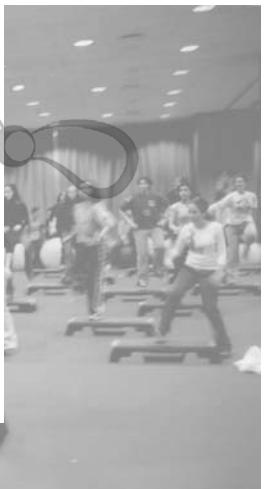


# 3 ENDURANCE



## BEFORE YOU BEGIN

- Endurance is a physical ability to withstand exercises that take a long time, whether they are sports or everyday activities, without becoming too tired.
- Endurance activities have major positive effects on health, and focus on enhancing the way our cardio-respiratory system works.

## AIMS

- To find out what endurance is and understand how your own body functions in relation to this capacity.
- To assess the benefits, risks and contraindications that might be encountered in the regular and systematic practice of endurance exercises for improving our health and quality of life.
- To take it upon ourselves to carry out suitable physical activities to improve our health and endurance.

## OUTLINE

A. What is endurance?

    A.1. The concept of endurance.

    A.2. Types of endurance.

    A.3. Why work on endurance?

B. To understand...

    B.1. The blood circulation system.

    B.2. The respiratory system.

    B.3. The heart rate.

C. How can we improve our endurance?

    C.1. Non-stop running.

    C.2. Circuit training.

    C.3. Progress tests.

## A. ENDURANCE AND HEALTH

### A.1. What is endurance?

A person who has endurance can go on doing exercise much longer without getting tired. A person is said to have endurance when they are capable of running or swimming for a long time, playing a game of football or going for a walk in the mountains, etc. and then picking up with their normal daily routine without suffering from such exertion.

Endurance is the physical ability that enables a person to carry out a task for a prolonged length of time, either tolerating or delaying the onset of fatigue.

### A.2. Types of endurance

When referring to physical activity, the term intensity indicates to which degree or level it is required. In endurance exercises, intensity relates to the number of heart beats: a high heart rate means that the activity is being performed with too much intensity.

In exercises where the exertion is high-intensity -a sprint, for instance, in which the pulse rate can exceed 180 beats per minute (180 bpm)- the type of endurance developed is anaerobic, which means that it is performed with a lack of oxygen. In very intense anaerobic exercises, the person cannot go on for long as they are soon overcome with fatigue.

On the other hand, since aerobic or long-term physical exercises - walking, slow swimming, cycling, dancing, etc., ranging from several minutes to several hours - are conducted with slow or moderate intensity with the intervention of large muscle groups, the person can remain active for much longer without feeling tired.

#### ANAEROBIC ENDURANCE

- SHORT-TERM
- HIGH INTENSITY
- THERE IS A LACK OF OXYGEN
- ENERGY RUNS OUT IN SECONDS

#### AEROBIC ENDURANCE

- LONG-TERM
- MODERATE INTENSITY
- THERE IS NO LACK OF OXYGEN
- ENERGY RUNS OUT IN HOURS OR DAYS



#### DID YOU KNOW THAT...?

- In exercises that require high-intensity exertion, the muscle cells do not receive enough oxygen to produce energy, and after a time they stop working. Exhaustion due to a lack of oxygen is similar to what happens when a lighted candle is covered with a glass.



- Furthermore, in anaerobic exercises, the person stops earlier because the muscles use up all the energy available in just a few seconds and fatigue sets in.



### A.3. Why work on aerobic endurance?

In aerobic endurance activities, you can go on doing exercise for much longer since the onset of fatigue is delayed. Aerobic exercises can have a major effect on health.

#### HEALTHY EFFECTS OF WORKING ON ENDURANCE

- It improves the blood circulation system: Increases the size of the heart, lowers blood pressure, greater number of capillaries, etc.
- It enhances the functioning of the respiratory system: enhances lung capacity and the use of oxygen.
- The muscles adapt to exercise: the person gets less tired when doing everyday activities that require exertion.
- It improves a person's state of mind.

## B. TO UNDERSTAND...

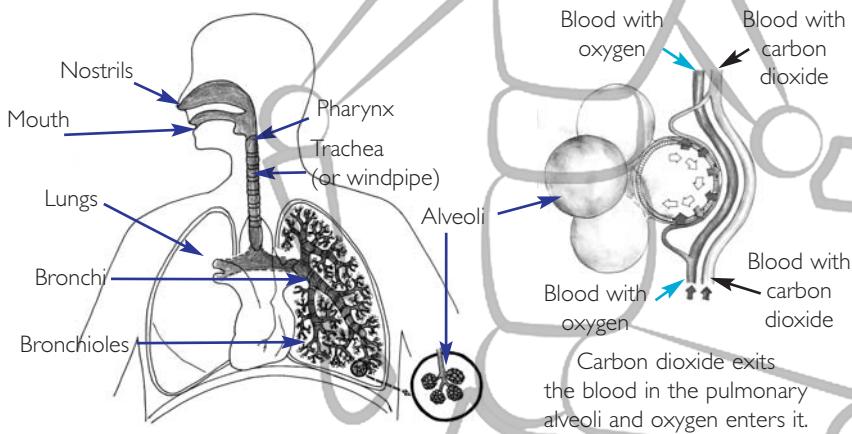
### B.1. The respiratory system



Physical aerobic endurance activities require a special sort of intervention by the cardio-respiratory system, which is formed by the respiratory system and the circulatory system.

Through the respiratory system we obtain the oxygen our body's cells need to carry out the reactions to produce energy and stay alive.

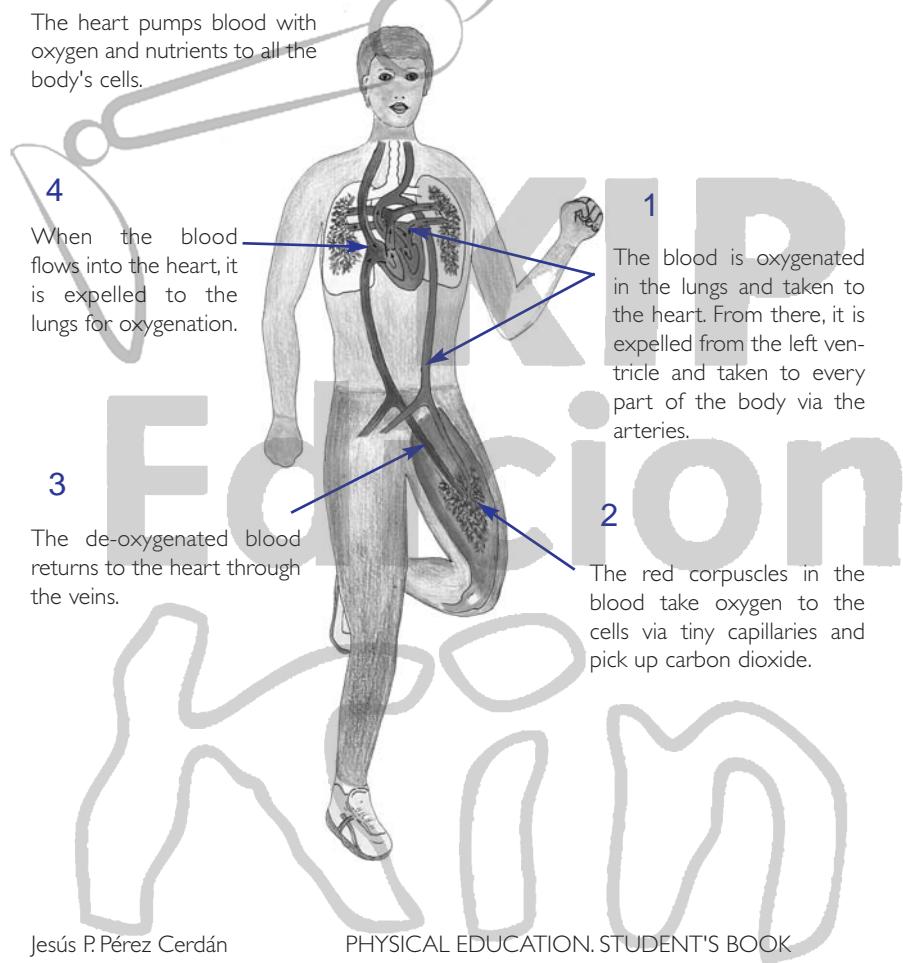
At rest people breathe in about 12 times per minute. When they do exercise, their breathing rate increases because the cells need an extra intake of oxygen.



### B.2. The circulatory system



The circulatory system comprises the heart and the network of blood vessels that take the blood to every part of the body.

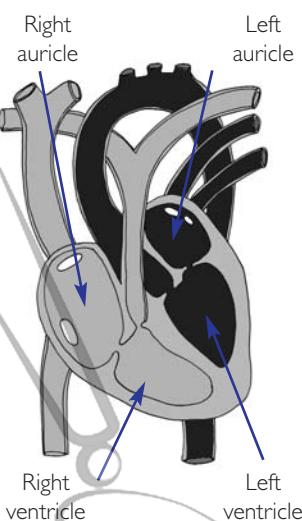


## KEY ASPECTS

- Breathing well during endurance activities delays the onset of fatigue and enables the person to go on doing exercise for much longer.

- You should not hold your breath in. The person should also be able to speak to a companion in the race with complete normality.

- Inhaling through your nose and exhaling through your mouth will avoid irritating the airways.



## DID YOU KNOW THAT...?

- If the alveoli were unwound, the total inner surface of the lungs would be 180 m<sup>2</sup> (1,937 sq ft): over two thirds of the size of a tennis court.

- If all the arteries, arterioles, veins and capillaries of the human body were laid out in a straight line, they would extend for a distance of approximately 80,000 km (49,710 miles): about 14 times the perimeter of Spain.

- As with any other muscle, exercise leads to cardiac hypertrophy, that is to say, the heart becomes bigger to enable it to work better.

### B.3. The heart rate

The heart or pulse rate measures how fast the heart beats. At rest a normal heart beats about 70 times per minute, and when you do exercise, it beats faster to send more oxygen and nutrients to the body's cells.

In order for physical exercise to be healthy, you should never exceed the maximum heart rate, which is calculated by subtracting the person's age from 220.

The pulse rate is taken by applying the thumb and index finger on the carotid artery, beneath the lower jaw. It can also be located by placing your index and middle fingers on your wrist, beneath the base of the thumb. Normally the pulse is counted for 15 seconds and the number of beats is multiplied by 4, which indicates the heart rate per minute.

When doing exercise, it is important to stop and check your heart rate every so often. Physical exercise is considered to be aerobic when the heart rate per minute is kept between 60% and 85% of the person's maximum heart rate.

#### TO LEARN, YOU NEED TO PRACTISE

1. Find out your heart rate per minute: lying down on your bed, after remaining seated for several minutes, standing up, after doing exercise, etc. Is there any change? What do you think the reason is?

2. The recovery time or the time the heart rate takes to return to normal after exertion, indicates the person's adaptation to the exercise.

- While your partner times you, do the skipping exercise for 20 seconds at maximum speed. Take your pulse rate as soon as you stop. Repeat the same exercise 3 minutes later. Compare the results with those of your classmates. Whose pulse rate has gone back to 80 bpm soonest? What might that indicate?

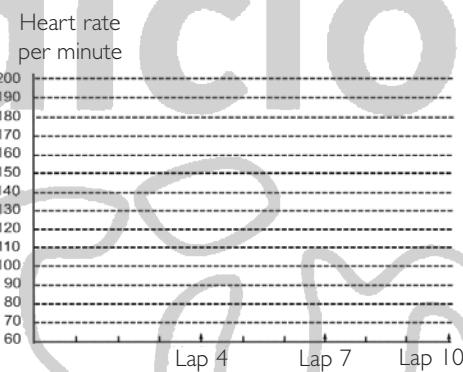
Pulsations in rest	Pulsations at the conclusion of the exercise	Pulsations passed 3 minutes
- In 15 seconds:	- In 15 seconds:	- In 15 seconds:
- (x4) In 1 minute:	- (x4) In 1 minute:	- (x4) In 1 minute:

3. Aerobic endurance improves when the heart rate is between 60% and 85% of the maximum heart rate (220 heart beats - the person's age). Therefore, for an aerobic workout, a 13-year-old should reach 124 bpm. (60%) and not exceed 176 bpm (85%).

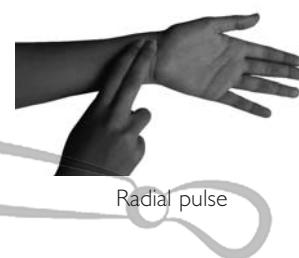
- With the help of your teacher or a classmate to time you, do 10 laps on a 100-metre track, taking about 40 seconds for each lap.

- At the end of laps 4, 7 and 10, stop and check your pulse for 15 seconds and jot it down.

- With the results obtained, fill in a chart and comment on whether our heart bpm have stayed between the limits for aerobic endurance.



Carotid artery



Radial pulse

#### KEY ASPECTS

• The heart rate indicates the adaptation of the heart to the exercise; the less time the pulse rate takes to get back to its rest value after a bout of exertion, the greater the person's degree of adaption.

• The heart rate per minute indicates the intensity of an activity: a heart rate above 170 bpm while doing exercise is associated with high intensity.



#### ATTITUDES

• *Perseverance.* It is impossible to improve your endurance in just one day's training. Here are some fun ways to work on it: accompanied by music, running with other people, etc.



## C. How can we improve our endurance?

### C.1. Non-stop running

Non-stop running consists of running for an extended period of time at a steady, even pace on flat and preferably soft terrain.

Running means repeating cyclic movements of the legs known as strides. This characteristic may lead to an overload on the muscles and joints, which does not necessarily need to cause any adverse effects if you use a good running technique.

### C.2. Circuit training

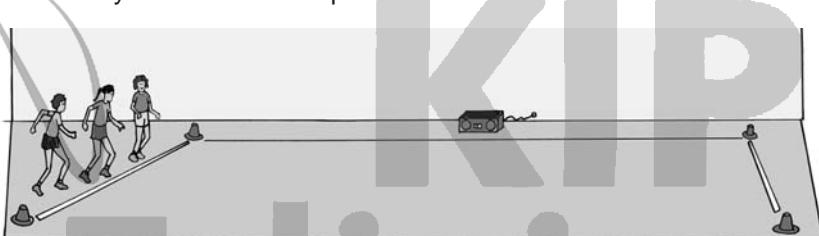
Circuit training is a method that involves doing gym exercises for a set amount of time, and alternating between periods of work and rest.

To design a circuit, first of all, 6, 8, 10 or more exercises are selected. Then the time for the workout periods is determined - ranging from 10 to 30 seconds - and the rest periods, which should last between 10 and 40 seconds. The work and rest periods can always last the same length of time, or they can vary: 20 seconds of work, with 30 seconds' rest, 15 and 25, etc.

### C.3. Progress tests

Several progress tests are used to assess a person's endurance level. The tests also enable us to observe our own development over the course of time. The beep test entails covering a distance of 20 metres repeatedly for as long as possible.

- Move from one side to the other, beginning each segment when the digitally recorded signal is given. Apart from the acoustic signals, a voice announces the level you are on: the more levels you complete, the better your result on the test will be.
- If you hear a beep but you have not managed to reach the line, you should abandon the test, remembering what level was mentioned the last time you heard the beep.



### TO LEARN, YOU NEED TO PRACTISE

- Implement the following circuit training programme, with 15-second work periods and 25-second rest periods. Doing it once forms a set: Before starting the second set, you should take a 3-minute rest. At the end, check your pulse to see whether your workout was aerobic.



1. Skipping rope.
2. Lift one leg and then the other alternately.
3. Skipping.
4. Stepping on and off a bench.
5. Throwing and catching the ball without letting it touch the ground.

### DID YOU KNOW THAT...?

- While still at the growing stage, running for too long may lead to bone or muscle problems.



- As a general rule, it is good for a child to be able to run twice the number of minutes as their age in years.

- Regarding distance, it is not considered to be a good idea to run more kilometres than half the number of years of the runner's age.

### KEY ASPECTS

#### CIRCUIT TRAINING

- The exercises should not be excessive. If they can be repeated 10 to 40 times in a row without the onset of fatigue, they will activate the cardio-respiratory system.
- To develop aerobic endurance, it is preferable for the rest periods to be longer than the work periods.

### DID YOU KNOW THAT...?

- Longer-lasting sports involving the intervention of large areas of muscle mass (swimming, skating, etc.) develop aerobic endurance. Also team and racket sports, as the breaks in play mean that you can remain active for longer.



## \* READ MORE...

### - What factors does endurance depend on?

- The capacity of the respiratory and circulatory systems.*

People who have done a lot of exercise in their youth develop a larger heart and respiratory system. A large heart, which pumps more blood, and large lungs can keep up an endurance activity with less fatigue.



- The number of mitochondria.* With the habit of doing exercise, the muscle fibres work more efficiently since they increase the number of mitochondria, where energy is produced.

*Type of muscle fibre.* There are two types of fibre in muscles: white or fast twitch fibre, and red or slow twitch fibre. White fibres contract very quickly but soon exhaust the energy available. Red fibres contract slowly and can remain active much longer. The more red fibres a person has, the greater their endurance will be.

### DID YOU KNOW THAT...?

- Some footballers have managed to run up to 17 kilometres in a match. However, on average they usually run about 8 kilometres, and from 23 to 28 minutes divided into periods of exertion lasting just a few seconds.
- Altogether, a footballer usually makes somewhere between 132 and 180 runs. Of these, 60 include sprinting 10-30 metres. 2,100 metres (2,296 yards) are covered at great speed, 4,100m (4,483 yards) at a slower pace and 500m (546 yards) going backwards.



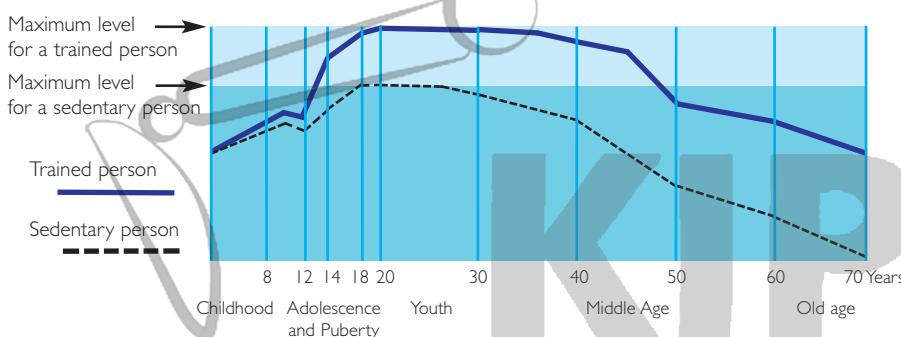
*Energy.* Muscle cells store ATP, glucose, glycogen and fats. This fuel produces the energy required to keep up any type of exertion, with an increase in reserves leading to an improvement in endurance.



*Age.* Although endurance increases with age, it plateaus out at the age of 13 or 14, after which there is another spurt of growth.



### HOW ENDURANCE DEVELOPS



- Intensity of the exercise.* If the intensity of the activity is not high, it can be kept up for quite a long period of time. Thus, intensity determines how long exertion and endurance can last.

### TO LEARN, YOU NEED TO PRACTISE

- Many games are used to improve endurance while having fun at the same time. With your classmates, draw up a list of games and practise them in class.
- What is your favourite sport? How can you work on endurance to improve in that sport?
- Interview a sportsman or woman from your town or city. What importance do they give to endurance in their sport? What training methods or exercises do they do to improve this aspect? How many days a week do they work on it?

### REMEMBER

- In what ways are aerobic and anaerobic endurance different?
- Can you cite 2 positive effects on health caused by improving aerobic endurance?
- Why does the heart rate increase when you do physical exercise?
- Explain the procedure for finding out your heart rate per minute.
- What drawbacks can arise from non-stop running?
- What elements should be taken into account when designing circuit training?