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Decizie de indexare a faptei de plagiat la poziţia
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A. Notă de constatare şi confirmare a indiciilor de plagiat se bazează pe fişa suspiciunii inclusă în decizie.

Fişa suspiciunii de plagiat / Sheet of plagiarism's suspicion	**Indexat la: 00286.06**
Opera suspicionată (OS) Suspicious work	**Opera autentică (OA) Authentic work**

OS	CAVALU, Simona. *Medical biophysics and electronic medical devices.* Oradea: Editura Universităţii din Oradea. 2005. ISBN 973-613-832-2.
OA	HOLLINS, Martin. *Medical Physics.* Second edition. University of Bath.1992.

Incidenţa minimă a suspiciunii / Minimum incidence of suspicion	
p.13:04 – p.24:21	p.04:01-p.05:03; p.05:32-p.06:06; p.06:08-p.06:15; p.06:02-p.09:00; p.10:10-p.11:33; p.13:01-p.13:14; p.14:14-p.15:13; p.15:18-p.16:24; p.16:31-p.17:06;
p.13:Fig.3.1	p.04:Fig.1.2
p.14:Fig.3.2	p.04:Fig.1.3
p.20:Table 3.1	p.14:Table 1.1
p.21:Table 3.2	p.15:Table 1.2
Fişa întocmită pentru includerea suspiciunii în Indexul Operelor Plagiate în România de la Sheet drawn up for including the suspicion in the Index of Plagiarized Works in Romania at www.plagiate.ro	

Notă: Prin „p.72:00" se înţelege paragraful care se termină la finele pag.72. Notaţia „p.00:00" semnifică până la ultima pagină a capitolului curent, în întregime de la punctul iniţial al preluării.

Note: By „p.72:00" one understands the text ending with the end of the page 72. By „p.00:00" one understands the taking over from the initial point till the last page of the current chapter, entirely.

B. Incadrarea faptei se justifică prin fişa de argumentare a calificării alăturată care este parte a deciziei.

*Pe baza probelor şi argumentelor de mai sus fapta de plagiat se indexează la poziţia **00286** şi se publică la adresa electronică www.plagiate.ro la data de 25 aprilie 2016.*

Echipa Indexului Operelor Plagiate în România

Fişa de argumentare a calificării

Nr. crt.	Descrierea situaţiei care este încadrată drept plagiat	Se confirmă
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a) Prin „provenienţă" se înţelege informaţia din care se pot identifica cel puţin numele autorului / autorilor, titlul operei, anul apariţiei.

b) Plagiatul este definit prin textul legii[1].

> *„ …plagiatul – expunerea într-o operă scrisă sau o comunicare orală, inclusiv în format electronic, a unor texte, idei, demonstraţii, date, ipoteze, teorii, rezultate ori metode ştiinţifice extrase din opere scrise, inclusiv în format electronic, ale altor autori, fără a menţiona acest lucru şi fără a face trimitere la operele originale…".*

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> *„…este un element de comunicare prezentat în formă scrisă, ca text, imagine sau combinat, care posedă un subiect, o organizare sau o construcţie logică şi de argumentare care presupune nişte premise, un raţionament şi o concluzie. Piesa de creaţie presupune în mod necesar o formă de exprimare specifică unei persoane. Piesa de creaţie se poate asocia cu întreaga operă autentică sau cu o parte a acesteia…"*

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> *iii) Cele două opere conţin piese de creaţie identificabile comune care posedă, fiecare în parte, un subiect şi o formă de prezentare bine definită.*
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[1] Legea nr. 206/2004 privind buna conduită în cercetarea ştiinţifică, dezvoltarea tehnologică şi inovare, publicată în Monitorul Oficial al României, Partea I, nr. 505 din 4 iunie 2004
[2] ISOC, D. *Ghid de acţiune împotriva plagiatului: bună-conduită, prevenire, combatere*. Cluj-Napoca: Ecou Transilvan, 2012.
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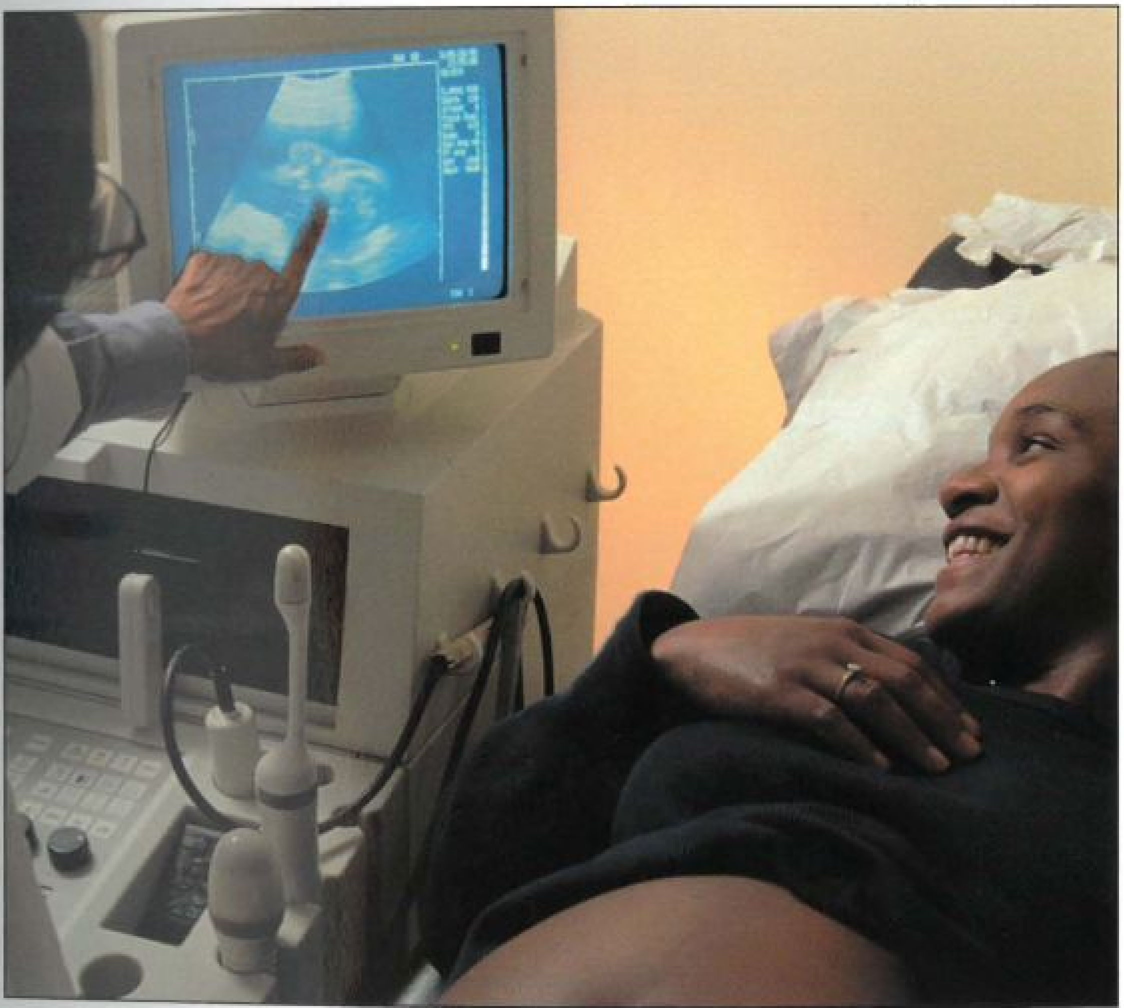

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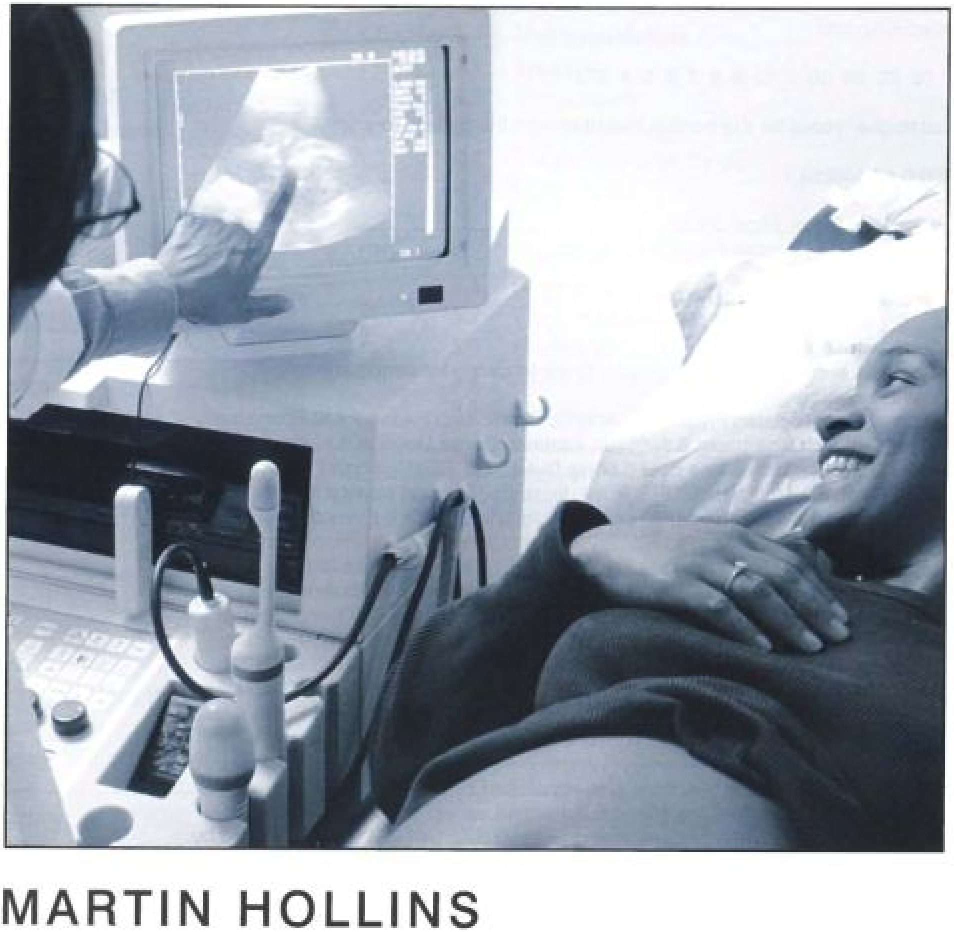

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1.1 INTRODUCTORY ANATOMY

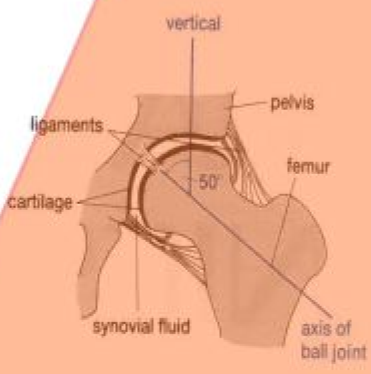

FIG 1.2 Structure of the hip joint.

FIG 1.3 Pairs of muscles raising a leg.

Muscles and skeleton

The human body is supported by a framework of some 200 bones connected together to make the skeleton. Bone is a living material; stiff, light and strong. Individual bones have the optimum properties required for their particular function. For example the femur, which must withstand forces of up to thirty times body weight, is a thick-walled, hollow cylinder with internal cross struts. This gives an excellent strength-to-weight ratio. The skeleton is held together at joints by ligaments. There are several kinds of joints to allow the considerable flexibility of human movement. These range from the plane joints of the toes through pivot (neck), hinge (elbow), ellipsoid (wrist) and saddle (ankle), to the ball and socket of the shoulder and hip which gives maximum freedom of movement (Figure 1.2). The illustration shows features common to all joints, namely the layers of the tough cartilage and the interposed synovial fluid, which prevent bone damage during movement.

Movement of the skeleton is effected by the muscles, which are attached to the bones by tendons. Muscle is a flexible fibrous material which surrounds the skeleton. (You can see the fibres in the 'meat' of a butcher's joint such as a leg of lamb.) Movement is produced by a tensing of the muscle which causes it to become shorter and fatter and pull on the bone. To restore the bone to its original position there is always an opposing muscle acting in antagonism. Hence to raise the leg as shown in Figure 1.3 the rear calf muscle and the front thigh muscles contract whilst the opposing muscles relax.

Some body figures

number of bones in the skeleton	206
number of joints in the skeleton	187
types of joints	6
number of voluntary muscles	620
(the involuntary muscles are those of the heart and the intestines)	
percentage of body weight which is bone	~17
percentage of body weight which is muscle	~40
strength of bone compared to reinforced concrete	×4

Forces and levers

The tensed muscle exerts a force on the bone at the place where it is attached by the tendon. This produces a turning effect about the joint. The system acts as a lever with the joint as fulcrum. The muscle provides the effort (E) and the load (L) may be the weight of the part of the body being moved, or may include an external load. From the principle of moments for a body in equilibrium:

$$L \times \text{distance of load from fulcrum} = E \times \text{distance of effort from fulcrum}$$

Often the effort is applied closer to the fulcrum than the load, giving the system a mechanical advantage of less than one, since:

$$\text{mechanical advantage} = \frac{\text{load } (L)}{\text{effort } (E)} = \frac{\text{distance of } E \text{ from fulcrum}}{\text{distance of } L \text{ from fulcrum}}$$

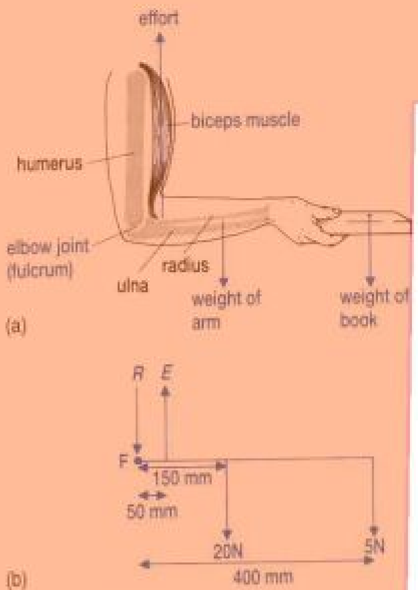

FIG 1.4 The lower arm as a lever.

This arrangement, illustrated in Figure 1.4 gives a greater control to the body movement, a small movement of the biceps muscle, with a large force, produces a much larger movement of the book.

QUESTION

1.1 (a) The head can be tipped back by the pull of the muscles on the back of the neck, with the top of the spine, the atlas vertebra, as fulcrum. Draw a simple diagram of this lever, showing the forces acting.
(b) Draw a similar diagram for the action of the calf muscle when a person stands on tiptoe, pivoting on the ball of the foot.

Solving lever problems

We can work out the forces in muscles when they are producing movements, by considering only the part of the body involved. Look at Figure 1.4, where we can take moments about the joint as the fulcrum. In this treatment it is assumed that the force of the humerus on the lower arm acts through the fulcrum, at a single point in the joint and that the tendon is acting at a single point on the lower arm. When the forearm is bent at right angles, with the dimensions shown in Figure 1.4(b), the contractile force of the biceps (E), and the reaction of the upper arm, can be calculated by taking moments about F.

$$E \times 50\ \text{mm} = (20\ \text{N} \times 150\ \text{mm}) + (5\ \text{N} \times 400\ \text{mm})$$
$$50E = 3000\ \text{N} + 2000\ \text{N}$$
$$E = 100\ \text{N}$$

Resolving forces vertically:

$$E = R + 20\ \text{N} + 5\ \text{N}$$
$$R = 75\ \text{N}$$

QUESTION

1.2 A champion weightlifter can raise a mass of 250 kg. His forearm has a length from elbow joint to palm of hand of 0.5 m, and a weight of 30 N. Assuming that the force of the biceps muscle acts at a point 0.07 m from the fulcrum, calculate the maximum values of the force in each biceps and the reaction in each upper arm.
(Take g, the gravitational field strength as 10 N kg^{-1})

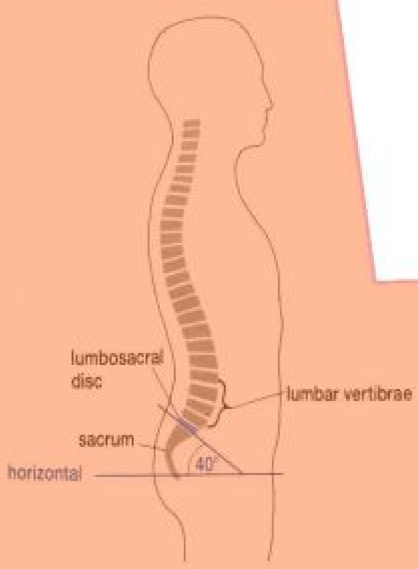

FIG 1.5 The vertebral column.

The vertebral column

The backbone provides the main support to the body, and is required to make a great variety of movements. It consists of 33 vertebrae, of which nine are fused together to make up the sacrum and the coccyx, and the remaining 24 are separate, covered with cartilage and interspersed with tough fibrous pads called discs. It is the discs which permit the free bending of the spine, whilst cushioning the bones from the compression of body weight and protecting the spinal cord which runs down the centre of the vertebrae. The discs are subjected to considerable wear throughout life and they also lose some of their toughness with age. If the stresses

1.3 WALKING AND RUNNING

Ground forces

A body standing on the ground is supported by a force equal and opposite to the body's weight. This force V, will therefore have a magnitude of W and act vertically upwards. When the body is moved relative to the ground the force will change. When the foot lands on the ground at the end of a step, a force is needed to decelerate it to rest. When the foot is thrust off the ground for the next step an accelerating force is required. In each case the ground force will be greater than W, and will be the resultant of a vertical force V, and friction F, as illustrated in Figure 1.10. The forces will of course increase as the speed with which the foot meets and leaves the ground increases.

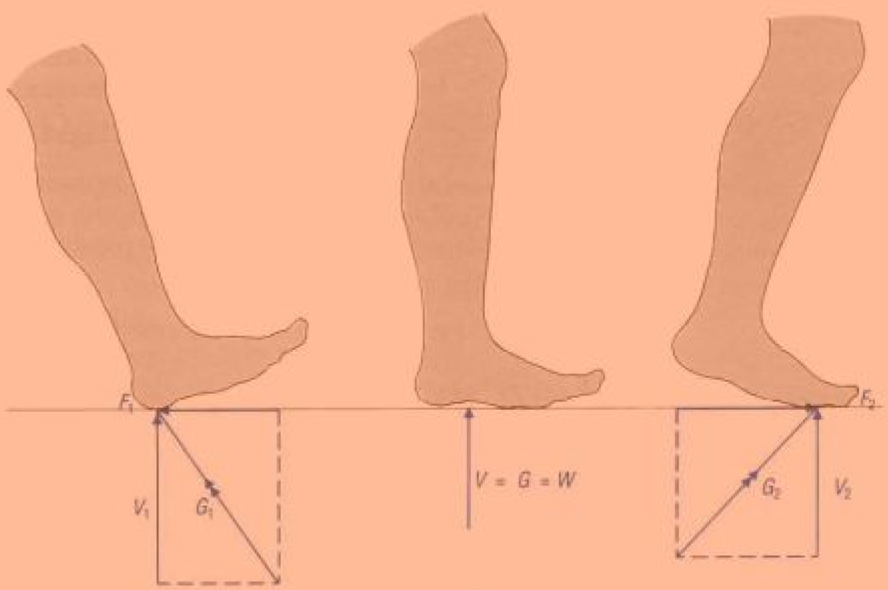

FIG 1.10 Ground forces while walking and running.

The maximum size of the vertical force depends on the material of the ground. If this is soft it may undergo considerable deformation in order to provide the force needed. The maximum size of the frictional force depends on the nature of the surfaces and the size of the vertical force. This is expressed as,

$$F = \mu V$$

where μ is the coefficient of static friction between two surfaces. Thus if the horizontal force needed is greater than μV the foot will slip. Typical values of μ for shoes on ground are 0.6 to 0.75.

The resultant force of the ground G, has magnitude given by:

$$G^2 = V^2 = F^2$$

and direction given by:

$$\tan \theta = F/V$$

and the horizontal forces required for walking are about 15 per cent to 20 per cent of body weight.

QUESTION

1.5 (a) With reference to the previous section explain:
(i) why slipping does not normally occur while walking;
(ii) why slipping is more likely to occur when the stride is long and when θ is small.
(b) Imagine you have to cross a wet and muddy ploughed field on a cross-country run. Use the above account to explain why your options are to slip across the surface slowly or plough through, ankle deep, with a great effort.

Walking

The forward acceleration of each leg requires a horizontal force given by:

Force = mass × acceleration

There is also a rotation of the leg as it moves forward, in which the turning force or torque produces an angular acceleration. The relationship here is given by:

torque = moment of inertia × angular acceleration

where the moment of inertia depends both on the total mass of the leg and its distribution. Thus any change such as the wearing of heavy boots, will result in extra energy expenditure and possibly muscle fatigue.

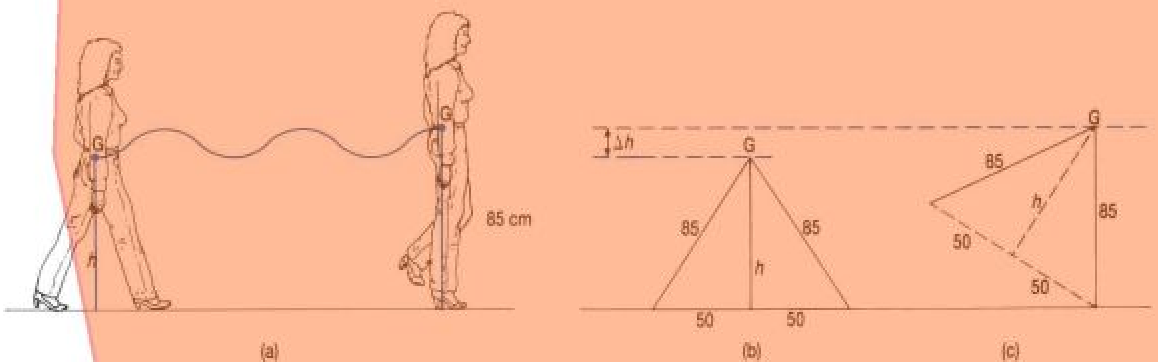

FIG 1.11 Changing the height of centre of gravity while walking.

Deceleration requires a similar application of force and torque, though this is assisted by gravity. A similar forward swinging movement occurs at the knee. Work is also done in raising and lowering the centre of gravity G, during each step. This is shown in Figure 1.11 which represents a walker of leg length 85 cm taking a stride of 1 m.

The rise in G is

$$\Delta h = 85 - h = 85 - \sqrt{85^2 - 50^2}$$
$$= 16.25 \text{ cm}$$

This is an over estimate as we actually bend our knees at the position where G is highest, which reduces the rise to about half of this value.

1.4 ENERGY EXPENDITURE

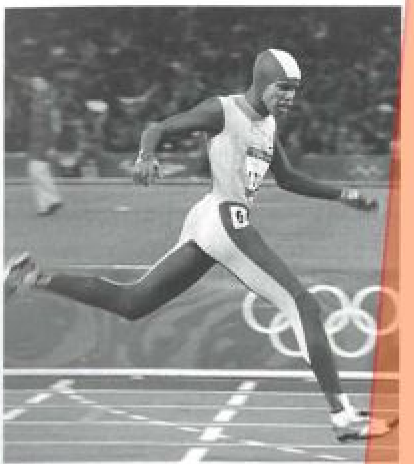

FIG 1.12 Kathy Freeman conserves angular momentum while running in the Olympic Games.

Running

Accelerations and torques in running are much greater, in order to produce the higher speed. A fast sprint (about 9 m s^{-1}) is six times faster than a typical walking speed. This is achieved by a combination of an increase in stride frequency and in stride length. To offset the considerable angular acceleration of the swinging leg, the opposite arm is swung forward. This causes the upper and lower parts of the body to twist in opposite directions to conserve angular momentum (Figure 1.12).

Energy is rather like wealth – a description of a situation or condition, rather than a thing in itself. We are usually interested in changes of energy and of wealth, not absolute values, and the currency we use is the joule. The human body expends energy doing mechanical work and maintaining a constant body temperature. The income is from the food we eat. Excess of income over expenditure is stored in the body, mainly as fat. Excess of expenditure over income leads to fatigue, ill health and eventually the possibility of death.

Doing work

Work is done by the body in moving against gravity, external forces of friction and air or water resistance, and internal resistance of the body. In walking for example, the raising of the centre of gravity with each step, as described in the previous section, results in an energy expenditure of:

$$\text{work done per stride} = \text{weight} \times \text{rise}$$
$$E = mg\Delta h$$
$$= 70\ \text{kg} \times 10\ \text{N kg}^{-1} \times 0.08\ \text{m}$$
$$= 56\ \text{J (joules)}$$
$$\text{work done per km} = 56\ \text{kJ (for strides of 1 m)}$$

Assuming a walking speed of 5 km h^{-1}

$$\text{power} = 5\ \text{km h}^{-1} \times 56\,000\ \text{J}/3600\ \text{sh}^{-1}$$
$$P = 78\ \text{W (watts)}$$

In jumping, the muscles do work to produce kinetic energy ($E_k = \frac{1}{2}mv^2$) at take off. This is converted to potential energy ($E_p = mgh$) as the body is propelled upwards. In high jumping and pole-vaulting the vertical height of the centre of gravity is all-important. In long jump and triple jump, speed and height are both important in carrying the jumper forward.

INVESTIGATION

The mechanics of jumping

This is an opportunity to measure performance and study how it may be improved (in yourself or a suitable volunteer!).

Standing jump

1. Measure take-off speed u, when jumping vertically. The normal laboratory ticker-timer will probably not be suitable for this. You could devise a photographic method, but a simpler way is to measure the height of Δh jumped (Figure 1.13) and use the equation

$$v^2 = u^2 + 2gh$$

For example, a good jump would be 1.0 m, giving a take-off speed of 4.43 m s^{-1}.

Long jump

A simple model of long jumping is that the athlete runs as fast as possible and jumps vertically at the take-off point.

Basal metabolic rate

The body is continuously performing involuntary functions which require energy. These include the beating of the heart, breathing, digestion and growth. This maintenance expenditure of energy is called the basal metabolic rate (BMR). In children BMR is high because of the energy used in the biosynthesis of components for growth. The rate levels off as we mature, falling again in old age as all processes slow down (Figure 1.15). From childhood onwards, males have a higher BMR than females, on average. This is because of the lower proportion of fat in the male body. If this is excluded from the calculations, both sexes have similar BMRs.

The energy expenditure can be calculated indirectly from temperature or respiration measurements as described below. Alternatively we could calculate the work done in the various processes. In Chapter 6 for example, the power of the heart is calculated from a knowledge of its volume, pulse rate and the pressure of the blood leaving it.

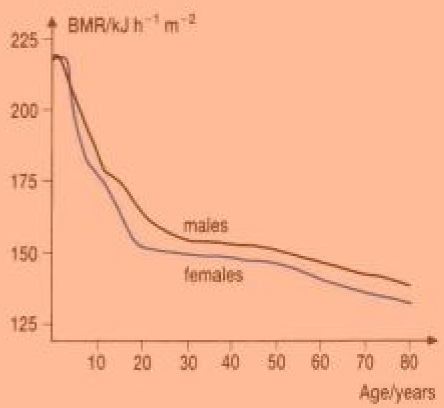

FIG 1.15 Basal metabolic rate variation with age and sex.

Getting warm and keeping cool

The values shown in the graph (Figure 1.15) are averages, individuals show a considerable variation. One of the factors which causes this variation is the maintenance of constant body temperature. The human body operates best at around 37 °C, and will cease to function if the temperature changes by more than about 6 °C from this, as described in Table 4.2 in Chapter 4. In temperate climates, such as Britain, the body will need to expend energy to keep itself at a higher temperature than the surroundings. In tropical climates, or during periods of intense exercise, the body will need to expend energy to cool itself, like a refrigerator. So the amount of energy expenditure will depend on the ambient temperature, the work being done by the body, the surface area of the body and what clothes are worn.

The body can lose energy by conduction, convection, radiation, evaporation (of perspiration), respiration (breathing out warm air and water vapour) and excretion. The relative importance of each depends on the condition of the body and its surroundings. Table 1.1 summarises the processes and gives some typical values.

The amount of energy released in body processes depends mainly on the **volume** V, of the tissues. The rate of loss of this energy depends on the **surface area** A, of the body. The smaller the body, the higher is the **surface to volume ratio**, A/V. This means that for example babies are much more at risk of hypothermia (low temperature), than adults. It also follows that smaller people need to eat more, relative to their mass, than larger people. Typical values of these quantities are given in Table 1.2.

TABLE 1.1 Energy loss processes

PROCESS	DETERMINING FACTOR	VALUES
conduction	temperature difference, area of surface, conductivity	very low due to insulating properties of fat, hair, clothing [skin 0.042 W m^{-1} K^{-1}]
convection	temperature difference air speed around body	low, except in draughts
radiation	absolute temperature, area and nature of surface [see Chapter 4 for details]	100 W for an unclothed body at 22 °C
evaporation	temperature difference, area of skin exposed, humidity, air movement	625 W maximum
respiration	air temperature and humidity	20 W resting at 22 °C

TYPICAL VALUES	STUDYING AT 22 °C	SUNBATHING AT 32 °C	WALKING AT −18 °C
% of body clothed	85	15	95
heat loss rate /W	170	400	400
% loss by:			
1 radiation	21	8	8
2 conduction and convection	67	10	50
3 evaporation	10	80	2
4 respiration and excretion	2	2	40

TABLE 1.2 Body sizes and surface area to volume ratios

	SURFACE AREA A/m^2	VOLUME V/dm^3	SURFACE AREA TO VOLUME RATIO $\frac{A}{V}$/m^2 dm^{-3}
Smaller person	1.53	56	0.0273
Larger person	1.97	80	0.0246

QUESTIONS

1.7 With reference to the data in Table 1.1, answer the following:

(a) The specific latent heat of sweat is about 2425 kJ kg^{-1}. What is the rate of its excretion from the skin to produce the maximum rate of energy loss quoted?

(b) Why is the percentage of energy loss by evaporation (i) high when sunbathing and (ii) low when walking in cold conditions?

(c) Why is a higher proportion of the energy loss by conduction and convection, when a person is studying?

1.8 Because of the importance of surface area in determining BMR, the values are expressed in Figure 1.15 as kJ h^{-1} *per square metre*. From the figure and Table 1.2, calculate the range of power dissipation, in watts, for males and females, in their seventeenth year.

Total energy requirement

This is the BMR value added to the work done in activities. It can be measured directly by putting the subject in an isolated room, (called an Atwater chamber, after its designer), and monitoring all energy exchanges. For example temperature changes are measured by water circulating in pipes through the chamber. Any work done which may be stored (such as raising weights), is added to this. Work which is not stored, (such as exercise movements) will produce a temperature rise so need not be separately considered. Typical ranges of values are given in Table 1.3. The lower values in the range are for young or old subjects, for females and for less vigorous activity. The highest values are usually for heavier fit adult males – and even fitter females!

These figures lead to estimates of total energy expenditures of about 10 MJ for an average woman, between the ages of 15 and 50, with a moderately active lifestyle and about 13 MJ for a man of similar age and lifestyle. The differences are mainly due to different BMR and body weights. A woman in the latter half of her pregnancy, and while lactating to feed her baby, requires an extra 1.5 MJ.

TABLE 1.3 Energy conversion

ACTIVITY	CONVERSION RATE/W
Resting (BMR)	60–100
Sitting or standing still	80–150
Moving around classroom or home	100–300
Walking or 'light' sports, housework	150–450
Moderate sports, e.g. swimming, gymnastics	300–550
Climbing stairs, carrying heavy loads	400–850
'Heavy' sports, e.g. running, rowing, squash	400–1400

QUESTION

1.9 From the data in Table 1.3 calculate the energy expenditure for yourself, on an active and on an inactive day. How do your answers compare with the totals given above?

1.5 ENERGY INCOME

Input

The body's energy is supplied from the chemical energy of the food we eat.

There are three types of fuel foods: carbohydrates, fats and proteins. The digestive system breaks these substances down into chemically simpler ones: (a) carbohydrates to sugars such as glucose, (b) fats (triglycerides) to glycerol and fatty acids, and (c) proteins to amino acids. These simpler molecules are absorbed into the bloodstream and transferred to the cells, where they are oxidised, by the oxygen inhaled by the respiratory system. Enzymes are required to catalyse the reaction, but, as when any fuel is burnt, energy is released. The process of releasing energy by oxidation in the body is called **aerobic combustion** or **respiration** and its general reaction is:

fuel + oxygen = carbon dioxide + water + energy

and the particular equation for glucose is:

$$C_6H_{12}O_6 + 6O_2 = 6CO_2 + 6H_2O + 4 \times 10^{-18}\,J.$$

The respiration reaction is the reverse of photosynthesis in which plants 'fix' energy from sunlight. The energy released by combustion can be measured by calorimetry, typical values (of standard enthalpies) are given in Table 1.4. In the body the amount of energy released will normally be less than this, due to incomplete digestion of the foods and incomplete absorption of substances into the blood, giving the available energy values shown.

Thus the energy used at any time can be measured by the consumption of oxygen. A **spirometer** is used to monitor the conversion of oxygen to carbon dioxide. The average energy liberated from the combustion of carbohydrates, fats and proteins is 20.17 kJ per litre of oxygen. The rate of oxygen intake is a useful measurement to make on people who are in training for sports or under treatment for obesity.

An alternative breakdown of glucose to lactic acid can also release energy. This does not require oxygen, it is **anaerobic respiration**. It occurs therefore when energy is required in the absence of oxygen, for example during extreme exercise. The process is inefficient, liberating only about one twentieth of the energy released by the aerobic process. It also causes feelings of fatigue and pain as lactic acid is poisonous. It is this which sets a limit on an athlete's performance. Recovery consists of the oxidation of the lactic acid and the making up of the oxygen shortage in the muscles.

The food normally used as a fuel is a carbohydrate, with fat being drawn on as a reserve, protein being used only in extreme cases of starvation or overeating. In the former the protein is not then available for growth or maintenance of the body. In the latter the body needs to remove the excess consumption. Usually excess fuel food can be stored in the body.

TABLE 1.4 Foods as fuels

	STANDARD ENTHALPY OF COMBUSTION/MJ kg^{-1}	AVAILABLE ENERGY/MJ kg^{-1}
carbohydrate	17.2	16.5
fat	39.4	37.5
protein	23.4	16.5

QUESTIONS

1.10 What is the BMR of a person who, when resting, consumes 1.5 dm^3 oxygen in 5 minutes? Give your answer in **(a)** kJ h^{-1} **(b)** W.

1.11 Explain how an increase in pulse rate and panting (deep, fast breathing), helps an athlete perform better. If an athlete is fatigued, how does massaging the muscles help?

Storage

Fat is the major energy store of the human body. Typically 12 per cent of a man's weight and 25 per cent of a woman's weight is made up of two types of fat, to be drawn on when energy is required. Fat is stored in adipose tissue, distributed throughout the body, especially under the skin where it provides good insulation. Adipose tissue is the white fat, and more is found in overweight people. Brown fat is usually found elsewhere in the body, and particularly in lighter people. As the brown fat has a higher metabolic rate it is thought that this can provide a less bulky energy store. Table 1.4 shows that fat provides double the energy produced by carbohydrate for a given mass. **Carbohydrate** breakdown products are stored in different parts of the body. Glycogen can be stored in the muscles or the liver, where it is broken down by enzymes to glucose, when required. It can also be converted

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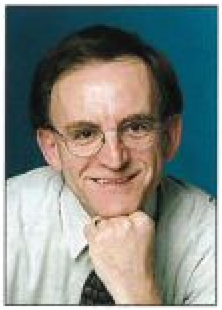

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