

CHAPTER 8: Principles and methods of training

Questions - text book page 111

1) An 18 year old rugby player is doing pre-season fitness training.

a) Calculate her heart rate training zone for moderate-intensity physical activity.

Answer:

- $\text{Maximum heart rate} = 220 - \text{age}$
 $= 202 \text{ beats/min}$
- *Moderate-intensity physical activity zone is 50-70% of maximum heart rate:*
- $50\% \text{ of } 202 = 0.5 \times 202 = 101 \text{ beats/min}$
- $70\% \text{ of } 202 = 0.7 \times 202 = 141 \text{ beats/min}$
- Hence **training zone** is between 101 to 141 beats per minute.

b) Calculate the heart rate training zone for moderate-intensity physical activity and for vigorous-intensity physical activity for a 40 year old female.

Answer:

- *Moderate-intensity physical activity zone is 50-70% of maximum heart rate:*
- $\text{Max heart rate is } 220 - \text{age} = 180 \text{ beats/min}$
- $50\% \text{ of } 180 = 0.5 \times 180 = 90 \text{ beats/min}$
- $70\% \text{ of } 180 = 0.7 \times 180 = 126 \text{ beats/min}$
- *Vigorous-intensity physical activity zone is 70-85% of maximum heart rate:*
- $\text{Max heart rate is } 200 - \text{age} = 180 \text{ beats/min}$
- $70\% \text{ of } 180 = 0.7 \times 180 = 126 \text{ beats/min}$
- $85\% \text{ of } 180 = 0.85 \times 180 = 152 \text{ beats/min}$
- Hence **training zone** is between 126 to 152 beats per minute.

2) What is the difference between a single and double periodised year?

Answer:

- A single periodised year has one competitive season.
- A double periodised year has two competitive periods.
- For example, an indoor and an outdoor athletics season.

3) Define macrocycle, mesocycle and microcycle.

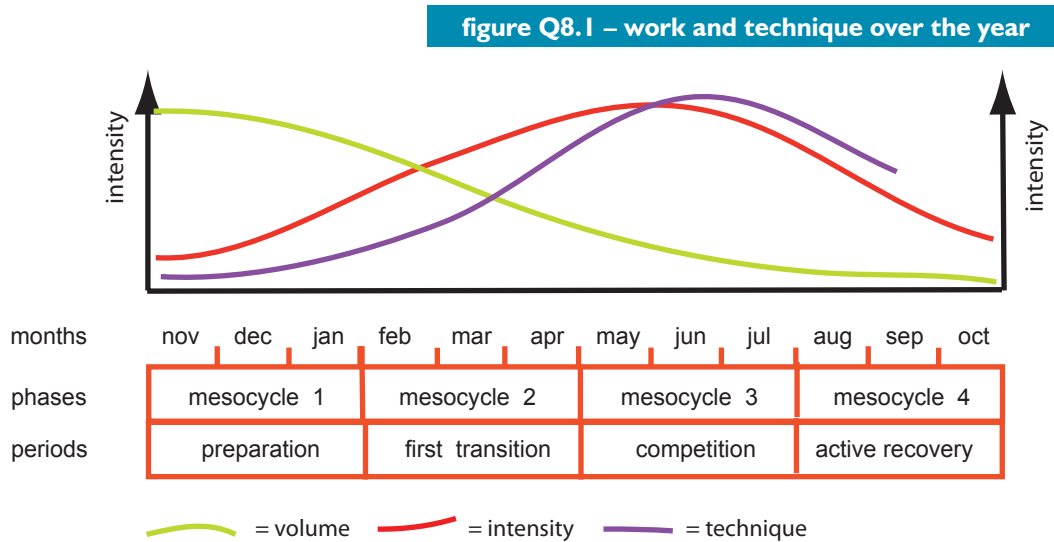
Answer:

- A **macrocycle** is a phase within the periodised year lasting between 4 to 26 weeks.
- Or the time available for preparation up to a major goal or competition.
- A **mesocycle** is a phase within the periodised year lasting between 2 to 4 weeks and has a specific purpose.
- A **microcycle** is a phase within the periodised year lasting 1 week or less, sequencing several training sessions.

- 4) a) The figure below shows a curve that represents the intensity of training over a single periodised year. Draw in a further two curves that represent volume of work and technique.

Answer:

- See figure Q8.1



- b) The competitive phase lets the performer peak for competition. Using the intensity curve explain how strength development changes over the periodised year. Gives examples of work volume in terms of sets, repetitions, and percentages of 1RM.

Answer:

The intensity curve:

- Starts off low and strength development gradually increases during **mesocycle 2** and peaking during **mesocycle 3** as shown on the graph.
- The closer to competition the lower the volume and the higher the intensity and the higher the specificity of strength work development.
- Strength development is gradually increasing during **mesocycle 2** and peaking during **mesocycle 3** on the graph.

Examples of work volumes:

- During **mesocycle 1** the emphases general preparatory exercises with intensity of workload.
- Circuit training is introduced early on during the preparation phase.
- Developing muscular strength and strength endurance.
- For example, an 8 station circuit consisting of shuttle runs, start jumps, v-sit ups, bench dips, chinies, alternate dumbbell press, steps ups, rope climb.
- 3 circuits/sets working at each exercise for 60 seconds at each station for the 1st circuit, 30 seconds at each station for the 2nd circuit, 15 seconds at each station for the 3rd circuit.
- Repetitions are dependent on the number achieved within the specified time period.
- 70-80 % Percentage of 1RM depending on the exercise.

Strength development

- Becomes more specific to the sporting event and so increases during **mesocycle 2 and 3**.
- For throws, sprints and jumps strength development would vary depending on the needs of the athlete.
- Strength training exercises such as Olympic lifts, explosive jumping, uphill sprinting, bounding exercises and resisted or assisted sprints medicine ball work.
- Work volume at 85% or more of 1RM, sets between 4-6 and repetitions low.
- For example, clean weight training exercise 4 sets of 5 repetitions with 2-3 minutes rest relief between each set.
- For example, 6 x 30 metre timed sprints towing a sledge at 100% effort, 3 minutes rest relief between each sprint.
- For example, 5 sets of 2 foot bounds over 15 metres at 100% effort, 3 minutes rest relief between each repetitions.
- **Strength development** peaking during the **competitive phase**.

- 4) b) (continued)
- Followed by tapering off during *mesocycle 4* - the *active recovery* phase
 - Which could include cross-training (which is athletic training in sports other than the athlete's usual sport) such as cycling and swimming for a track and field athlete.
 - For example, 60 minute continuous swim or 20 kilometre bike ride.
 - At around 50% of 1RM.
 - This type of exercise keeps the athlete 'ticking over' by providing lower intensity aerobic activity including strength endurance work.

Questions - text book page 113

Describe the following types of flexibility/stretching methods:

a) Static.

Answer:

- Static stretching refers to stretching exercises that are performed without movement.

b) Dynamic.

Answer:

- Dynamic stretching refers to stretching exercises that are performed with gentle motion.

c) Ballistic.

Answer:

- Ballistic stretching uses aggressive, dynamic or rapid bouncing or swinging movements to increase the range of motion of the stretch.

d) Proprioceptive neuromuscular facilitation (PNF).

Answer:

- Proprioceptive neuromuscular facilitation (PNF) refers to a stretch that achieves a range of motion which is then held in a isometric contraction held between 6-10 seconds.
- The joint is then actively pushed beyond the initial range of motion by an external force applied by a partner.

Exam style questions - text book pages 122-124

1) Define the following principles of training:

3 marks

a) Progressive overload.

Answer:

- Progressive overload is defined as training activities which get harder, more intense and/or lengthier.

b) Specificity.

Answer:

- Specificity is defined as the relevance of choice of exercise to the activity to be improved.

c) Reversibility

Answer:

- Reversibility is defined as when training loads are reduced or removed completely, the state of fitness or performance returns to its normal untrained state.

2) What is meant by the FITT principles of training? Use examples to illustrate your answer. 8 marks

Answer:

- The acronym **FITT** outlines the key components of an effective exercise programme, and the initials F, I, T, T, stand for: Frequency, Intensity, Time and Type.
 - **Frequency** ...refers to the frequency of exercise undertaken or how often you exercise.
 - **Intensity** ...refers to the intensity of exercise undertaken or how hard you exercise.
 - **Time** ...refers to the time you spend exercising or how long you exercise for.
 - **Type** ...refers to the type of exercise undertaken or what kind of exercise you do.
- Example for general fitness: Frequency - 3 days of aerobic running (type) activity per week, working for as long as you can at a moderate intensity, a 20 minute run on a Monday and a 30 minute runs on Wednesday and Friday (time).

3) Explain why you would use the principles of training, shown in figure 8.1 on page 103, when developing a training programme to improve the fitness of 16+ physical education students. 8 marks

Answer:

- **Specificity**
 - The need to make movements and energy system demands the same as the activity.
 - For example, hockey players would benefit from back-to-back stick shuttle sprints (stressing the fitness components speed and agility and developing the anaerobic lactic acid energy system).
 - This skill is sport specific because the players are replicating the movement patterns they use in their hockey game.
- **Progression**
 - Involves the gradual application of the overload principle in order to improve fitness.
 - The example below shows how progression is achieved by increasing the number of shuttle runs from session one to session three:
 - **Week one - session one:** 2 sets of 4 back-to-back shuttle sprints with 6 minutes recovery between sets.
 - **Week two - session two:** 3 sets of 4 back-to-back shuttle sprints with 5 minutes recovery between sets.
 - **Week three - session three:** 3 sets of 5 back-to-back shuttle sprints with 4 minutes recovery between sets.
- **Progressive overload**
 - Describes training activities which get harder, more intense or longer.
 - Overload is achieved by increasing the intensity and or time or duration of training – these two overload principles form part of what is commonly referred to as the **FITT principles**.
 - In the example above, progression made from session one to session three demonstrates the increase in anaerobic exercise as shuttle reps increase and recovery between sets decreases (intensity) and duration (time) of the exercise period increases.
- **Reversibility**
 - 'Use it or lose it' which means that if the training stimulus is not maintained, gains previously made from training are lost.
 - This means that our hockey players will need to maintain or even continue the increase the volume of work stressing the anaerobic lactic acid energy system, otherwise anaerobic adaptations will reverse.
- **Variance to avoid tedium**
 - Refers to training that lacks variety and causes boredom.
 - If our hockey players continue to do the same training session (with the same outcomes and feelings) week in and week out, they may become de-motivated as the feelings of mastery of the activity are reduced.
 - This can be overcome by setting goals for sessions which vary (even though the activity itself may be the same), or completely change the activity while retaining the same goals (for example goals to improve strength or endurance).
 - Changing activities in training with the specific aim of reducing tedium is called **variance**, and is a crucial feature of a successful training programme.

4) Explain how the fitness principles of progressive overload and specificity apply to flexibility. 3 marks

Answer:

- By increasing the frequency, intensity and/or duration (overload) of the stretch the joint range of movement will improve.
- By making the stretch specific to the needs of the activity the relevance of choice of exercise to the activity can be improved

5) a) Describe a method of determining your heart rate target zone.

3 marks

Answer:

Note select one method from the following:

- **Karvonen's training heart rate method** is a mathematical formula that helps you determine your target heart rate (HR) training zone.
- The formula uses maximum and resting heart rate with the desired training intensity to get a target heart rate.
- Target Heart Rate = $((\text{max HR} - \text{resting HR}) \times \% \text{intensity}) + \text{resting HR}$.

Or

- **The Borg Rating of Perceived Exertion (RPE)** requires a person to subjectively rate the difficulty of the training.
- Perceived exertion is how hard you feel like your body is working.
- Using a numerical scale between zero and 20.
- The score zero corresponds to being asleep, and the score 20 corresponds to absolutely flat out intensity.

Or

- **Heart rate maximum method** and relative heart rate intensity.
- Relative heart rate intensity can be calculated by working out HRmax as follows;
- $\text{HRmax} = 220 - \text{age}$ (of the performer)
- Classification of intensity, for example 60% of HRmax, can then be calculated.

b) Give one advantage and one disadvantage for the method you have selected.

2 marks

Answer:

- **Advantage of Karvonen's training heart rate method:**

1 mark for 1 of:

- Very reliable method because it incorporates resting heart rate values.
- Accounts for differences in fitness levels.

- **Disadvantage of Karvonen's training heart rate method:**

1 mark for 1 of:

- More calculations involved compared with other methods.
- So takes more time to work out.

- **Advantage of Borg's Rating of Perceived Exertion (RPE):**

1 mark for 1 of:

- A simple method that can be understood and used by people.
- Allows for an athlete to easily regulate their exercise intensity.
- Can predict exercise heart rate by multiplying RPE x 10.
- **Disadvantage of Borg's Rating of Perceived Exertion (RPE):**
- As exhaustion is subjective, this method loses its validity.

- **Advantage of Heart rate maximum method and relative heart rate intensity:**

- Very easy simple method to calculate.

- **Disadvantage of Heart rate maximum method and relative heart rate intensity:**

- Does not take into account differences in fitness.

c) Why is it important to monitor heart rate to make sure that it is in the desired heart rate zone?

2 marks

Answer:

2 marks from 2 of:

- As a person gets fitter and stronger, his or her cardiovascular system becomes more efficient.
- So that more work can be achieved for the same % effort, as a result of decreased heart rate.
- By monitoring heart rate regularly, the performer can chart their his or her fitness progress,
- Regular monitoring of heart rate might also reveal any performance drop-offs that can be the early warning signs of overtraining or impending illness.

- 6) a) How can athletes make sure that they are exercising at an intensity that is within their heart rate training zone? 2 marks

Answer:

- Wearing a heart rate monitor allows for the athlete to record their heart rate.
- So that they can ensure they work at the correct intensities for their training zones.

- b) Identify four issues associated with using heart rate training zones. 4 marks

Answer:

4 marks for 4 of:

- The use of maximum heart rate calculation is not always accurate.
- As it does not take into account factors such as bodyweight (BMI).
- The athlete can suffer from increased level of stress which could increase heart rate values.
- Providing a less accurate representation of intensity an athlete is working at.
- Heart rate training zones are not necessarily applicable to all types of training such as circuit or interval training.
- Heart rate can be affected by temperature.
- Heart rate can be affected by altitude.

- 7) a) Explain how the Borg scale can be used to monitor exercise intensity. 2 marks

Answer:

- The Borg scale allows for a subjective recording of intensity by providing a number which represents the level of intensity a performer is working at.
- Known as their rate of perceived exertion (RPE).

- b) Give one advantage and one disadvantage of using the Borg scale to measure exercise intensity. 2 marks

Answer:

Advantage

- A simple method that can be understood and used by people.
- Allows for an athlete to easily regulate their exercise intensity.
- Can predict exercise heart rate by multiplying RPE x 10.

Disadvantage

- As exhaustion is subjective, this method loses its validity.

- 8) An alternative, effective method of calculating lower and upper threshold heart rate (HR) levels at a percentage of the difference between resting and maximum HR (termed heart rate reserve - HRR) is known as the Karvonen method. Using Karvonen's theory, calculate the training threshold of the lower training heart rate 50% to the upper training heart rate of 85% by completing the missing figures below. 4 marks

	heart rate - beats per minute
resting heart rate (bpm)	72
maximum heart rate (bpm)	202
heart rate reserve (bpm)	130
lower training heart rate (bpm)	137
upper training heart rate (bpm)	182.5

- 9) a) Stretching is a key element in any warm-up. Using an example, identify two other elements of a warm-up and explain how they help to prepare an athlete. 4 marks

Answer:

- **Jogging** gradually elevates heart rate and ventilation rates.
 - Increases core temperature.
- **Sport specific** skill practice.
 - This works the neuromuscular systems related to the chosen activity.

- b) Describe three different methods of stretching and state a sport that would benefit most from each type. 6 marks

Answer:

- **Passive stretching:**
 - This happens when the stretch is **assisted** by a partner or object to stretch the muscle beyond its normal range.
 - Suitable for activities where movement ranges is important, for example in gymnastics.
 - Could be developed into PNF.
- **Proprioceptive neuromuscular facilitation (PNF):**
 - PNF involves **stretching**.
 - Followed by an **isometric** contraction.
 - Followed by **further stretching** (PNF).
 - Suitable for activities where range of movement is important.
 - Example gymnastics.
- **Static stretching:**
 - This is a form of stretching when the muscle is **stretched to a point of tension**.
 - And then **held** for a time period.
 - Very relevant to activities where **static** balance is important.
 - Example gymnastics balance.
- **Active stretching:**
 - Occurs when the stretch is done slowly to extend the joint.
 - And stretch the muscle to an **unassisted** range of movement.
 - Suitable for all sports.
- **Ballistic stretching:**
 - Occurs when body movements are used in a **swinging/bouncing** fashion to extend joint range.
 - Suitable for explosive events such as sprinting.

- c) Identify two physiological adaptations to skeletal tissue following a three-month flexibility training programme. 2 marks

Answer:

- **Inhibition** of **stretch reflex** as muscle spindles lengthen.
- Which means that muscle will **stretch further** before stretch reflex limits flexibility.
- To **increase in resting length** of skeletal muscle.

- 10) Core stability and SAQ training methods are used by most sports performers. Briefly describe these two training methods and the advantages of using these training methods within a general training programme. 6 marks

Answer:

3 marks for core stability training:

- **Core stability** training is a type of training using a number of different exercises using fit-balls and medicine balls.
- Working the **basic trunk muscles** such as transverse abdominus.
- Enhancing **neuromuscular** anaerobic adaptations such as coordination.
- Helping with **balance** and basic **posture**.
- And aiding force transfer from ground to upper body.

3 marks for SAQ training:

- **SAQ** stands for speed-agility-quickness training.
- Involves a number of different exercises using **agility** as the main fitness component.
- Such as the use of horizontal ladder drills, and small and large hurdles.
- Emphasises **precision and speed** of foot placement.
- Hence developing **fast twitch motor unit** neural firing patterns of the neuromuscular systems.
- To initiate more automatic, explosive movement patterns.

- 11) The 2016 Olympic Games was held in Rio de Janeiro. Assess why an athlete might train at altitude for the 10,000 metres event prior to the Games. 8 marks

Answer:

- Altitude training results in a number of physiological changes which **increase the delivery and uptake of oxygen** within active tissue cells as follows:
 - Increased oxygen uptake results from the following structural and functional changes:
 - Increased haemoglobin concentration.
 - Increased muscle myoglobin.
 - Increased muscle cell mitochondria.
 - Increased oxidative enzymes in mitochondria.
 - More efficient gaseous exchange in muscle cells.
 - Improved working capacity of muscles.
 - Increased muscle .
- Most elite athletes have a minimum of 2 training blocks of between 4-6 weeks per year during the preparation training phase of the periodised year.
- Followed by a shorter block of between 2-3 weeks just prior to a major competition such as the Olympic games ie. during the competitive phase of the periodised year.
- When returning to sea level, these endurance athletes would retain the adaptations and therefore perform better in events that require a high proportion of aerobic energy.
- An alternative altitude training method is to **'live high and train low'** using hypobaric or **hypoxic chambers** such as a hypoxic tent.
- The athlete will live and sleep within this low-oxygen environment to simulate the effects of altitude on the human body, thus gaining hypoxic adaptations.
- And training within his or her normal training environment.
- Intermittent Hypoxic Training (IHT) is achieved by using aerobic and/or anaerobic interval training methods alternating between low oxygen air during the exercise period and normal air during rest relief.
- This is achieved by either using a mask attached to an altitude generator that adjusts to the required oxygen concentrations or training in a hypobaric chamber.
- Although substantially different than sleeping and training at altitude, the goal of IHT is the same: improving athletic performance and/or acclimatization to high altitude.
- Recent studies, typically limited to treadmill running or stationary cycling, indicate that intermittent hypoxic training at lactate threshold intensity and medium duration (30-40min) is an effective training means for improving aerobic capacity and endurance performance at sea level.

- 12) What does 'refinement in technique' mean to sports performers and coaches? 2 marks

Answer:

- Refinement of technique refers to **fine tuning** the **efficiency of movement** that moves closer to the perfect technical model.
- Involving a **long-term process** starting from basic skills specific to a sport and then making adjustments as the performer learns how to perform.

- 13) How do the following technologies aid analysis and feedback for improvements in sporting performance? 12 marks

a) Video and computer software analysis.

Answer:

- Enables **observational feedback** of the performance.
- The ability to **compare** with the required **technical model**.
- Using software systems such as Dartfish for individual sports.
- Which provides **frame to frame comparison** between the performer and a technical model.
- And Prozone, which looks at the **movement of players** on the pitch by using up to 12 fixed cameras and sensors.
- Analysing positions and speeds of players at up to 10 times per second.
- Enabling a coach or manager to **analyse strategies** and tactics within the game.

13) b) Heart rate monitor.

Answer:

- A heart rate monitor accurately **records and displays heart rate** function during physical activity.
- Allowing athlete to **predetermine training intensity** based on heart rate.
- And **maintain** the training intensity or training zone during the session.

c) 3D scanning machine.

Answer:

- 3D scanner is a device that analyses an object to collect data on its **shape**.
- Which is then used to construct a **digital three-dimensional model**.
- For example, this type of scanning technology can be used to create **personalised footwear**.
- That will make movement more efficient and improve performance.

d) Force plate technology.

Answer:

- Force plate technology provides information about the **pattern of force** made by a foot striking the plate.
- This information tells the coach/athlete the precise way in which the foot is active **during the strike with the ground**.
- And enables him or her to assess whether changes in **foot posture** are required.
- Force plate technology is used in conjunction with a 3D scanner in the construction of **personalised footwear**.

14) Elite performers use the concept of the periodised year when planning their training programmes. Examine how technology, used to measure exercise intensity, can contribute to successful periodisation for these elite performers.

8 marks

Answer:

- Periodisation specifically utilises different training periods with different training intensity within a cyclical manner.
- Contemporary technology that measures exercise training intensity will vary depending on aerobic to anaerobic requirements of the training programme.
- **Period one** is known as the preparation period and so is normally associated with basic aerobic conditioning work.
- Technologies, such as **heart rate monitors**, ensure that HR operates within the predetermined training zone, thus controlling training intensity.
- Today's heart rate monitors are very sophisticated and rely on GPS tracking technology and associated mobile apps that can calculate training intensities in relation to performer's age, height, weight and gender.
- They can accurately track calorie burn, distance run and time splits.
- And store data facilities to compare data and plot performance graphs.
- **Period two**, of the periodised year, is normally aimed at strength development and technique.
- During this period, regular **strength testing protocols**, using equipment such as the Lido isokinetic machines, can provide valuable information on strength and strength endurance progress, in addition to providing information regarding muscle imbalances.
- And **force plates** to monitor and track leg strength development.
- **Period three** is all about speed development and getting ready for competition.
- Technologies such as **photocell timing gates** give very accurate feedback of performance speeds.
- That can be critical in preparing an athlete for competition.
- **Force plates** (combined with video footage) can provide feedback in foot strike at take-off.
- That will measure striking intensity needed for the refinement techniques during high jump and long jump take-offs.

15) Describe how an athlete is able to control his or her body temperature during a marathon race.

4 marks

Answer:

- Replace **body fluids** to prevent dehydration and over heating.
- Wear suitable **clothing** such as mesh running vest.
- That allows air to circulate.
- Hence body is cooled by evaporation of sweat, convection and radiation.
- Use **sponge stations** to cool down body parts.

- 16) What are the major avenues for loss of body heat energy?
Which of these four pathways is important for controlling body temperature at rest, and during exercise? 6 marks

Answer:

4 marks for the major avenues:

- Radiation.
- Conduction.
- Convection.
- Evaporation.

1 mark for which of these four pathways is most important:

- **Radiation** is the primary method for discharging the **resting** body's excess heat.

1 mark for during exercise:

- **Evaporation** is the primary method for heat dissipation during **exercise**.

- 17) Why is humidity an important factor when an athlete is performing in high temperatures? Why are wind and cloud cover important? 4 marks

Answer:

2 marks for humidity:

- Water vapour in the air plays a major role in evaporative heat loss.
- Hence high humidity **limits sweat evaporation and heat loss**.

2 marks for wind and cloud cover:

- Wind **increases heat loss** by convection.
- Known as the windchill factor.
- Cloud cover **reduces heat gain** by solar radiation.

- 18) What is meant by heat acclimatisation? Outline the main physiological adaptations which occur to allow an athlete to acclimatise to training and competition at high temperatures. 8 marks

Answer:

2 marks for heat acclimatisation:

- Refers to the **physiological adaptive responses** that improve **heat tolerance**.
- Repeated exercise in the heat causes a relatively fast physiological adjustment that enables an athlete to perform better in hot conditions:

6 marks for major physiological adaptations:

- **Improves cutaneous blood flow:**
 - Transports metabolic heat from deep tissues to the body's shell.
- **Lowers threshold for start of sweating:**
 - Hence evaporative cooling in the form sweating, particularly on exposed body parts such as arms and legs.
 - Increased sweat output maximises evaporative cooling.
- **Lowers sweat's salt concentration:**
 - Dilute sweat preserves electrolytes in extra cellular fluid.
- **Cardiovascular functioning:**
 - Short-term physiological adjustments to cardiovascular functioning result in increased plasma volume.
 - Thus supporting stroke volume.
 - And allowing the body to maintain cardiac output.
 - Giving greater stability in blood pressure during training and competition.
- **Acclimatisation to hot, humid conditions:**
 - Results in increased sweating.
 - Because high humidity contributes little to evaporative cooling.
- Combined effect of improved sweating and cardiovascular adaptations is to **reduce core temperature and heart rate response**.
- Therefore more training can be done before the onset of fatigue.
- And **no adverse heat effects** during a competition.

- 19) Describe the conditions at altitude that could limit performance. 3 marks

Answer:

- Altitude causes **hypobaric** conditions or a reduction in barometric pressure.
- Resulting in decreased partial pressure of oxygen (pO_2) throughout the body.
- Reducing the oxygenation of haemoglobin.
- **Air temperature** decreases as altitude increases.
- **Solar radiation** is more intense.
- Thus limiting human activity when compared with sea level performance.

- 20) Describe the major physiological responses and adaptations that accompany acclimatisation to altitude over a period of three weeks. 8 marks

Answer:

4 marks for 4 of:

Immediate physiological responses:

- **Pulmonary:**
 - **Hyperventilation** occurs immediately.
 - As body fluids become more alkaline.
 - Due to reduced CO_2 (H_2CO_3^-) with hyperventilation.
 - Corrected by the kidneys, which excretes a more alkaline urine solution.
- **Cardiovascular:**
 - Increased submaximal **heart rate**.
 - Increased submaximal **cardiac output**.
 - **Stroke volume remains the same** or lowers slightly.
 - Maximum cardiac output remains the same or lowers slightly.

4 marks for 4 of:

Longer term physiological adaptations following 3 weeks of altitude training:

- **Cardiovascular:**
 - **Stroke volume** lowers.
 - Maximum **cardiac output** lowers.
 - **Decreased plasma volume**.
 - Increased haematocrit (the percentage of blood volume occupied by red blood cells).
 - Increased **haemoglobin** concentration.
 - Increased total number of **red blood cells**.
 - Possible increased **capillarisation** of skeletal muscle.
- **Cellular changes:**
 - Increased mitochondria.
 - Increased oxidative enzymes such as pyruvic dehydrogenase.
- **Net effect** is to improve the aerobic working capacity of muscles to compensate for the reduced pO_2 .
- And to improve the capacity of the oxygen transport system.
- To purge the oxygen debt.

- 21) What is meant by the concept 'living high and training low'? Identify two advantages of using this acclimatisation method. 6 marks

Answer:

4 marks for 4 of:

- '**Living high and training low**' is an at-home acclimatisation method achieved at sea level.
- The athlete rests and sleeps in a **hypobaric** or **hypoxic** chamber.
- Created by a hypoxic generator that continually feeds altitude-stimulating hypoxic air into the tent.
- The hypoxic chamber provides an environment in which the athlete will gain the beneficial physiological adaptations expected from being exposed to hypobaric conditions.
- This is called '**living high**'.
- '**Training low**' refers to the athlete maintaining a sea level training environment.

2 marks for 2 of advantages:

- Less costly.
- Less disruptive to lifestyle, such as family relations.
- **Maintains relationships** and **support systems** such as quality training facilities, the personal coach, training group and medical team.

- 22) Following an intense training session, explain how the following ergogenic aids can assist with the recovery process: having an ice bath, having a massage, wearing full-body compression clothing, and ingesting a hypertonic sports drink. 8 marks

Answer:

2 marks for having an ice bath:

- Will reduce joint and muscle inflammation (hot spots).
- Produced by torn blood vessels and microtears in muscle tissue.

2 marks for having a massage:

- Stretches soft tissue thereby relieving muscle tension and increasing muscle relaxation.
- Reduce swelling caused by torn blood vessels.
- Increases the movement of interstitial fluids that carry away the waste products of fatigue.
- And stimulate a supply of nutrients, such as O₂ and glucose, which speed up the recovery process.
- Relieves pain and anxiety – it is often a pleasant experience.
- Helps prevent injury by dealing with niggles.

2 marks for wearing full body compression clothing during a cool-down:

- Aids venous return
- Reduces DOMS.
- Hence enhanced recovery.

2 marks for ingesting a hypertonic sports drink:

- Aids rehydration.
- Aids refuelling of depleted glycogen stores.
- Replaces electrolytes (minerals - such as sodium) lost through sweating.
- The inclusion of sodium facilitates water storage.

- 23) Comment on how the future of sport may be affected by the developments in technology. Illustrate your answer with examples. 12 marks

Answer:

- Changes brought in by technological development are **inevitable**.
- Sport may a mere vehicle for technology and all its **commercial interests**.
- The **cost** of sporting technology widens the chasm between rich and poor nations and elite and grass roots participation.
- **An example** could be performers using a treadmill who will be able to have gas analysis, heart rate monitoring, gait analysis, and suggested training programmes produced as a result of a single session.

Many possible examples of developments in technology:

- **Kit and equipment:**
 - **Athletic clothing** will be a single composite fibre that does everything currently achieved by a range of materials.
 - Such as stretchy, light and steel-tough that wicks away sweat, insulates in such a manner as to maintain a constant body temperature, is rainproof, perhaps fireproof.
 - For **protective** ski clothing and sports such as motor racing there is the potentially revolutionary **d3o** - a shear-thickening material in a soft foam base.
 - Its shear-thickening property means that the greater the force acting on it, the more solid the material becomes.
 - On impact it suddenly hardens to provide instant **armour** without padding.
- **Rackets:**
 - Cutting edge development in racket design includes the incorporation of piezoelectric crystals into the frame, which produce electricity under stress.
 - The current generated by a ball hitting the strings is amplified and returned to the crystals in the frame.
 - Causing them to stiffen to give greater power and 50% less vibration.
- **Motor car racing** is a good example of how progressive technological advancements revolutionise the Grand Prix circuit each year.
- Drivers are only as good as their car's performance!
- The shape of the car body will govern the down force (via the Bernoulli effect) - which would increase wheel to ground friction.
- **Footwear:**
 - The shoes of the future will be even more **sport-specific** than they are now.
 - With football boots, the aim must be to let the players feel as if they are playing in bare feet.
 - Some form of sheer-thickening material where ball contact is made.
 - Support and grip might be met with **intelligent fabrics** and materials.
 - And **sole grips that self-adjust** to the requirements of the pitch and conditions.
 - **Cushioning** will improve so that the incident of hairline fractures reduces.
 - **Self-cleaning** shoes goes without saying.

23) (continued)

- **Protective clothing:**
 - The **safety helmet** of the future will be wholly breathable.
 - Far less bulky thanks to d3o-type materials.
 - Packed with **microchip** technology and personalised by the wearer.
- **Environmental conditions:**
 - What about playing in all light conditions?
 - Currently **cricketers** wear sunglasses that cut out ultraviolet (UV) rays, glare (polaroid lenses) and enhance the light in dark conditions.
 - These lenses get dirty and can only be used in slow-moving sports.
 - The answer would be to develop a form of contact lens that does everything done by sunglasses.
- **Stadia of the future:**
 - The 2012 Olympic stadium in London was being built with the latest technological specifications.
 - Japan is staging the 2020 Olympic Games and aims to provide a central sporting complex that has a **negative carbon footprint**.
- The concept of millions of people traipsing across the world for global entertainment, leaving an enormous green footprint may be unacceptable in years to come.
- The online digital alternative may be the solution!
- The concept of **Sports Villages**, providing multi-sport access to all sports performers, may be the part of our future heritage.
- These future technologies are not far off but are heavily dependent on **commercial** finance.

24) **A Level.** Periodisation is a training concept that explains the variation in training volume and intensity over a specific period of time. Outline the basic structure of a single periodised year and illustrate how a coach is able to use this structure when planning a training programme for an athletics group. 15 marks

Answer:

- Diagram or chart showing the layout of a single periodised year (see figure Q8.1).

Features of periodised year:

- Year blocked into **periods** lasting 2 to 6 months each.
- Labelled **preparation, competition, recovery, transition**.

Use of the structure:

- During **preparation** phase, the athlete will do gross conditioning training.
- Involving fitness, strength, speed or cardiovascular endurance work depending on the events or sport being performed.
- This phase will be split up into **mesocycles** lasting between 4 and 6 weeks.
- Each mesocycle will have its own aims.
- For example to improve strength, speed, fitness, and so on.
- Each cycle will have **progression and overload**.
- Each cycle will follow a plan for each fitness component like that in figure Q8.2.
- Each mesocycle will be split up into **microcycles** lasting typically one week.
- The training intensity will vary according to a plan as in figure Q8.3.
- This is to allow **recovery** after intense training.
- And to spread out all the different elements of training so that learning can take place when the athlete is recovered.
- **Microcycles** will include rest and recovery.
- **Mesocycles** can include rest and recovery - this will be built into the training plan so that injury may be avoided.

figure Q8.1 – a single periodised year

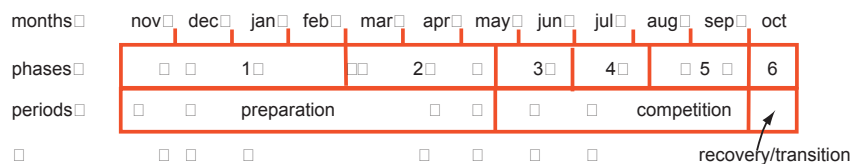


figure Q8.2 – training intensity by mesocycle

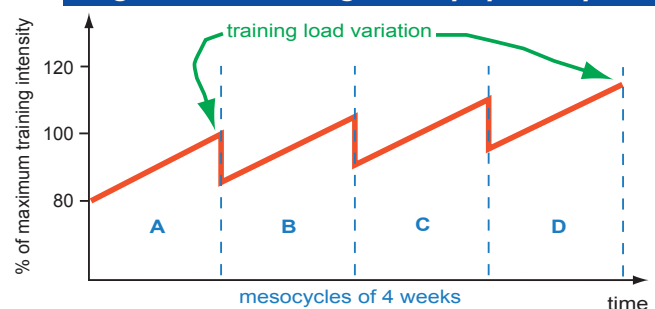
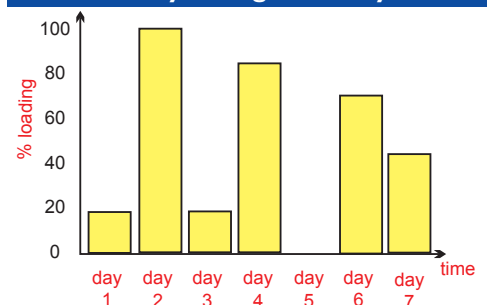


figure Q8.3 – variation in training intensity during a microcycle



24) (continued)

The competition period includes:

- Reduction in training loads.
- Tapering in preparation for important competitions, for example the Olympics.
- Maintenance of sufficient intensity to keep and possibly develop the fitness achieved in the preparation period.
- This period will again be organised into mesocycles and microcycles.

The recovery period includes:

- Almost complete reduction in training intensity.
- To allow rest and recovery.
- Best achieved actively – playing games or undertaking another activity to keep basic fitness during this period.
- Without risk of injury or overtraining.

25) **A Level.** Discuss the relationship between training loads, recovery, and monthly field testing performance in young elite soccer players to develop training guidelines to enhance performance. 15 marks

Answer:

Note: This is a hard question and so needs careful planning. Note the use of examples used to illustrate the relationship between training loads, recovery and monthly field testing.

- Many athletes, coaches, and support staff are taking an increasingly scientific approach to both designing and monitoring training programmes for performers, such as young elite soccer players.
- Appropriate training load monitoring can aid performance in determining whether an athlete is adapting to a training programme.
- In addition to minimizing the risk of fatigue, overtraining, illness, and injury.
- There are number of technologies that can be used as monitoring tools, such as power output measuring devices.
- Regular field testing, say once a month, forms a vital part when assessing performance in young players.
- For example, the Yo-Yo Intermittent test level 2 has the subject running and then turning back over a distance of 20 metres to a timed set pace.
- Followed by an active recovery period of 10 seconds between each run.
- The athlete stops running when he or she can no longer maintain the required pace.
- Estimated $\dot{V}O_{2max}$ is calculated from the results as an indicator of aerobic fitness.
- Heart rate monitors with GPS tracking technology and associated mobile apps can calculate training loads and recovery within training sessions.
- Such devices have storage facilities to compare data and plot performance graphs that can be used when planning training loads.
- The Karvonen training heart rate method can be used to work out an individual's training heart rate zone and thus programme training loads.
- By comparing trends in heart rate results with those in field test results, such as the Yo-Yo intermittent test, one would expect relationships between predicted $\dot{V}O_{2max}$, HRmax and HRrest. These results could provide indicators as to the effectiveness of the training programme.
- These young soccer players could subjectively assess training loads by simply rating perceived exertion using for example, the Borg scale RPE.
- This simple method rates corresponding exercise levels from very light to very heavy using a numerical scale from 9-20.
- RPE could be monitored and recorded after each session and would indicate severity of the training loads, as the training programme progresses during the periodised year from general to specific macrocycles.
- Training loads can be measured using regular lactate testing, requiring a small blood sample and blood analyser.
- By comparing repeated lactate tests, as fitness increases, a lower lactate for a given intensity should decrease. This is a result of both producing less lactate during the exercise period and clearing lactate faster (at any given intensity) during recovery.
- Lactate testing is an established reliable method of monitoring training loads and recovery.
- Due to adaptations primarily in the muscles, such as increased mitochondria and blood supply.
- Recovery from training is a planned event and in addition to having adequate rest within and following training sessions, it involves a well-balanced diet.
- High in carbohydrates needed to restore muscle and liver glycogen levels.
- Particularly when training loads are at maximum intensity.
- As athletes strive to improve their performance, modifications in training loads are required, particularly increases in frequency, duration, and intensity.
- Training loads are adjusted at various times during the training cycle to either increase or decrease fatigue depending on the phase of training from preparation to competition and recovery phases of the periodised year.
- Technologies, field testing and nutrition all assist in this process.