration Theory (OIT)	How regulations become internalised	People internalise reasons & integrate them with their sense of self.	Athlete moves from training for rewards to training because it fits who they are.
3. Causal Orientations Theory (COT)	Why people act (importance attributed to causes)	Internal, stable, controllable attributions promote motivation and well-being.	Attribute success to effort (internal, controllable) not luck (external).
4. Basic Psychological Needs Theory	Role of autonomy, competence & relatedness	Need satisfaction supports motivation & well-being; frustration undermines.	Feeling supported (autonomy), skilled (competence) & connected (relatedness).
5. Goal Contents Theory	How goal content influences outcomes	Intrinsic, learning & approach goals → positive; ego & avoidance goals → negative.	Focus on mastering skills (learning goal) rather than beating others (ego goal).
6. Relationships Motivation Theory	How relationships influence motivation	Close, caring relationships meet needs and enhance self-determined motivation.	Trusted coach-athlete relationship increases commitment & enjoyment.

★ Together, the six mini-theories explain the 'why', 'how' and 'what' of SDT.

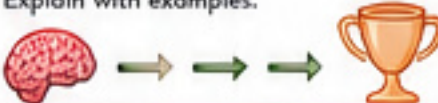
SPORT APPLICATION

- Use autonomy-supportive coaching: offer choice, explain reasons, listen.
- Provide optimal challenge & constructive feedback to build competence.
- Build team belonging through inclusion, respect & support.
- Result: higher quality motivation, better performance & well-being.

DO NOT OVERLEARN

Do not only memorise terms. Understand how they work together!

- Link needs → motivation → outcomes.
- Apply theories to real sport situations.
- Explain with examples.



KEY LINKS

- Needs satisfied → autonomous motivation → well-being & performance.
- Needs frustrated → controlled motivation / amotivation → ill-being.
- CET (context) + OIT (internalisation) explain how quality of motivation develops.
- All six mini-theories interconnect and complement each other.

QUICK CHECK

- What are the three basic psychological needs?
- How does motivation quality change along the continuum?
- What is the difference between controlled and autonomous motivation?
- Give examples of contexts that support vs. undermine intrinsic motivation.
- Describe the four types of extrinsic regulation and what each feels like.
- Name and briefly explain the six SDT mini-theories.



IB SPORTS, EXERCISE AND HEALTH SCIENCE – VISUAL REVISION GUIDE

THEME C • C.3.2 SELF-DETERMINATION

1

C.3.3 MOTIVATIONAL CLIMATE

Coaching environment and motivation

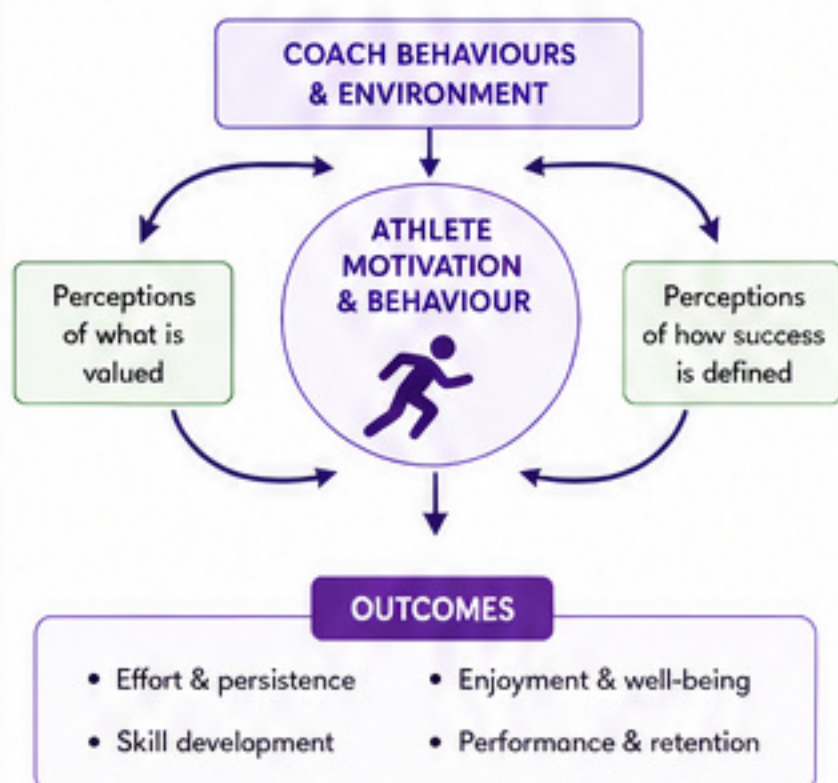
GUIDING QUESTION: How does the environment created by a coach shape motivation?

★ EXAM PRIORITY – MUST KNOW

- Motivational climate = the quality of the coaching environment that shapes motivation and behaviour.
- Mastery climate → intrinsic motivation, effort, persistence, learning.
- Ego climate → extrinsic motivation, pressure, anxiety, dropout.
- Coaches shape climate through what they emphasise, how they act, and how they structure the environment (TARGET framework).

1. WHAT MOTIVATIONAL CLIMATE MEANS

The motivational climate is the environment created by a coach that influences why athletes participate and how they behave.



★ Climate shapes motivation; motivation shapes behaviour.

2. MASTERY CLIMATE (LEARNING-INVOLVEMENT)

Focus on learning, improvement and personal growth.



★ Leads to intrinsic motivation, confidence, persistence and long-term development.

3. EGO CLIMATE (PERFORMANCE-OUTCOME)

Focus on outperforming others and winning.



★ Leads to extrinsic motivation, stress, burnout and dropout.

4. TARGET FRAMEWORK – HOW COACHES SHAPE CLIMATE

Coaches influence climate through six controllable dimensions (TARGET). The way each is handled sends powerful messages about what is valued.



★ When TARGET dimensions promote learning, it creates a mastery climate. When they promote winning and comparison, it creates an ego climate.

5. HOW COACHES USE TARGET TO CREATE A MASTERY CLIMATE

Practical coaching behaviours that build a positive, learning environment.



★ Coaches create the climate; athletes create the culture.

6. LINKS TO ACHIEVEMENT MOTIVATION & SELF-DETERMINATION THEORY

Motivational climate influences why athletes are motivated and the quality of that motivation.



★ Positive climate fuels achievement motivation and satisfies basic needs.

SPORT APPLICATION

- In team sports, mastery climate builds culture and cohesion.
- In individual sports, it builds confidence and self-belief.
- In youth sport, it protects long-term participation and enjoyment.
- Use TARGET every day, in every session.

DO NOT OVERLEARN

TARGET is the named framework for shaping climate.

Do not confuse with other models (e.g., Achievement Goal Theory model types, SDT categories).

Focus on TARGET dimensions and how they create either a mastery or ego climate.

KEY LINKS

- Links to C.3.1 (Personality, self-efficacy and motivation) – climate influences self-belief and motivation.
- Links to C.3.2 (Goal setting) – mastery climate supports learning goals and process goals.
- Links to A.1.2 (Communication) – coach communication shapes climate.
- Links to C.2.1 (Learning processes) – feedback and reflection support learning.
- Links to B.1 (Skill Classification) – learning climate supports skill development.

QUICK CHECK

- Define motivational climate.
- List the four features of a mastery climate.
- List the four features of an ego climate.
- What does each letter in TARGET stand for?
- Give one mastery and one ego example for each TARGET dimension.
- How does mastery climate satisfy SDT needs?
- Why does mastery climate improve long-term participation?

C.4.1 AROUSAL AND ANXIETY

Optimising mental states for performance

GUIDING QUESTION: How do activation and anxiety influence performance?

★ EXAM PRIORITY – MUST KNOW

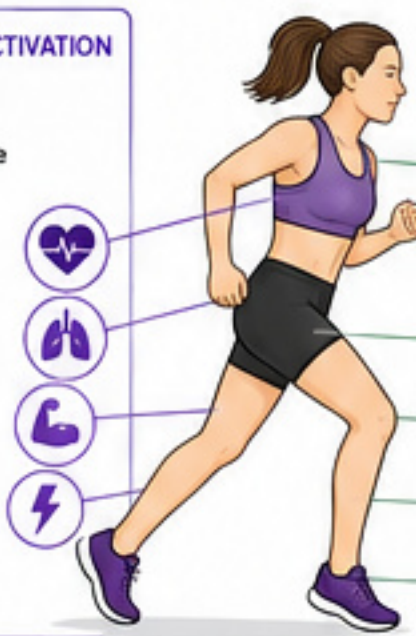
- Arousal = level of activation (physical + psychological)
- Arousal-performance relationships: drive theory and inverted-U
- Individual Zone of Optimal Functioning (IZOF)
- Anxiety: low (e.g. excitement) vs high (e.g. worry, fear)
- Multidimensional anxiety + Catastrophe theory
- Measuring anxiety: subjective (self-report) and objective (HR, BP, GSR)

1. WHAT IS AROUSAL?

Arousal is the state of being mentally and physically activated and ready to respond.

PHYSICAL (SOMATIC) ACTIVATION
Body-based changes

- Increased heart rate
- Faster breathing
- Muscle tension
- Sweating
- Adrenaline release
- Greater energy availability

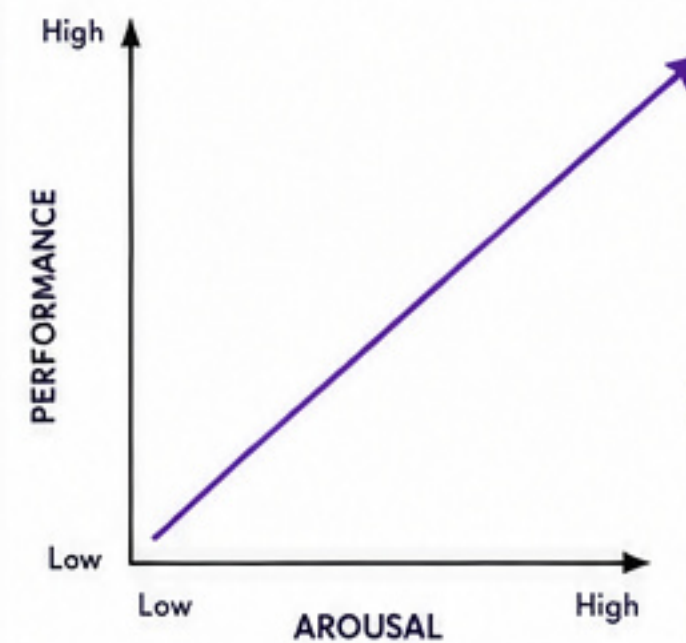
PSYCHOLOGICAL (MENTAL) ACTIVATION
Mind-based changes

- Greater alertness
- Improved attention
- Faster information processing
- Increased motivation
- Stronger emotions
- Readiness to act

★ Arousal can help performance – but too little or too much can hurt it.

2. DRIVE THEORY (SIMPLE POSITIVE LINEAR RELATIONSHIP)

More arousal leads to better performance.



KEY POINTS

- Performance improves as arousal increases.
- Assumes more arousal is always better.
- Too simple – does not explain declines at high arousal.

SPORT EXAMPLES



POWER SPORTS: benefit from high arousal (e.g. weightlifting, sprinting).

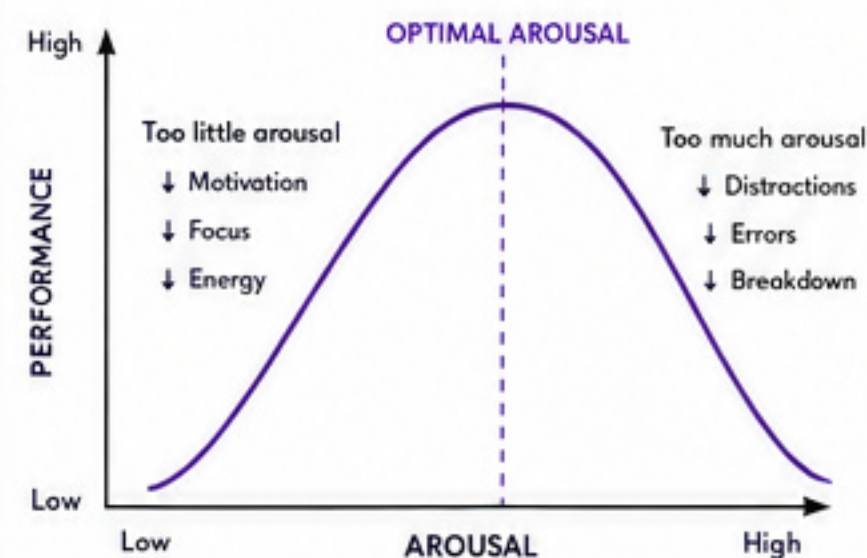


ENDURANCE SPORTS: always more arousal is not better.

★ Drive theory works for some tasks – especially short, explosive activities.

3. INVERTED-U THEORY AND IZOF

Performance improves with arousal up to an optimal point, then declines.



IZOF – INDIVIDUAL ZONE OF OPTIMAL FUNCTIONING

- The arousal range where you perform best.
- Differs between individuals.
- Can change depending on:
 - task difficulty
 - experience
 - situation
 - time and fatigue

★ Effective performers regulate arousal to stay in their IZOF.

4. ANXIETY: LOW VS HIGH

Anxiety is a negative emotional state linked to worry and tension.

LOW ANXIETY CAN INCLUDE (EUSTRESS)

- Excitement
- Enthusiasm
- Desire to perform well
- Confidence
- Positive challenge



LOW ANXIETY (helpful)



HIGH ANXIETY CAN INCLUDE (DISTRESS)

- Fear
- Worry
- Nervousness
- Despondency
- Loss of confidence
- Panic



SPORT EXAMPLES



PRECISION SPORTS (e.g. golf, archery): benefit from low-moderate anxiety.



POWER SPORTS (e.g. sprinting, rugby): can function with higher anxiety.

★ The key is keeping anxiety at a level that helps, not harms, performance.

5. MULTIDIMENSIONAL ANXIETY AND CATASTROPHE THEORY

Anxiety has two dimensions that affect performance in different ways.

MULTIDIMENSIONAL ANXIETY

COGNITIVE ANXIETY (WORRY)

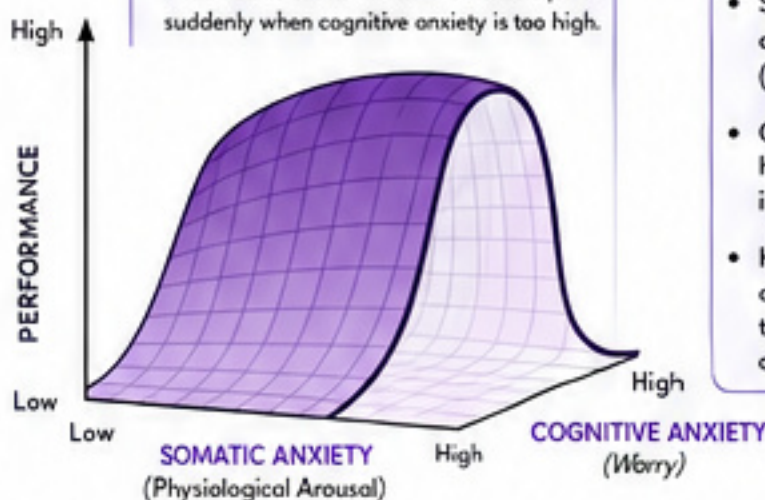
- Negative thoughts
- Self-doubt
- Distraction

SOMATIC ANXIETY (PHYSIOLOGICAL)

- Physical tension
- Heart pounding
- Sweaty palms

CATASTROPHE THEORY

Performance remains stable, then collapses suddenly when cognitive anxiety is too high.



KEY POINTS

- Somatic anxiety can help (up to a point).
- Cognitive anxiety has a negative impact.
- High cognitive anxiety leads to a performance collapse.



GOLF (precision): Low somatic + low cognitive anxiety = best performance.



100 m SPRINT (power): Higher somatic anxiety can help, but high cognitive anxiety causes sudden drop in performance.



★ Control worry (cognitive) to prevent a performance catastrophe.

6. MEASURING ANXIETY

Anxiety can be measured using subjective and objective methods.

SUBJECTIVE: SELF-REPORT

Perceived anxiety reported by the athlete.

- Questionnaires
- Rating scales (e.g. 1–10)
- Mental readiness inventories
- Ask about worry, tension, confidence



ADVANTAGES

- Simple and quick
- Measures internal experience
- Athlete insight and reflection

LIMITATIONS

- Subjective
- Bias (wanting to please)
- May not be fully accurate

OBJECTIVE: PHYSIOLOGICAL INDICATORS

Body responses linked to anxiety.

HEART RATE (HR)

- Higher HR at rest or before performance



BLOOD PRESSURE (BP)

- Higher BP reflects increased arousal and tension



GALVANIC SKIN RESPONSE (GSR)

- Measures sweat gland activity on the skin (in microsiemens)
- Increases with anxiety



★ Use both subjective and objective measures for the most accurate picture.

SPORT APPLICATION



- Different sports need different arousal/anxiety levels.



- Train mental skills to regulate arousal (breathing, routines, self-talk, imagery).



- Know your IZOF and aim to stay in it during performance.



DO NOT OVERLEARN

Do not assume one universal 'best' arousal level.

- Individuals are different.
- Tasks are different.
- Contexts change.
- Effective performers adapt and self-regulate.



KEY LINKS

- Links to C.1.3 (Goal setting) – clear goals reduce worry and optimise arousal.
- Links to C.3.1 (Stress management) – techniques help control anxiety.
- Links to C.4.2 (Leadership) – leaders create environments that manage arousal.
- Links to A.2.1 (Cardiovascular system) – arousal increases heart rate and BP.
- Links to A.1.1 (Nervous system) – activation of SNS increases arousal.



QUICK CHECK

1. Define arousal and give examples of physical and psychological activation.
2. Compare drive theory and inverted-U theory.
3. What is the IZOF and why is it individual?
4. Give examples of low anxiety (helpful) and high anxiety (harmful).
5. Explain the catastrophe theory.
6. Give three objective ways to measure anxiety.



C.4.2 STRESS AND COPING

Coping: using strategies to manage stress and maintain performance and wellbeing

GUIDING QUESTION: How should athletes match coping strategies to different stressors?

★ EXAM PRIORITY – MUST KNOW

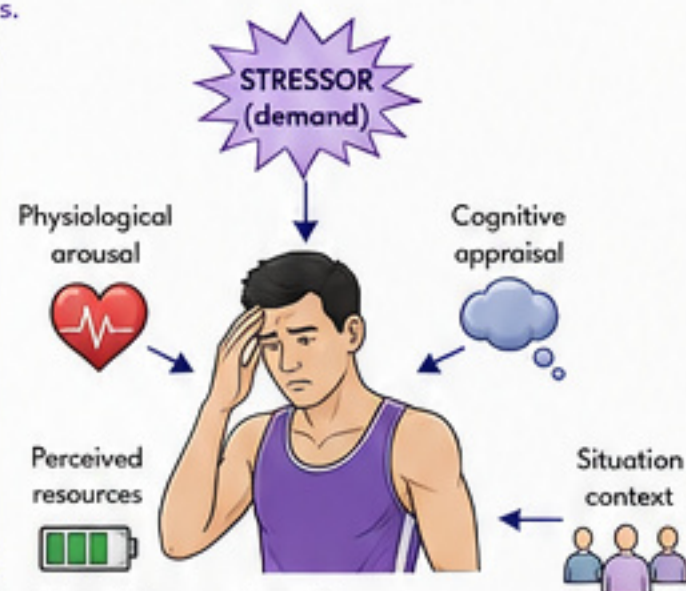
- Stressors create demands that can lead to psychological strain.
- Strain can be positive (eustress) or negative (distress).
- Coping strategies can be matched to the type and controllability of the stressor.
- Multiple strategies can be combined as needed.
- Effective coping improves performance, wellbeing and recovery.
- Maladaptive strategies provide short-term relief but harm long-term adaptation and performance.

1. STRESSOR CAUSING PSYCHOLOGICAL STRAIN

A stressor is any demand or challenge that taxes an athlete's psychological or physiological resources.

COMMON STRESSORS (examples)

- Competition pressure & expectations
- Injury and rehabilitation
- Academic / work demands
- Time pressure and scheduling
- Selection and playing time
- Travel, unfamiliar environments
- Financial concerns
- Goal setting and performance slumps
- Family and relationship issues



The athlete appraises the stressor: "What does this mean for me?"
If demands > resources = **STRAIN** (psychological + physiological).

POSITIVE STRAIN (EUSTRESS)

- Optimal challenge
- Motivates and energises
- Enhances focus and performance
- Short-term and manageable

NEGATIVE STRAIN (DISTRESS)

- Overwhelm or threat
- Reduces concentration and confidence
- Increases anxiety and tension
- May lead to burnout or injury

★ Some stress is helpful. The goal is the right amount of stress at the right time.

2. THREE CATEGORIES OF COPING STRATEGIES

Coping strategies help athletes manage stress and reduce negative strain.

PROBLEM-FOCUSED COPING
(CHANGE THE STRESSOR)

Address the source of stress to reduce or eliminate it.

Aim: solve the problem or change the situation.

Best for: controllable, changeable stressors.

Examples:

- Time management
- Skill practice
- Seeking resources
- Adjusting plans
- Talking to coach/teacher
- Planning and preparation

EMOTION-FOCUSED COPING
(MANAGE YOUR RESPONSE)

Manage thoughts, feelings and physical arousal.

Aim: reduce emotional distress and stay calm.

Best for: stressors you can't change or while solving them.

Examples:

- Relaxation
- Self-talk
- Mindfulness
- Positive reframing
- Breathing control
- Imagery

AVOIDANCE-FOCUSED COPING
(ESCAPE OR AVOID)

Avoid thinking about or dealing with the stressor.

Aim: short-term escape from distress.

Best for: rarely helpful. Use with caution.

Examples:

- Withdrawal
- Venting
- Distraction
- Substance use (harmful)
- Procrastination

★ No single strategy works for all stressors. Match the coping type to the situation.

3. SELF-TALK AND RELAXATION – MANAGING EMOTIONS

Self-talk shapes thoughts. Relaxation reduces arousal. Together they control stress and help maintain performance.

SELF-TALK

Use short, positive, present-tense statements that are realistic.

POSITIVE EXAMPLES

- "Stay calm and focused."
- "I can control my effort."
- "One point at a time."
- "I've trained for this."
- "Breathe. Believe. Perform."

UNHELPFUL EXAMPLES

- "I must not make mistakes."
- "What if I mess up?"
- "They're better than me."
- "I can't handle this."
- "I have to win."

RELAXATION TECHNIQUES

Lower physiological arousal to a calm, alert state.

- Diaphragmatic breathing (slow, deep breaths)
- Progressive muscle relaxation
- Autogenic training
- Mindfulness and meditation
- Visualisation with calm scenes



HEART RATE CONTROL (HRC)

Use breathing to lower and stabilise heart rate.



Target effect:
Reduced HR,
muscle tension
and anxiety.

★ Use self-talk to guide your mindset and relaxation to control your body.

4. MATCHING COPING TO STRESSORS (HL)

Match coping strategies to whether stressors are controllable or uncontrollable.

CONTROLLABLE STRESSORS
(CHANGEABLE)

You can do something about the cause.

EXAMPLES

- Poor time management
- Lack of preparation
- Technical weaknesses
- Poor nutrition
- Communication issues

DECISION FLOW

Identify the stressor

Can I change it?

YES

Partly

NO

Use primarily
PROBLEM-FOCUSED
strategies

Use primarily
EMOTION-FOCUSED
strategies

Combine both
(problem + emotion)

MATCHED COPING

Plan, practice, seek help,
create routines, set goals,
organise, problem-solve.

UNCONTROLLABLE STRESSORS
(UNCHANGABLE)

You cannot change the cause directly.

EXAMPLES

- Weather conditions
- Opponent's ability
- Selection decisions
- Past mistakes
- Injury you can't speed up

MATCHED COPING

Relaxation, self-talk, imagery,
mindfulness, positive reframing,
acceptance, focus on process.

★ Assess controllability first. Then choose the coping strategy that fits best.

5. OTHER EFFECTIVE COPING STRATEGIES (HL)

A wider toolkit helps athletes cope flexibly and adapt to different demands.

SEEKING SOCIAL SUPPORT



Use support from others.

Examples:

- Coach feedback
- Teammate support
- Family and friends
- Sport psychologist

Helps with:

- Perspective
- Advice
- Encouragement
- Practical help

LOGICAL ANALYSIS
(PROBLEM-SOLVING)

Break the problem down and solve it.

Steps:

- Define the problem
- List causes
- List solutions
- Evaluate options
- Choose and act
- Review outcome

Helps with:

- Clear thinking
- Control
- Confidence

IMAGERY (MENTAL REHEARSAL)



Mentally practise success.

Types:

- Outcome imagery (success)
- Process imagery (technique)
- Coping imagery (staying calm)

Helps with:

- Confidence
- Focus
- Skill execution

THOUGHT CONTROL
(COGNITIVE COPING)

Change unhelpful thoughts.

Techniques:

- Reframing
- Positive self-talk
- Challenge negatives
- Focus on controllables

Helps with:

- Anxiety reduction
- Confidence
- Resilience

EFFORT EXPENDITURE
(ACTION COPING)

Channel stress into productive action.

Examples:

- Extra training
- Skill practice
- Active recovery
- Preparing for next opportunity

Helps with:

- Control
- Momentum
- Achievement

★ Build a personal coping toolkit with a mix of strategies.

6. MALADAPTIVE COPING STRATEGIES – USE WITH CAUTION

These strategies may give short-term relief but increase negative strain long-term.

WITHDRAWAL /
DISENGAGEMENT

Avoid people and responsibilities.

Examples:

- Isolating from team
- Skipping training
- Avoiding homework

Consequences:

- Less support
- Poor performance
- Relationship strain
- Increased stress

VENTING



Express anger or frustration outwardly.

Examples:

- Shouting
- Complaining
- Blaming others

Consequences:

- Damages relationships
- Does not solve problem
- Increases tension

SELF-BLAME



Overly criticise and blame yourself.

Examples:

- "It's all my fault."
- Harsh self-criticism
- Negative labels

Consequences:

- Low confidence
- Anxiety and sadness
- Reduced motivation

SHORT-TERM
DISTRACTION

Escape through distraction.

Examples:

- Excessive social media
- Video games
- Binge eating
- Substance use

CAVEAT:

May rest briefly but can lead to avoidance, addiction and poor outcomes.

★ Avoid maladaptive strategies. They increase stress and reduce performance.

SPORT APPLICATION



- Identify your common stressors.
- Use the decision flow to match coping.
- Practise strategies in training, not just in competition.
- Review what worked and adjust.



Result: Better stress management leads to consistent performance and wellbeing.



DO NOT OVERLEARN

You are not required to know:

- Detailed lists of every coping model
- Advanced counselling techniques
- Clinical treatment for mental illness
- Hormonal pathways of stress
- Pharmacological treatments



KEY LINKS

- Links to C.1.1 (Mental skills) – coping strategies support mental skills like focus and confidence.
- Links to C.1.2 (Motivation) – coping maintains motivation under pressure.
- Links to A.1.2 (Homeostasis) – coping helps maintain internal stability.
- Links to D.1.1 (Injury prevention) – stress affects injury risk and recovery.
- Links to D.2.1 (Sleep) – stress management improves sleep quality.



QUICK CHECK

- Define stressor and strain.
- Differentiate positive strain and negative strain.
- Name the three categories of coping and give examples.
- Which strategies lower heart rate and reduce arousal?
- How do you match coping to controllable vs uncontrollable stressors?
- Give four maladaptive coping strategies and explain why they are problematic.



C.5.1 GOAL SETTING

Performance enhancement: understanding improvement

GUIDING QUESTION: How can goal choice and adjustment direct attention and motivation?

★ EXAM PRIORITY – MUST KNOW

- Directs attention to what is important
- Organises effort and motivates behaviour
- Provides a standard for evaluation and feedback
- Influences persistence and resilience
- Guides planning, practice and strategy
- Requires adjustment as performance and context change

1. PURPOSE OF GOAL SETTING

Goals focus attention, guide behaviour and sustain motivation.



DIRECTS ATTENTION

Focuses on key cues and reduces distractions.



MOTIVATES EFFORT

Provides challenge and reasons to try hard.



IMPROVES PERFORMANCE

Encourages effective practice and learning.



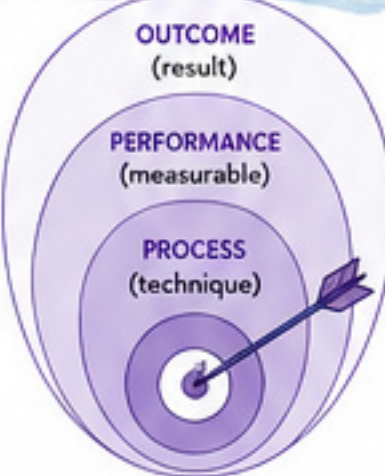
ENABLES EVALUATION

Provides standards to measure progress.



GUIDES ADJUSTMENT

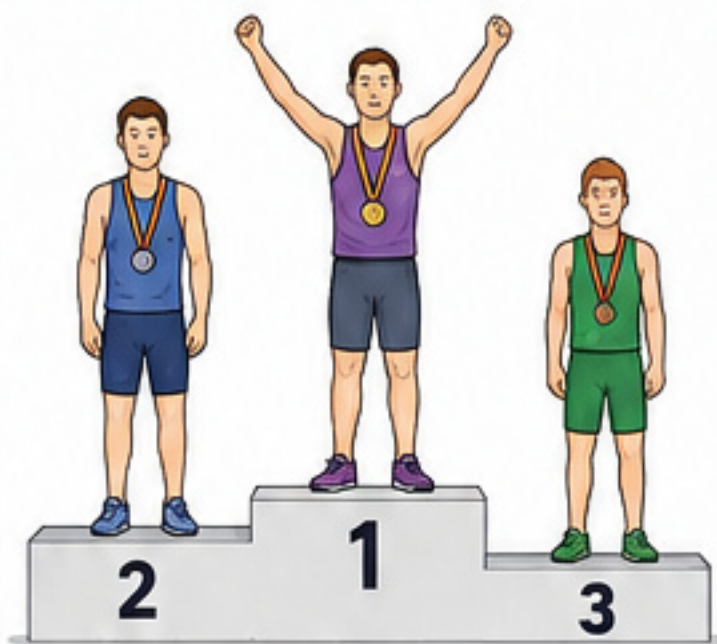
Helps adapt goals to performance and context.



★ Good goals channel attention and effort toward success.

2. OUTCOME GOALS – NORM-REFERENCED RESULTS

Focus on the end result and comparison with others.



Examples (norm-referenced)

- Win the 100 m final.
- Finish in the top 3.
- Beat my opponent.
- Qualify for nationals.

BENEFITS

- ✓ Provides clear target.
- ✓ Motivates competition.
- ✓ Useful for major events.

LIMITATIONS

- ✗ Depends on others' performance.
- ✗ Less controllable.
- ✗ Can cause anxiety.

★ Useful for big events, selection and ranking.

3. PERFORMANCE GOALS – SELF-REFERENCED, MEASURABLE TARGETS

Focus on measurable improvement and personal bests.



Examples (self-referenced)

- Run 100 m in under 12.50 s.
- Swim 400 m in under 4:50.
- Increase vertical jump by 5 cm.
- Lower 5 km time by 2 minutes.

Characteristics

- ✓ Specific
- ✓ Measurable
- ✓ Challenging
- ✓ Achievable
- ✓ Relevant
- ✓ Time-bound



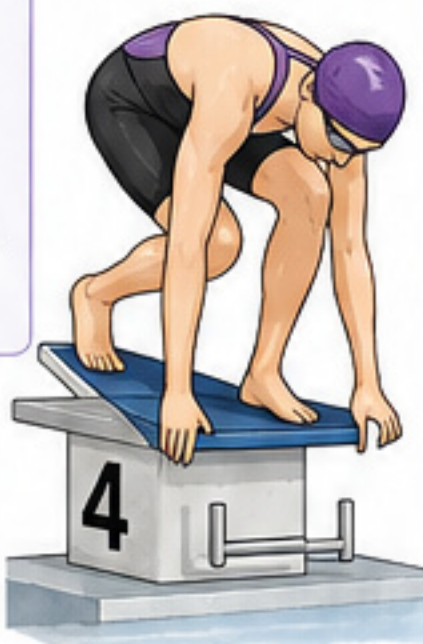
★ Performance goals build improvement and confidence.

4. PROCESS GOALS – TECHNIQUE / STRATEGY TARGETS

Focus on controllable actions and how the task is performed.

Examples

- Keep a high elbow catch.
- Breathe every 3 strokes.
- Maintain long, relaxed stride.
- Start reaction time under 0.15 s.
- Stay in rhythm during the race.



Why process goals work

- ✓ Fully controllable.
- ✓ Direct attention to technique and decision-making.
- ✓ Build good habits.
- ✓ Help regulate arousal and reduce worry.

Cue

What to focus on?

e.g. "Tall body at the catch."

Action

What will I do?

e.g. "Reach long, press back."

Outcome

What will happen?

e.g. "Stronger pull, faster swim."

★ Focus on the process to influence the performance.

5. HL: THE GOAL-SETTING PARADOX AND POSSIBLE DEFLATION AFTER SUCCESS

Very high goals can motivate, but success may reduce drive.

The paradox

Higher goals → greater effort and performance
BUT success → reduced motivation and effort

Why deflation happens

- Goal no longer challenging.
- Sense of satisfaction / relief.
- Reduced need to try as hard.
- External rewards may replace internal motivation.

How to reduce deflation

- ✓ Set new, higher or different type of goals.
- ✓ Focus on mastery: learning, improvement, contribution.
- ✓ Use process and performance goals as next steps.
- ✓ Reflect on reasons for sport beyond winning.

★ Plan the next challenge before the previous one is reached.

6. HL: GOAL ADJUSTMENT, DO-YOUR-BEST GOALS AND OPEN GOALS

Goals must adapt; "do-your-best" and open goals help.

Why adjust goals?



Goal adjustment steps

- 1 Review current performance and context.
- 2 Decide: maintain, modify or set new goal.
- 3 Update target, plan and strategies.
- 4 Monitor and review regularly.

Do-your-best goals

Focus on giving maximal effort and using best effort strategies.

E.g. "Give 100% effort in every race."

Open goals

No specific outcome stated; focus on experience, exploration and participation.

E.g. "Have an enjoyable training camp and learn."

★ Flexible goals keep motivation high across situations.

SPORT APPLICATION

SWIMMING

Outcome: Win the final.
Performance: Swim 50 m freestyle in 24.50 s.
Process: High elbow catch; breathe every 3 strokes.

RUNNING

Outcome: Finish in top 3.
Performance: Run 5 km in under 18:30.
Process: Maintain cadence; relaxed shoulders.

DO NOT OVERLEARN

SMART goals are NOT the core syllabus model for IB SEHS.

IB goals are grouped by:

- Outcome goals (results)
- Performance goals (measurable)
- Process goals (technique/strategy)

Focus on purpose, choice and adjustment – not SMART.



KEY LINKS

- Links to C.1.1 (Motivation) – goals maintain and direct motivation.
- Links to C.4.1 (Feedback) – goals guide feedback and evaluation.
- Links to C.4.2 (Arousal) – goals help regulate optimal arousal.
- Links to C.5.2 (Motivational theories) – goals support need satisfaction and self-regulation.

✓ QUICK CHECK

1. What are the three types of goals in IB SEHS?
2. What is the key difference between outcome and performance goals?
3. Give one example of a process goal in running.
4. Explain the goal-setting paradox.
5. Why are goal adjustment and open goals important in sport?



C.5.2 IMAGERY (HL ONLY)

Optimising performance through psychological strategies

GUIDING QUESTION: How can mental simulation improve sporting performance?

★ EXAM PRIORITY – MUST KNOW

- Imagery = mental simulation of performance and contexts
- Uses multiple senses to mimic real experience
- Enhances cognitive, motivational and emotional readiness
- Works best when vivid, controllable, specific and regular
- Integrates with practice and other mental skills
- Used by performers at all levels to improve performance

1. IMAGERY – DEFINITION

Imagery is the mental simulation of a performance or situation that mimics real experience using multiple sensory modalities.



★ The more vivid, controllable and realistic the imagery, the more effective it is.

2. COGNITIVE FUNCTIONS – REHEARSAL

Imagery enhances thinking and decision-making skills.

SKILL REHEARSAL

Practising the physical execution of a skill mentally.

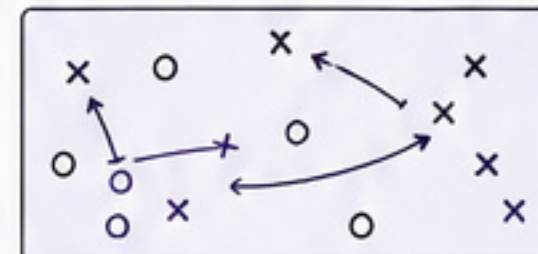
- Learn new skills faster
- Refine technique
- Improve coordination and timing
- Strengthen neural pathways



STRATEGY REHEARSAL

Practising tactics, plans and problem solving.

- Anticipate opponents' actions
- Plan and evaluate options
- Improve decision-making
- Prepare for different scenarios



★ Mental rehearsal primes the brain and body for optimal execution.

3. MOTIVATIONAL FUNCTIONS

Imagery influences motivation, emotions and psychological readiness.

GOAL SETTING

- Clarify goals
- Visualise the process to success
- Maintain focus and direction



CONFIDENCE

- Experience success mentally
- Reduce self-doubt
- Build belief in ability



AROUSAL REGULATION

- Increase arousal when needed
- Calm over-arousal
- Achieve optimal arousal zone



EMOTIONAL CONTROL

- Manage anxiety and nerves
- Develop composure
- Reframe pressure as challenge



★ Imagery prepares the mind to feel, think and act like a successful performer.

4. PETTLEP MODEL – STRUCTURING EFFECTIVE IMAGERY

Use PETTLEP to make imagery as effective as real practice.

P	E	T	T	L	E	P
Physical	Environment	Task	Timing	Learning	Emotion	Perspective
Simulate physical sensations and movements	Recreate the competition setting and surroundings	Focus on the specific skill or strategy to perform	Match the timing and sequence accurately	Include goals, feedback and corrective processes	Include the emotions and arousal you expect	Choose the best viewpoint: internal or external

★ The more closely imagery matches real performance, the greater the transfer.

5. PAIVIO'S DUAL CODING FRAMEWORK IN IMAGERY

Imagery is processed through dual coding, influencing both mind and body.

TWO CHANNELS OF PROCESSING

VERBAL (LOGICAL)

Words, symbols and internal dialogue (e.g. self-instruction, strategy talk)

+

NON-VERBAL (IMAGINAL)

Images, sounds, feelings, sensations, smells and tastes

FOUR IMAGERY CATEGORIES



COGNITIVE (Thinking)

- Understanding and planning
- Strategy rehearsal
- Decision-making



MOTIVATIONAL (Affective)

- Confidence and belief
- Emotion regulation
- Motivation and arousal

SPECIFICITY CONTINUUM

SPECIFIC

Detailed, concrete and sport-specific (e.g. a hockey penalty corner routine)



GENERAL

Broad, abstract and outcome-focused (e.g. winning the final, being confident)

★ Effective imagery uses both channels and the right balance of specificity.

6. APPLICATIONS OF IMAGERY IN SPORT

Imagery supports performance across key areas.

EXAMPLE – SKIER

	SKILL ACQUISITION / REFINEMENT • Learn new skills • Refine technique • Correct errors		Mentally rehearse perfect turns, edge control and pole plant timing.
	COMPETITION STRATEGY • Plan and rehearse tactics • Anticipate scenarios • Adapt to opponents		Visualise race line choices, gate combinations and contingency plans.
	CONFIDENCE BUILDING • Experience success • Reinforce self-belief • Reduce self-doubt		See yourself executing clean runs and handling pressure well.
	MOTIVATION • Stay committed • Focus on process • Overcome setbacks		Visualise achieving your goals and the rewards of consistent effort.
	AROUSAL REGULATION • Activate before performance • Calm when over-aroused • Reach optimal zone		Use calming imagery to reduce nerves or energising imagery to prepare to race.

★ Regular, purposeful imagery builds a performance mindset that transfers to competition.

SPORT APPLICATION

Elite skiers use imagery daily to rehearse their runs, feel the snow, hear the wind and sense speed and balance.

- ✓ Before training: plan and focus.
- ✓ Before competition: prepare and regulate.
- ✓ After performance: review and learn.

This leads to greater consistency, confidence and performance under pressure.



DO NOT OVERLEARN

Imagery is not visualisation only.

Effective imagery includes:

- All senses (not just sight)
- Process and outcome
- Effort, mistakes and recovery
- Negative and positive scenarios
- Realistic emotions and body feelings

Overly perfect imagery can reduce adaptability.



KEY LINKS

- Links to C.1 (Skill acquisition) – accelerates learning and refinement.
- Links to C.3 (Motivation) – enhances goals, confidence and persistence.
- Links to C.4 (Arousal & emotion) – regulates arousal and emotions.
- Links to A.2 (Neuroscience) – activates neural pathways similar to real performance.
- Links to ATL skills – self-management and reflection.



QUICK CHECK

1. Define imagery and explain how it mimics real experience.
2. Outline the cognitive and motivational functions of imagery.
3. Describe the PETTLEP model.
4. Use Paivio's framework to explain cognitive/motivational and specific/general imagery.
5. Give examples of how imagery improves performance.

