3.2 Training principles and adaptations

Name: _____ Class: _____ Date: _____ **Total: 30 marks**

KEY WORDS progressive overload • reversibility • Karvonen method • periodization • tapering • overtraining

Objective

Build the skills to answer exam questions on **training** : principles of training, measuring intensity, training methods and **periodization** , long-term **adaptations** , and training load and health.

You must be able to:

- apply the principles of training, including progressive overload and reversibility
- calculate a training heart rate with the Karvonen method
- explain cardiovascular, respiratory and muscular adaptations to training
- explain periodization, tapering and the risks of overtraining
- plan and justify training for different groups and environments

1 Key knowledge and worked examples

Training and adaptations

principle	meaning
specificity	train the systems, muscles and movements used in the sport
progressive overload	gradually increase the load (frequency, intensity, time) so the body keeps adapting
reversibility	fitness gains are lost when training stops
variation	change sessions to keep progress and motivation, and reduce overuse
individual differences	people respond differently (age, genes, training history)
recovery	adaptation happens during rest after training (**supercompensation**)

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Intensity: maximum heart rate $\approx 220 - \text{age}$. **Karvonen method:**

$$\text{training HR} = (\text{HR}_{\text{max}} - \text{HR}_{\text{rest}}) \times \text{intensity} + \text{HR}_{\text{rest}}$$

Also the **rating of perceived exertion** (RPE, Borg scale 6–20).

Methods: continuous, interval (incl. **HIIT**), fartlek, circuit, resistance, plyometric, flexibility training.

Periodization divides the year into **macrocycles**, **mesocycles** (several weeks) and **microcycles** (about a week), with preparation, competition and transition phases. A **taper** (less volume, keep intensity) before a main event lets the body recover fully.

Adaptations

aerobic (endurance) training	resistance training
larger heart, higher stroke volume, lower resting HR	**hypertrophy** (larger fibres)
more capillaries, mitochondria and myoglobin	better recruitment of motor units (**neural** adaptation; most of the early strength gain)
higher $\dot{V}O_2$max and lactate threshold	stronger tendons and bones

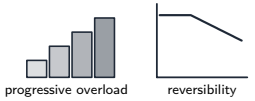
Training load and health: too much load with too little recovery raises the risk of injury, illness and **overtraining** (performance falls, mood and sleep worsen). The **acute:chronic workload ratio** compares this week's load with the 4-week average; a sudden rise (about > 1.3–1.5) is linked with more injuries. The WHO recommends 150–300 minutes of moderate activity a week for adults, plus muscle strengthening on 2 or more days.

AHL – different groups and environments: children (play, skill, avoid early specialization), older adults (balance, strength and bone loading; longer warm-up and recovery), pregnancy (moderate activity is usually safe with medical advice), people with disabilities (adapt equipment and rules), and training in heat or at altitude.

Answer shapes: name the principle or adaptation, explain how it works, and link it to performance.

2 Practice

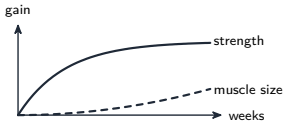
2.1 Define progressive overload and reversibility. [2]



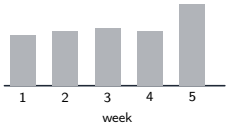
2.2 An 18-year-old has a resting heart rate of 60 beats min^{-1}. Use the Karvonen method to calculate her training heart rate at 70% intensity. [3]



2.3 Explain why most of the strength gained in the first weeks of resistance training is due to neural adaptation. [3]



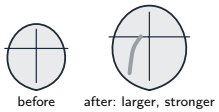
2.4 A player's training load this week is 2400 units. Her average weekly load over the last four weeks is 1600 units. Calculate her acute:chronic workload ratio and comment on it. [3]



3 Exam-style questions

3.1 After six months of endurance training, a runner's resting heart rate falls from 72 to 58 beats min^{-1}.

(a) Explain why resting heart rate falls. [2]



(b) State **two** other adaptations to endurance training. [2]

3.2 The diagram shows a swimmer's training year.

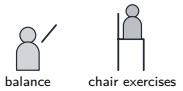
(a) Outline the purpose of a taper. [2]

(b) Explain how periodization helps to avoid overtraining. [3]



3.3 A gym plans a programme for adults aged over 70.

Suggest and justify **two** ways the programme should differ from one for young adults. [4]



3.4 A busy office worker wants to improve $\dot{V}O_2max$ and has about 3 hours a week to train.

Evaluate high-intensity interval training (HIIT) and continuous training for this person. [6]



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Solutions

Marking: **M1** a correct method, **A1** the correct answer, **B1** an independent mark.

Each answer shows the steps, then the **result**.

2.1

progressive overload: gradually increasing the training load so the body keeps adapting; reversibility: fitness gains are lost when training stops or is reduced

2.2

$\mathrm{HR}_{\max} = 220 - 18 = 202$; $(202 - 60) \times 0.70 + 60 \approx \mathbf{159}$ beats min^{-1}

2.3

strength rises before muscles get noticeably bigger; the nervous system learns to recruit more motor units and fire them faster and more together; antagonist muscles relax more, so more force is produced; hypertrophy adds strength only later

2.4

$2400 \div 1600 = \mathbf{1.5}$; a sudden rise above about 1.3 is linked with a higher injury risk, so the load should be increased more gradually

3.1

(a) the heart muscle (left ventricle) gets larger and stronger, so stroke volume rises; the same resting cardiac output is reached with fewer beats

(b) any two: more capillaries; more mitochondria; more myoglobin; higher $\dot{V}\mathrm{O}_2\mathrm{max}$; higher lactate threshold; more blood plasma and haemoglobin

3.2

(a) training volume is reduced before a main competition while intensity is kept; so the body recovers fully and performance peaks on the day

(b) it plans hard and easy periods, so load rises gradually; recovery weeks and a transition phase allow adaptation (supercompensation); load can be monitored and adjusted, so fatigue does not build up over many weeks

3.3

any two, each with a justification: include balance and strength exercises, because falls are a major risk and muscle mass declines with age; include weight-bearing or loading exercise, to slow bone loss; longer warm-up and recovery, lower starting intensity and slower progression, because of a lower $\mathrm{HR}_{\max}$, slower recovery and more chronic conditions

3.4

award up to [6]: HIIT: short, intense intervals improve $\dot{V}\mathrm{O}_2\mathrm{max}$ in less total time, so it fits a busy week; but it feels hard, needs good motivation, and has a higher injury risk for untrained people; continuous: easier to start and keep doing, builds an aerobic base and fat use; but needs more time for similar gains; conclusion: a mix, e.g. two short HIIT sessions plus one longer easy session, with gradual progression

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