CHAPTER 4: Diet and nutrition

Practice questions - text book page 74 - 76

1) Complex carbohydrates do not include:
   a. lipids.
   b. triglycerides.
   c. cholesterol.
   d. haemoglobin.

Answer: d.
Explanation:
- *This is because haemoglobin is a red blood cell protein that functions in gas transport.*

2) A measure of the energy value in food is:
   a. the resting metabolic rate (RMR).
   b. a joule.
   c. the recommended daily allowance (RDA).
   d. a vitamin.

Answer: b.
Explanation:
- *BMR is defined as the least rate of energy usage needed to carry out basic body functions and would be measured while lying down after 8 hours sleep or 12 hours fasting.*
- *RDA is the estimated amount of a nutrient (or calories) per day considered necessary for the maintenance of good health.*
- *A vitamin is any of a group of substances that are essential, in small quantities, for the normal functioning of metabolism in the body.*
- *The correct answer is b. which is defined as the energy needed to raise the temperature of 1 gram of water through 1 °C.*

3) Which one of the following statements is false with respect to the functions of water within the human body?
   a. lubricates joints, keeping body surfaces from grinding against each other.
   b. constitutes 70 percent of muscle weight.
   c. fluid loss during exercise depends on the intensity and duration of the exercise, temperature and humidity, body size and fitness levels.
   d. the major water loss during moderate exercise is as vapour via the respiratory system.

Answer: d.
Explanation:
- *Answer d. is false because the major water loss during moderate exercise is through sweating.*
- *Water does lubricate joints, is a major constituent of muscle weight and is dependent on duration and intensity of exercise - choices a. b. and c. respectively.*

4) For endurance trained athletes, the best carbohydrate strategy for a competition in a marathon or endurance triathlon appears to be:
   a. to consume carbohydrate 3-4 hours prior to the event.
   b. to consume carbohydrate within an hour of the event.
   c. to consume carbohydrate during the event.
   d. all of the above.

Answer: d.
Explanation:
- *Carbohydrate is the main energy supplier in the form of glucose and is available for immediate energy use, needed prior to and during the event.*

5) An expected side effect of creatine supplementation is:
   a. cramping and gain in body mass.
   b. reduction in power output.
   c. muscle weakness.
   d. all of these.

Answer: a.
Explanation:
- *The role of creatine is to enhance the ATP/PC system and hence power output and so b. and c. are invalid.*
- *Creatine supplementation is often responsible for gain in body mass as more water is needed to store creatine which can cause imbalances in hydration and electrolytes, resulting in cramping.*

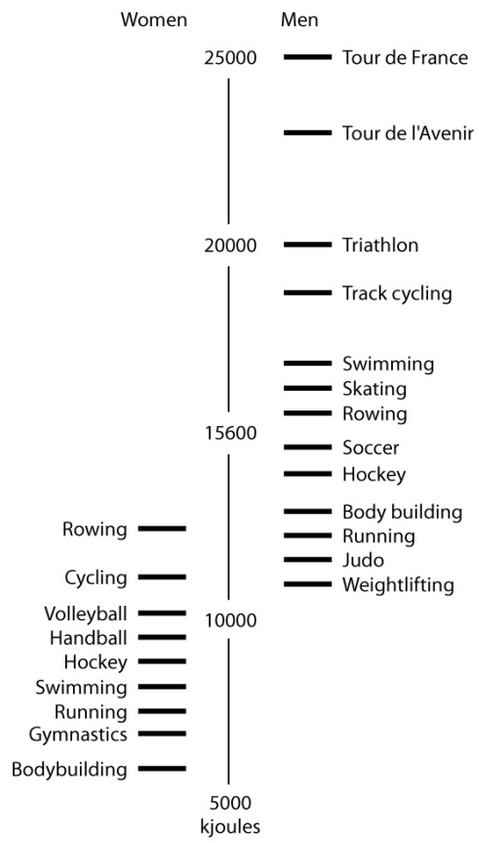
6) Figure 4.17 shows the daily energy intake (kjoules) of elite male and female endurance, strength and team sport athletes.

a) Account for the differences in the daily intake for males and females. 2 marks

Answer:

- *The difference between males and females can be accounted for by size difference.*
- *And so values per kg of body mass would be similar.*
- *Females have lower basal metabolic rate of when compared with males, because they have less fat-free tissue.*

figure 4.17 – daily energy intake for elite athletes



b) Give reasons why cyclists competing in the Tour de France require a daily intake of up to 25000 kjoules. 3 marks

Answer:

- *The Tour de France is a gruelling endurance cycling race, organised over three weeks.*
- *This race includes mountain and flat stages, and time trials.*
- *Each stage taking several hours to complete.*
- *Hence the daily energy expenditure of each competitor is very high.*

c) Why do female body builders have the lowest daily energy intake? 2 marks

Answer:

- *Bodybuilding is the use of progressive resistance exercise to control and develop one's physique of extreme muscle hypertrophy.*
- *Because training is predominantly strength-based, consisting of short high intense bouts of exercise, the energy requirements are less when compared with other female sports such as running or playing a game, as illustrated on figure 4.17.*

d) How can a negative energy balance ultimately compromise an athlete's potential to train and complete. 3 marks

Answer:

3 marks for 3 of:

- *A negative energy balance occurs when energy output is greater than energy input.*
- *This means that more energy is used (via exercise in the case of a sports performer) than is eaten as food.*
- *And over time leads to a bodyweight reduction.*
- *Due to loss of muscle protein as protein is broken down and used as a supplementary energy supply.*
- *Symptoms such as lack of energy (due to low muscle and liver glycogen content), tiredness and inability to complete training sessions and prepare for competitions are experienced by the athlete.*
- *Athlete is more likely to suffer from stress fractures as body becomes vulnerable to impact of training sessions.*
- *Overall a negative energy balance will negatively affect training and competitive performance.*

7) The ideal precompetition meal should maximise muscle and liver glycogen storage and provide glucose for intestinal absorption during exercise. How can these goals be achieved? 4 marks

Answer:

4 marks for four of:

- *Eat light complex CHO such as pasta or wholemeal bread.*
- *Eat fruit, such as a banana, containing complex CHO.*
- *Small amounts of glucose as supplied in an isotonic sports drink or energy gel.*
- *To be consumed 3 to 4 hours prior to exercise/competition period.*
- *These foods contain very little fat and fibre to facilitate gastric empting and minimise gastrointestinal distress.*
- *So good absorption of glucose to muscle and liver glycogen stores.*

8) An athlete is competing in a decathlon (consisting of 10 track and field events) over a period of two days.

a) What nutritional advice would you give this athlete during and between the events in order to achieve an optimal performance. 6 marks

Answer:

6 marks for 6 of:

- *Plan and practice a proposed diet/fluid intake that would nutritionally support the nutritional needs for a decathlon.*
- *During and between events, keep fat intake low and focus on slow-release (low GI) carbohydrates such as wholemeal bread and bananas.*
- *That can help even out blood glucose levels and support muscle and liver glycogen levels.*
- *Use energy gels and energy bars that top up blood glucose levels quickly.*
- *Drink water at regular intervals to remain hydrated. More fluid intake is needed in hot, humid conditions.*
- *Drink sports beverages, such as isotonic sports drinks, between events, thus providing a continued source of carbohydrates to the body.*
- *Plus added sodium, potassium and caffeine, available in some products.*
- *Help to improve electrolyte balance and overall performance.*
- *Watch out for hyperhydration or excessive water intake.*
- *Check colour of urine – it should be pale yellow or nearly clear.*

b) At the end of day one, how could this athlete replenish his glycogen reserves? 4 marks

Answer:

4 marks for 4 of:

- *Eat to recover.*
- *Have a meal as soon as possible following the end of day one. The body has a two hour window immediately following exercise, during which it is more effective in restoring muscle and liver glycogen levels.*
- *A meal consisting of an equal ratio of carbohydrates and protein is the best choice.*
- *Avoid meals with a high fat content, as fat slows digestion and delays the delivery of much needed nutrients to your muscles.*
- *Suggestions for meals include protein shakes, eggs and orange juice, tuna fish sandwiches, bananas, low-fat yogurt and oatmeal with fresh fruit.*
- *In addition, eat 50 grams of carbohydrates every two hours to continue the rate of restoring the depleted glycogen stores.*

9) Different classification systems rate the strenuousness of physical activities. How are multiples of resting metabolism, known as metabolic equivalent task (MET) system used to assess energy expenditure associated with differing physical activities intensities? 3 marks

Answer:

- *The MET system is based on the assumption that the amount of oxygen the body consumes is directly proportional to the energy expended per kilogramme per minute ($O_2 kg^{-1} min^{-1}$).*
- *So a resting metabolic rate is referred to as 1.0 MET.*
- *A 2 MET activity (such as slow walking) would require double the resting metabolic rate.*
- *Moderate jogging or swimming requires 15 METs and very vigorous activity such as a 5000 metre race could be as much as 30 METS.*

10) Identify some of the benefits of taking commercially prepared liquid meals. 3 marks

Answer:

- *Offer well-balanced nutritive value.*
- *Contribute to fluid needs.*
- *Are rapidly absorbed.*
- *Leave little residue in the digestive tract.*

11) Table 4.9 provides information on exercise intensity and duration. Information on the appropriate fuel foods for action has been omitted.

Table 4.9 – **fuel and exercise**

exercise intensity	exercise duration	fuel used
maximal sprint	**short**	***carbohydrate***
low to moderate	**moderate - up to 2 hours, eg jogging**	***carbohydrate and fat equally***
severe	**prolongued - eg cycling**	***less carbohydrate and more fat***

a) Complete the third column to show which fuel foods supply the glycogen needed as exercise intensity and duration change. 3 marks

Answer:
see table 4.9 above.

b) Why is carbohydrate a much faster fuel (energy) source when compared with fat utilisation? 2 marks

Answer:
2 marks for 2 of:

- *Carbohydrates are absorbed as glucose in the small intestine.*
- *And transported around the body to provide an immediate energy source.*
- *Although fat provides twice the energy yield of carbohydrates, fats are absorbed as fatty acid and glycerol, stored as triglycerides in adipose tissue.*
- *And then converted to glucose in the liver.*
- *And so there is a delay in fat conversion of 20 minutes minimum before fat becomes a usable energy fuel food.*

c) Although fat reserves have value as a source of energy, in other ways they can be detrimental to sport performance. Discuss. 6 marks

Answer:
6 marks for 6 of:

- *Eating a low-carbohydrate, a high-fat diet increases fat reserves and can force the body to adapt to burn fat more efficiently.*
- *Body fat reserves represent a relatively abundant fuel substrate even in the leanest of athletes even with low body fat percentages of 10%.*
- *Yielding twice the energy yield of carbohydrates.*
- *And so fat becomes a valued secondary fuel food as the exercise duration increases.*
- *Endurance athletes can exercise at a higher submaximal exercise level from improved fat oxidation.*
- *Thereby conserving glycogen stores, a physiological adaptation called 'glycogen sparing'.*
- *Excess fat reserves are detrimental to most sport performance due to increased body mass.*
- *Which can have a negative effect on sport performance.*
- *For optimal competition performance, the athlete needs a combination of adequate fuel stores from CHO and fats in relation to the demands of his or her event.*

12) What are the benefits of adding a small amount of sodium to a rehydration beverage? 2 marks

Answer:
1 mark for:
Benefits of adding a small amount of sodium:

- *Sodium is an electrolyte, and it helps regulate the amount of water that's in and around your cells.*

13) Why is water considered an important nutrient to the human body, and why might a person who is exercising need extra amounts of it? 4 marks

Answer:

2 marks for 2 of:

Function of water within the human body:

- *Water makes up 72% of muscle weight and 50% of adipose tissue.*
- *The human body uses water in all its cells, organs, and tissues to help regulate its temperature and maintain other bodily functions.*

2 marks for 2 of:

Why might a person who is exercising need extra amounts of it?

- *During exercise more water is produced during tissue respiration.*
- *And is transported to the skin where sweating occurs.*
- *More water must be consumed to replace the amount lost.*
- *Since excess loss of fluids impairs performance.*

14) a) Discuss how a balanced diet could be manipulated to increase an athlete's glucose reserves prior to a marathon race. 6 marks

Answer:

- *Carbo-loading (or glycogen loading) before the event (modern method).*
- *This consists of tapering of training, whilst eating 50% CHO diet.*
- *Partially depletes glycogen stores.*
- *Therefore energy levels are not compromised.*
- *And glycogen synthase activity is increased (enzyme responsible for converting glucose to glycogen).*
- *Then, gradually increase CHO intake to 70% of diet, with light training.*
- *Day of rest and 70% CHO diet.*
- *Repletes glycogen stores on day of marathon.*
- *Taking in isotonic fluids during the event will top up blood glucose levels during the event.*

b) Carbohydrates are used as an energy source during both aerobic and anaerobic conditions. It is therefore beneficial that an elite athlete's stores of carbohydrate are at a maximum before competition day. Discuss the advantages and disadvantages of glycogen loading. 4 marks

Answer:

Advantages:

- *Enhanced glycogen stores in muscle and liver.*
- *Overall effect is for overall times in aerobic activities beyond 90 minutes to improve significantly.*

Disadvantages:

- *Increased body mass due to increased water retention.*
- *Needed for enhanced glycogen storage.*
- *During CHO depletion phase decreased energy levels.*
- *And increased fatigue (if using classic method of carbo-loading).*

c) How can an athlete's diet aid the recovery process? 2 marks

Answer:

2 marks for 2 of:

- *Quick ingestion of carbohydrates after exercise (2 hour window of opportunity) will speed up recovery.*
- *Eating foods, such as rice and bananas, that have a high glycemic index.*
- *To raise blood glucose levels quickly and stimulate greater insulin release needed to convert glucose into glycogen.*
- *Water needed to rehydrate the body.*
- *Electrolyte replenishment needed to aid the metabolic process.*
- *Protein needed to aid tissue damage, repair and growth.*

15) Give a brief outline and comment upon the following techniques, which may be employed in the belief that they will enhance sport performance: 12 marks

3 marks for each technique.

a) Whey protein.

Answer:

- *Whey protein is a natural protein present in milk and is used as a protein supplement in sports drinks.*
- *Whey protein contains a branch chain of amino acids which are the first ones to be used during intense training.*
- *Because it is extremely easy to digest and so can provide instantaneous nourishment to the muscles.*
- *Whey protein provides the body with these amino acids and in turn they assist with repairing and rebuilding lean muscle tissue.*

b) Ginseng.

Answer:

- *Ginseng is derived from a root and consumed as tea.*
- *It is thought to increase mental alertness, boot energy levels, increase $\dot{V}O_{2max.}$, reduce OBLA and boost the immune system.*
- *There are a limited amount of scientific studies to support these claims.*

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c) Bicarbonate loading.

Answer:

- *Bicarbonate loading is a process whereby a performer ingests bicarbonate prior to competition.*
- *Used in anaerobic sports that generate high levels of lactic acid, such as a 400 metre race.*
- *The ingestion of bicarbonate provides a buffer, thus allowing higher concentrations of lactate in the blood.*
- *Thus delaying the onset of fatigue (OBLA).*
- *Bicarbonate loading can cause cramping, vomiting, bloating and diarrhoea.*

d) Caffeine.

Answer:

- *Caffeine stimulates the central nervous system, thereby reducing reaction time.*
- *Caffeine is used as a substance to promote fat metabolism.*
- *Thus sparing glycogen reserves during prolonged exercise.*
- *And reduces adipose tissue in elite performers.*
- *Benefits are likely to occur across a range of sports, including endurance events, stop-and-go events (e.g. team and racquet sports), and sports involving sustained high-intensity activity.*

16) What is an ergogenic aid? Discuss the role which nutritional supplements play in improving performance. 10 marks

Answer:

2 marks for definition:

- *An ergogenic aid is defined as any means of improving the efficiency.*
- *And enhancing the quality of sporting performance.*

6 marks for examples of nutritional ergogenic aids, identifying at least 3 ergogenic aids and giving an explanation for its use:

- *Creatine supplementation increases PC levels.*
- *Thereby enhancing ATP-PC energy system.*
- *Glutamine supplementation reduces the risk of infection by boosting the body's immune system.*
- *Vitamin supplementation (C and E) act as antioxidants, thereby enhancing recovery from exercise.*
- *Isotonic sports drinks prevent dehydration.*
- *And supplement energy reserves.*
- *Hypotonic sports drinks replenish blood glucose levels.*
- *And top up glycogen stores after exercise has finished.*
- *Caffeine ingestion increases mental alertness.*

17) The dietary requirements of a power athlete and an endurance-based athlete have similarities and differences. Discuss. 8 marks

Answer:

- *A balanced diet for both groups of athletes is essential for optimal performance.*
- *Consisting of between 10-15% proteins, 20-25% fats and 60-75% carbohydrates.*
- *And nutritionally complete to meet the demands of the individual's training and competition programme.*
- *As well as providing nutrients for tissue growth and repair.*
- *A tailor-made diet will include the additional nutrient and fluid demands that will enable an athlete to train hard, recover between sessions and maintain ideal body weight.*
- *The energy requirements between a power and endurance-based athlete will be different because of the differences in the intensity and duration of the training or competition programmes.*
- *As reflected by the daily energy intake of around 8500 kJ for a female swimmer and around 6000 kJ for a female gymnast.*
- *Glycogen is the most important fuel reserve and the major fuel that supports any type of exercise.*
- *Hence a high carbohydrate (CHO) diet significantly improves performance for both power athlete and endurance-based athlete.*
- *However, an endurance-based athlete, such as a marathon runner, would need to consume at least 6-10 grams of CHO per kg of body mass.*
- *The additional stored carbohydrate provides the critical energy for improved endurance performance.*
- *Furthermore, carboloading, used by many endurance-based athletes, is a very effective technique for increasing both muscle and liver glycogen stores.*
- *CHO requirement for a power athlete would be around 4-6 grams of CHO per kg of body mass.*
- *Thus reflecting a reduced intake as discussed above.*

- *Protein requirements would differ between these two groups of athletes.*
- *For an endurance-based athlete the recommended protein intake is 1.2-1.4 grams per kg of body mass.*
- *In contrast, for a power athlete the recommended protein intake is 1.4-1.8 grams per kg of body mass.*
- *This need for a difference in protein intake is because after heavy resistance training the rate of protein breakdown and resynthesis is greater for the power athlete.*

- *Fat intake should be restricted for both endurance and power athletes, since muscle mass is more powerful than fat.*

- *Water intake before, during and after training or competitions is vital to all sports performers.*
- *Since excessive fluid loss can lead to dehydration and reduced performance.*
- *Sports drinks also reduce the risk of dehydration.*
- *And provide an important source of energy.*
- *And so improve the performance of both endurance-based and power athletes.*

- *Elite power and endurance-based athletes supplement their diets with nutritional ergogenic aids.*
- *Such as glucosamine, a herbal supplement that is known to reduce joint inflammation and stiffness.*
- *And protein supplements such as glutamine, which is known to reinforce the immune system.*
- *Thus reducing the risk of infection.*

18) How can an elite athlete assess whether his or her diet meets the demands of their training and competitive programmes? 4 marks

Answer:

4 marks for 4 of:

- *Elite athlete needs to be nutritionally assessed.*
- *Required to create a dietary log recording all food eaten and portions within an elected time period.*
- *Required to complete a questionnaire about food habits.*
- *Required to analyse training and competition demands.*
- *Checked for body composition to assess ideal body weight.*
- *Once assessment is completed, a tailor-made diet can be created that meets the specific and dietary requirements of the athlete.*

19) Critically evaluate the effects of legal physiological ergogenic aids that an elite performer could benefit from using. 10 marks

Answer:

5 marks for 5 of:

- *Hypoxic chambers/tents– 'sleep high, train low' concept whereby an athlete lives/sleeps in a hypobaric house or even in a hypoxic tent situated at sea level in which the chamber is infused with low oxygen air.*
- *So the elite athlete gains hypoxic physiological adaptations whilst asleep.*
- *Namely, effect of elevating EPO, red blood cell levels (hence haemoglobin), myoglobin, mitochondria and oxidative enzymes in a similar way to altitude training.*
- *He or she then trains outside the chamber at normal sea level oxygen levels 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.*
- *IHT training methods are used by distance runners, triathletes and endurance cyclists.*

5 marks for 5 of:

- *Cooling aids aim to cool core body temperatures.*
- *Cold packs do this by absorbing heat from the injury.*
- *Ice baths are a modern popular method used during recovery from hard training sessions/competitions.*
- *The ice bath is thought to constrict blood vessels, flush waste products, such as lactic acid, from muscle tissue, and reduce swelling and tissue breakdown.*
- *Thus reducing the effect of delayed onset of muscle soreness (DOMS).*

- *These cooling methods are well established in the treatment of acute sports injuries by reducing inflammation, swelling and pain and promoting vasoconstriction.*

- *Cooling jackets (packed with ice or chemical coolants) are used to help reduce core temperatures of sports participants in very hot conditions.*
- *Wet-ice packs allows for greater energy transfer.*
- *For example, tennis players use wet-ice packed towels during match intervals in long matches.*
- *Cooling aids are very cheap to buy and easy to use, and do make a big difference to sports performances in terms of preventing overheating, dehydration, cramp and early fatigue.*

20) Cryotherapy methods are used as aids to recovery and rehabilitation for the elite performer. Briefly describe how an ice bath can assist this process. 3 marks

Answer:

- *Ice baths are a modern popular method used during recovery from hard training sessions/competitions.*
- *The ice bath is thought to constrict blood vessels, flush waste products, such as lactic acid, from muscle tissue, and reduce swelling and tissue breakdown.*
- *Thus reducing the effect of delayed onset of muscle soreness (DOMS).*

21) Briefly describe an illegal ergogenic aid that would be of benefit to an a endurance athlete.
How would the use of this aid help performance? What are the health risks and how is this aid detected? 10 marks

Answer:

There are several possible illegal ergogenic aids and so one from the following:

2 marks for brief description:

- *Blood doping refers to any means by which a person's total volume of red blood cells can be increased.*
- *It is often achieved by transfusion of red blood cells previously withdrawn from the recipient or a compatible donor.*

2 marks for benefits:

- *Temporarily increasing the number of oxygen carriers.*
- *Increasing the oxygen carrying capacity of the blood.*
- *Allowing more oxygen to be delivered to the active tissues.*
- *Thus aerobic performance can be substantially improved.*

2 marks for health risks:

- *Health risks include the problem of mismatching.*
- *Which can lead to a transfusion reaction or allergic reaction.*
- *Because of increased red blood cell count the blood becomes too viscous.*
- *Could cause blood clotting and possible heart failure.*
- *Also recipient runs the risk of infection from hepatitis or HIV pathogens.*

1 mark for how the aid is detected:

- *Excessive red blood cell production can be detected in blood tests.*

Or

2 marks for brief description:

- *rEPO (recombinant erythropoietin cloned through genetic engineering) is a form of blood doping.*
- *rEPO mimics body's naturally occurring hormone EPO that stimulates red blood cell production.*

2 marks for benefits:

- *To increase oxygen transport.*
- *Thereby increasing aerobic capacity.*
- *rEPO has been widely used in endurance based activities such as the Tour De France.*

2 marks for health risks:

- *It carries a major risk of thrombosis and heart failure.*
- *Due to increased blood viscosity.*
- *Reduces resting heart rate to dangerously low levels during sleep.*
- *Reduces production of naturally occurring hormone EPO.*

1 mark for how the aid is detected:

- *Excessive red blood cell production can be detected in blood tests.*