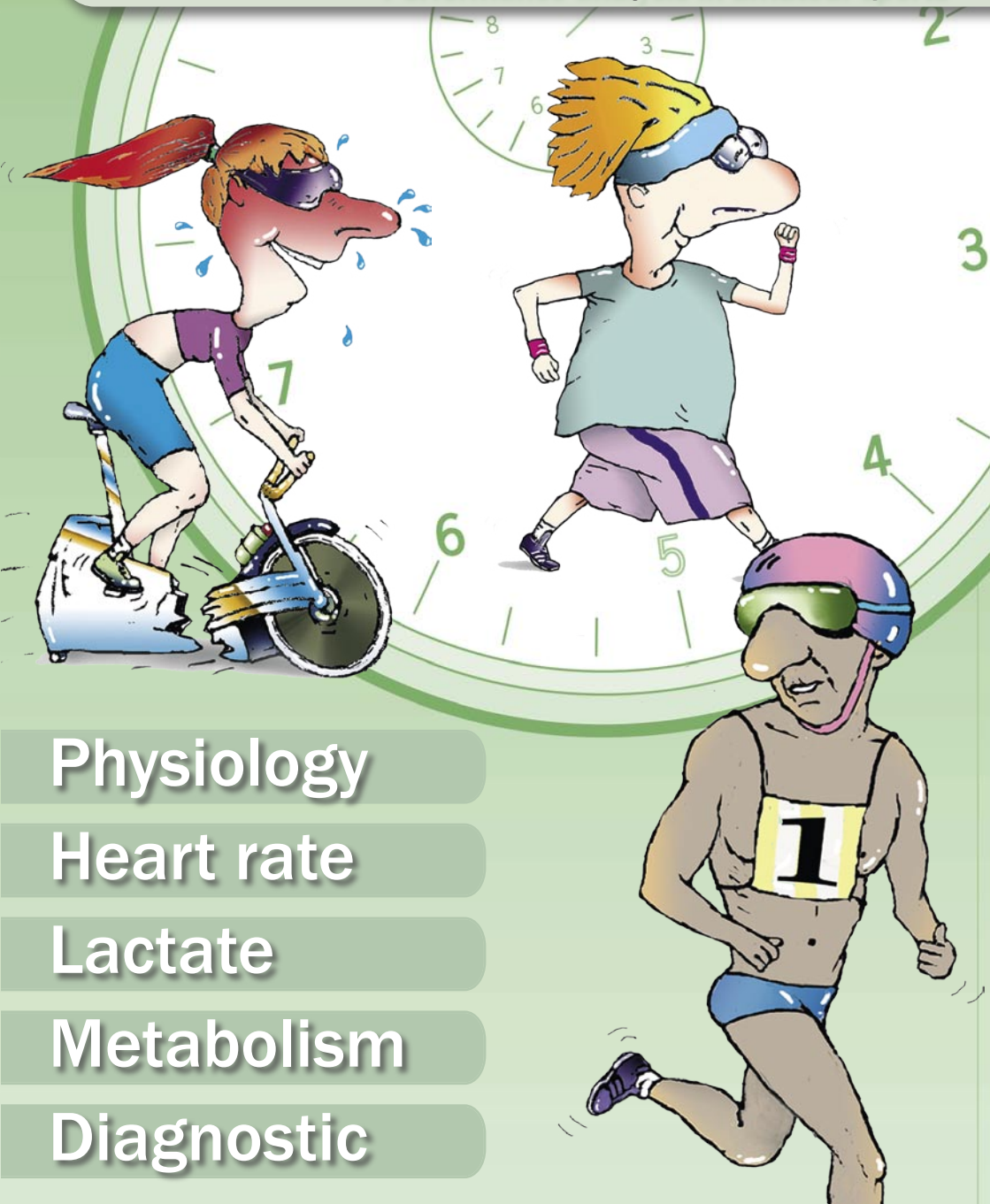
Martin Kusch, Stephan Nüsser

Training in your hand

Performance analysis in amateur sports



Physiology

Heart rate

Lactate

Metabolism

Diagnostic

Already available in 2nd edition, „Training in your hand“ offers handy information for health-conscious people as well as recreational and ambitious amateur athletes. It aims to help explain the many different workout methods and target their implementation. In addition to the basic theories the brochure also includes reports from „typical“ amateurs, demonstrating typical mistakes and success stories.

Martin Kusch, born 1966, studied Sports Science at the German University of Sports, Cologne. Graduate studies in performance analysis and biomechanics. Long-term experience in sports diagnostics as well as consultant, advisor and coach in the health care business.

Stephan Nüsser, born 1970, studied Sports Science at the German University of Sports, Cologne. Director of the Competence Center for Performance Analysis (ZeLD) in Cologne, manages his own diagnostic centre for professional and amateur athletes since 2008.

Christian Weyer, born 1968, studied Theology at the Universities in Marburg, Bonn and Halle/S. Long-term experience in advertising, IT- and media branches of business. Marketing director in the medical-diagnostic industry since 2003, editor of several publications.

CONTENT

Many thanks to all friends, families and business partners: Their kind support, patience and helpful ideas form the basis of this brochure!

1. PREFACE

1.1 Why this brochure?

There are already a huge number of training guides in the market written from high-ranking experts for numerous target groups. So why we have produced another one?

We'd like to show you principles and methods which will help to improve your understanding of your workout and of your individual sports activity. This also includes basic background information regarding scientific theory and practical aspects. With this knowledge it will be easier to plan a successful workout.

When speaking about success we are not talking about specific targets as good times in marathon runs or winning a championship. This kind of success depends on too many factors. Success in your workout has another meaning.

If you know why you should organise your workout in a special way, if you can always properly estimate your capabilities and your personal fitness: Then you'll have the „training in your hand" and will be able to undertake it successfully.

1.2 Who is being addressed?

„Training in your hand" is a brochure for health-conscious and recreational athletes as well as for ambitious amateurs. It contributes to an understanding of the various workout methods, and their implementation.

You don't have to be an expert in sports or medicine to use this brochure! As well as theory you will also find practical experiences taken form the training diaries of three „typical" people. It's up to you to decide which section to start with. In order to move from the abstract concepts to real life the last chapters provide a jump start to figure out your personal workout parameters.

1.3 Our intention

With simple, but important information, this brochure aims to qualify you for an improved insight into your physical capacities and the tools that you can use: These may be tools which you haven't yet considered or have not fully utilised.

An essential key for your success is the control of time and effort - at every level, independently of your individual target. Besides the physical strain and the time spent each week, effort always means a financial investment and personal motivation as well.

We want to help you to use these precious and limited resources more effectively, in order to avoid „empty" workout units. How you can benefit from modern technology in this context will be a further part of this brochure.

Leading manufacturers of well-established devices and workout systems continuously supported the publishers in their work. Thus it was possible to combine knowledge from sports sciences, practical experience and technical know-how to focus on the target of a healthy and individual workout for everybody.

Turn the page, and discover how to get your training in shape!

2. HOW THE BODY WORKS

2.1 Physiological basics

Heart, circulation, respiration and metabolism determine the physical performance of our organism. Thus it's important to understand the function and the interaction of these systems if you want to plan your workout effectively. The first step in this direction will be the analysis of your „current state".

Just because you start out with the same conditions, it doesn't mean that the workout will always be identical. Workout plans will differ significantly depending on the target (health prevention, endurance or performance increase), the preferred kind of sport and the time available.

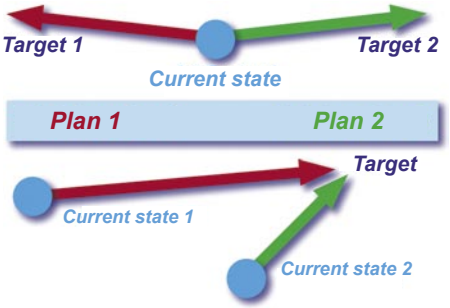


Fig. 1: A workout plan reflects the current state and the final target - no one fits for all

To form a view of your own workout and to understand how it contributes to success as well as failures a brief explanation of the most important physiological and sports training basics will be given in the following sections.

2.2 Cardiovascular system

All areas in the body are provided with blood carrying oxygen and diverse nutrients. In this process the heart is the „motor" of the cardiovascular system, enabling blood circulation through the blood vessels.

A frequent endurance workout is the perfect way to keep this system rolling since it helps to extend the heart volume and its „transport capacity".

The frequency of heartbeats („pulse") is reduced due to the increased stroke volume (more blood per heartbeat is carried). If the heart works more effectively, the pulse will become quieter, even under stress.

As heart growth is naturally limited, the heart frequency will increase under physical strain to an individual maximum during an intensive workout practised over many years. Sufficient blood has to be carried into the muscle cells to cover the high energy demand.

The current heartbeat frequency and the according adaptation due to the workout can be observed easily by a heart rate monitor, a so called „pulse watch" (see section 4.2).

2.3 Lung functions

The lung has a strong influence on the oxygen volume transported by respiration into the body. By breathing through mouth and nose and the upper and lower respiratory tracts the air reaches the pulmonary alveoli where the lung's gas exchange takes place.

Very often, the respiration of untrained people is very inefficient. It is flat and fast and the lungs' capacity will not be used sufficiently. Since they get out of breath so quickly their body isn't able to

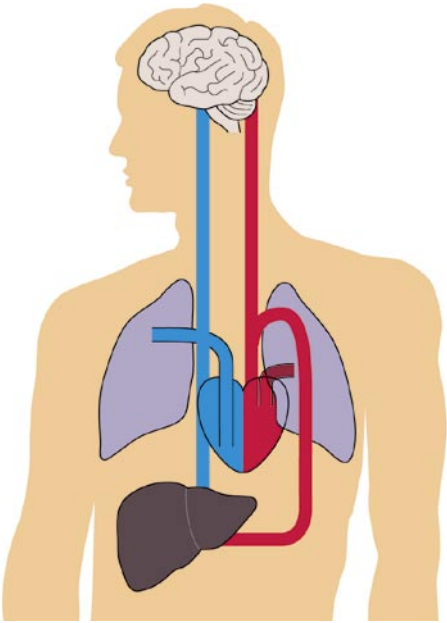


Fig. 2: Scheme of human cardiovascular system with arteries, veins and liver

supply the energy demand. A quiet workout without too much strain can initially lead to a better „breathing economy“, whilst the lung will be better „ventilated“.

During a workout the usable lung volume will increase, this is also known as „lung capacity“. But, in contrast to our heart, the lungs don‘t get bigger. Their growth is completely finished between the ages of 15 and 18 and can‘t be influenced later.

Nevertheless, it is possible to improve the physical performance by an enlargement of the usable lung volume and a better breathing musculature: Laughing is a great medicine because of its phrenic stimulation, which also enhances the chest mobility. Similar useful methods are singing, playing wind instruments or using the „PowerBreath“ lung trainer, available in sports shops.

The „vital capacity“ can be determined with the help of a lung function test and a ergospirometrical measurement.

Ergospirometry evaluates the oxygen consumption and the carbon dioxide output, which is an end product of the aerobic energy extraction. Both parameters are decisive concerning the assessment of an athlete‘s endurance capacity.

2.4 Oxygen transport and blood flow

Oxygen enriched blood from the lungs passes through the heart and is transported firstly into the aorta. The arteries of the system then deliver the blood to the organs and tissues.

All arteries contain a widely ramified plexus with very thin structures, the so-called capillary vessels in the muscle cells. The rapid exchange of gases (oxygen, carbon dioxide), of nutrients and the transport of metabolites (e.g. lactate) takes place here.

In a workout, modifications within the vascular system are only possible under long-term conditions - even though they are enormously important with regards to various health aspects:

As a consequence of the extension of the vascular system, meaning a better dissipation and ramification of the blood vessels, the muscle cells can be provided with more oxygen from the blood.

An improved vessel-wall elasticity, as well as an enhancement of transport function and blood flow behaviour are effects which lead to a noticeable risk reduction of blood vessel diseases, e.g. arteriosclerosis - a typical phenomena in modern society.

2.5 Blood - a very special liquid

Blood ensures the supply of oxygen and nutrients, the removal of carbon dioxide, metabolites and warmth. The blood liquid, the so-called plasma, contains cellular components such as blood cells. These are responsible for numerous functions such as defence mechanism against viruses or infections and closing wounds.

The red blood cells (erythrocytes) play an important role within endurance sports by carrying oxygen to the tissues. Simply said: The better the oxygen supply by red blood cells, the better the endurance capacity.

During a workout, the blood's transport capacity can be enhanced by an increased blood volume on the one hand, and by a larger amount of erythrocytes on the other hand - the secret of doping...

A heavy fluid loss will occur as a result of physical strain (including sweating). Consequently the blood will „thicken". In the worst case dehydration such as this can lead to a circulatory collapse if an athlete doesn't pay attention to his higher demand in liquids, especially during intensive sports activities.

Fig. 3: Higher energy demand for higher activities

Fig. 4: Active people have to counterbalance their continual fluid loss by minerals and sports drinks

2.6 Energy supply

Daily life processes and all physical activities need energy. By splitting up the food components in useable combinations, such as the important ATP (adenosine triphosphate), will be released as an energy source.

In muscle cells a small amount of ATP can be found, which ensures a basic supply, but this energy source will be rapidly exhausted during physical strain. Then the body is in need of new ATP, which can be provided in three ways:

Firstly, the use of stored phosphate is a very fast energy provider, but this energy only lasts for short-term actions, e.g. jumping or throwing a ball. This form of energy production, in which no oxygen is required and no lactate is produced, plays no role within endurance sports.

The second way is based on the splitting of saccharide into glucose (glycolysis) and can provide energy comparatively quickly. In this process there is no need for oxygen, so we speak about „anaerobic" metabolism. The muscle cells generate lactate when performing glycolysis,

which is then flushed into the blood and can be determined by diagnostic methods (lactate test).

Since lactate is the salt of lactic acid, rising lactate concentrations lead to an increasing acidity of the muscle cells. The consequence of this is exhaustion and a limited duration of physical strain: The body protects itself to avoid too much strain and potential damage to its musculature.

This kind of energy supply is typically used in middle distance running in which specially trained athletes tolerate high lactate concentrations temporarily. Intensive interval workouts in competitive sports are also used to train the metabolism to eliminate lactate more quickly.

Lactate is also produced more quickly during physical strain at a medium level. To avoid high acidity by too much strain, regular endurance sports should only take place within the respective „lactate steady-state“: This means a well balanced relationship between lactate production and elimination. Eliminating lactate by oxygen also provides additional energy.

Finally, the third and the „normal“ way is by burning sugar and fat using oxygen („aerobic“ metabolism). This is the main source for supplying energy, which runs in parallel with other energy supply routes, even when most energy is produced through the use of stored phosphates or anaerobic metabolism. Burning sugar is definitely a faster way of producing energy than burning fat. Whilst even for svelte people the body's fat reserves are practically inexhaustible, the reserve of stored sugar in our body's glycogen depot is limited.

Fig. 5: Always fill up with the right „fuel“

During most sports the burning of sugar and fat take place at the same time, but in different proportions. During physical strain at a medium level and a duration of approximately one hour sugar burn prevails. The lower the strain intensity and the longer the strain duration, the higher the percentage of fat burn.

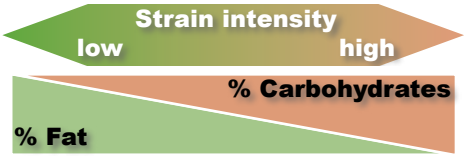


Fig. 6: Shifting burn rate of fat and sugar

On the other hand, the percentage of fat burn decreases with increasing strain intensity. Therefore, for overweight people it is the length of the training which is important, not its intensity. Red-faced runners will never lose their beer belly...

The percentage of fat burn for aerobic energy supply is linked to the current workout state. At a similar intensity level, endurance-trained people profit from a better fat burn rate than less trained people with a lower aerobic capacity. This effect is not just true for the training period: People who continually stimulate their metabolism through sport are not prone to gain weight so quickly again.

If there is a high strain intensity with too small a percentage of fat burn, the high energy demand can't be provided permanently by sugar burn. Thus, after a few hours a hypoglycaemia (low blood sugar), a so called „hunger knock" can occur. That's why amateurs often experience a drop in performance at the last stage of a marathon run.

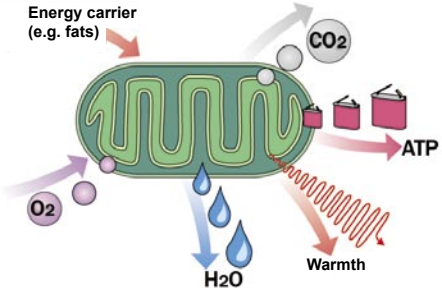


Fig. 7: Aerobic energy provision by mitochondria, the „power stations" of the muscle cells

The efficiency of the use of aerobic metabolism, i.e. the burn rate of sugar and fat along with oxygen, essentially determines the endurance performance:

A higher percentage of the aerobic energy production means a lower use of the anaerobic metabolism and a reduced lactate concentration in the blood. That in turn means that the body is capable of more power and prolonged activity before too high an acidity and exhaustion set in.

2.7 Energy from carbs, fat and protein

As demonstrated above, oxygen, fat and sugar (carbohydrates) are the main ingredients of the body's energy production. This process of conversion is realised by the mitochondria, the „power stations" of the cells. A frequent workout stimulation can increase the number of mitochondria, enhancing the efficiency of energy support.

Carbohydrates are taken up from food and stored in the liver and in the skeletal muscles in the form of glycogen.

These reserves can be highly reduced by a strict diet (or fasting) or an intensive workout and can even be used up completely during marathons. As well, repeated short-term stress leads to a reduced input of carbohydrates and to the continual reduction of the glycogen depot.

Rich „pasta partys" the evening right before sports events are a popular method to fill up the energy depot in advance but a complete restocking of glycogen reserves requires days or weeks after heavy physical strain.

Proteins have an important function in the regeneration of muscle cells and tissue development, but they don't play an essential role within the energy metabolism. Protein drinks are a reasonable addition to sugary soft drinks, but too high a consumption may harm the kidneys.

Fig. 8: Easy to digest, sports nutrition helps to bring back lost energy very quickly

3.1 A natural born sportsman?

Our individual sports, or physical performance depends on several factors. Firstly, there are factors which are out of our hands such as age, sex and genetic preconditions.

Younger people are capable of more physical strain than older people, men more than women, and of course there's the question of talent which mustn't be forgotten. But apart from these general facts we have also to face controllable factors such as workout organisation, personal discipline, motivation and current fitness.

Everything must be right on „day X" for a competition athlete. For most of us, however, the most important thing is to organise our training according to our requirements.

We should listen to our body and consider diagnostic data in order to fit the stress in training to our existing abilities and always remain close to our actual aim. The importance of age here is often overrated.

Whilst newcomers and untrained people need to pay more attention to the first stages of training to prevent training accidents or injuries, the old-timers still possess good basic abilities which can always be built on, even after many years. As the German professor Wildor Hoffmann said: „Sport can help you to stay 40 years old for 20 years", preserving the individual performance by a consequent lifestyle.

A further influencing factor concerning our current strain is our personal psycho-social situation. Work-place stress or upcoming holidays can indeed cause a noticeable „up" or „down".

All these factors point out the importance of keeping your workout close to the current conditions and not only to a fixed programme. Finally, it is up to you to estimate your physical strain and to decide whether there are objective reasons for limited performance or if you are just lacking motivation!

Fig. 9: Best-agers can be as fit as 20 years before

3.2 Sport for healthy people only?

Nowadays, life expectancy has continuously increased thanks to a wide range of quality foods and high-level medical support. In order to live long and healthily, there is a growing need for prevention of illnesses.

Half of all people in our modern industrial nations currently die from cardiovascular diseases; a large proportion of these deaths being caused by heart attacks.

Particular risk factors for cardiovascular diseases are: smoking, high blood pressure and disorders in fat metabolism, as well as high cholesterol levels, diabetes and adiposis - very often in a fatal combination, with one problem causing another.

Continuous lack of physical exercise can

encourage these diseases significantly. In contrast, endurance sports, along with a healthy lifestyle, evidently have a preventative effect for the whole body and a positive influence on the immune system.

Health doesn‘t only mean „physical health“ but also mental and social well being. Besides external effects, e.g. the catabolism of fat, there are real „internal“ changes. Only after a few workout sessions people already feel more relaxed, and daily stress decreases. They are more balanced and able to cope better with any sort of pressure.

For good reason doctors pay more and more attention to sport therapy and specific movement exercises regarding the care of many chronic illnesses.

For diseases of the musculoskeletal system stabilising muscle- or building up exercises are preferred, but for internal diseases most of the exercises used are those that require endurance.

Although acute diseases often unavoidably lead to a reduction of sports activities, sometimes sport is explicitly recommended (if well dosed and controlled) for long-term therapies. This also takes into account the patient’s mental state which will have an influence on the desired physical effects.

Fig. 10: Cardio-workout on a medical accredited treadmill ergometer (h/p/cosmos mercury)

3.3 Changes are possible

Like most things, a successful workout will depend on the right dose, an adequate effort and the relaxation possibilities after the workout.

The development of our physical capacity is essentially defined by the quality (the kind of sports and exercise method) and the quantity, i.e. the intensity and duration of the workout.

That means that our physical capacity will only increase if our body experiences a (qualitatively) suitable strain and has the possibility to get used to this strain during the course of the following (quantitative) time.

The scale of the workout strain should be „unfamiliar", i.e. it should be above the habitual performance level. That way it is possible to achieve a workout effect. Equally a reasonable recuperation time is necessary in order to ensure that the required adaptation processes can take place after the strain.

Our body's ability to recover and thus to receive enough time for regeneration plays an important role regarding the planning of the workout- and strain management. If the athlete attends a workout unit his body will become exhausted if it is placed under an „unusual" strain and the training will thus be effective.

If our body has the possibility to recover sufficiently after a period of physical strain it will soon regain its base level and be as strong as before. The real workout effect is based on the fact that the body will try to be better prepared for such a physical strain in order to „steel" itself for future exhaustion.

This preparation is shown by an adaptation of musculature, of the heart and circulatory system and of metabolism. If stimulated properly, the whole system of energy support will be improved during the recreation phase. It will operate more economically and become „fitter".

4. DIAGNOSTIC METHODS

4.1 Overview

Even in the ancient world performance diagnostics, time and distance measurement were used as scale units of success. Similarly, today's stop watches or measuring tapes can be useful tools e.g. during the so called Cooper-test. In this test you have to achieve a maximum distance in 12 minutes: A simple, but meaningful test.

Fig. 11: Today, heart rate monitors from POLAR are standard equipment of active people

A common efficiency control method is the workout with a device for measuring the current course of your heart frequency (HF). The „pulse" has been used for several decades in sports medicine and sports sciences. Furthermore, comparatively simple test procedures have been established to record the heart frequency during different physical strain periods.

The PWC (physical work capacity) test is a classic example. It gives information about one's physical capacity at certain heart frequencies. A bike ergometer is required and the power rate of pedalling must be increased in a stepwise fashion following a specified scheme.

In the beginning you will start with a power rate of 50 Watt, which is a very low level of strain. The rate then increases by 25 Watt per minute. As soon as the intended targeted heart frequency is reached the performed power rate on the ergometer (e.g. 150 watt) has to be noted.

Integrated into the formula is the weight of the athlete, adding important information, which ensures a degree of individuality of the test.

The PWC-test of a 75 kg man would give a result of 2 watts per kg (the reached power rate of 150 Watts divided by the man's weight of 75 kg). This result will be now related to the targeted heart frequency. Three different heart frequencies have been established as a basis for the evaluation.

Total beginners, older people or rehabilitation patients will be tested at a targeted pulse (heart frequency) of 130 beats per minute (bpm): Their maximum load values, calculated by „maximum heart frequency = 220 minus age" are nominally lower than those of average people.

Age up to 35 years	PWC 130 Women	PWC 130 Men
excellent	above 2,0	above 2,5
good	1,6 - 2,0	2,0 - 2,5
sufficient	1,25 - 1,6	1,5 - 2,0
insufficient	1,0 - 1,25	1,0 - 1,5

Active recreational or leisure sportsmen without serious health defects are tested at a slightly higher level of 150 bpm.

Age up to 35 years	PWC 150 Women	PWC 150 Men
excellent	above 2,5	above 3,0
good	2,0 - 2,5	2,5 - 3,0
sufficient	1,6 - 2,0	2,0 - 2,5
insufficient	1,25 - 1,6	1,5 - 2,0

Lastly, for totally healthy and performance oriented athletes, the PWC 170 is recommended as a suitable test.

Age up to 35 years	PWC 170 Women	PWC 170 Men
excellent	above 3,0	above 3,5
good	2,5 - 3,0	3,0 - 3,5
sufficient	2,0 - 2,5	2,5 - 3,0
insufficient	1,6 - 2,0	2,0 - 2,5

On the basis of the PWC tables it is now possible to read the physical endurance capacity. For instance, let's take a 34 year old man. Referring to the first group as a „total beginner", a heart frequency of 130 bpm and a capacity of 2 Watts per kg weight at the same time would mean a good physical condition.

However, when tested with the expectations for regular „fit" people or even for athletes, the result looks very poor: The higher the heart frequency at the same power level the worse the test result.

The heart frequency measurement has been widely used. The development of radio transmission allows the communication of data using a chest belt to the pulse watch. Introduced by the market leader Polar in the late 1970s, they enabled sports medical examinations to take place outside the lab and replaced the manual pulse sensing at the wrist,

which was prone to errors. A few years earlier the research work of Prof. Mader led to a widespread alternative. He systemised the relationship between lactate production as a result of anaerobic energy supply and the permanent performance limit.

With the help of his development of tests, applicable in sports practice, an optimised workout supervision was first possible: One drop of blood is sufficient in order to evaluate reliably the fitness of an athlete, his endurance capacity and the risk of potential „over-acidification“, caused by high physical strain.

Very soon, lab analysers were developed for lactate diagnostis used in sports centres, hospitals and university areas supervised by qualified staff.

In the last few years lactate diagnosis has become possible even for the private user, due to the easy use of mobile, pocket-sized handheld devices. They offer ambitious amateurs, clubs, gyms or rehab patients the chance to determine an optimal workout management.

Fig. 12: Mobile lactate analyzers as the Lactate Scout are affordable and suitable for outdoor use

Another far reaching examination technique is the ergospirometry, which is historically one of the oldest methods. It has been used since the beginning of the 20th century to test the capacity of athletes to absorb oxygen.

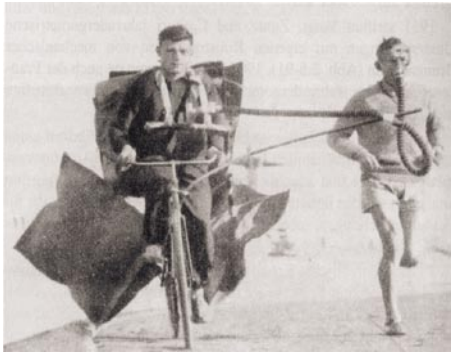


Fig. 13: Respiratory analysis of a runner by „very special“ technology of the early 20th century

The measurement of the maximum oxygen uptake (VO2 max) is considered to be the most reliable criterion for the assessment of endurance capacity. Due to the technical effort involved, it has become accepted mainly in elite sports.

Thanks to the progress of electronics and sensor technology, respiratory analysis is also becoming popular with health providers, making this technique available to private customers and amateurs as well. Besides computer based lab systems the first mobile devices are also now available.

As well as the measurement of the VO2 max, the analysis of each single breath offers detailed diagnostic insights, comparable to the engine management system of a car:

The oxygen taken up by the body provides the energy for physical activities (comparable to the intake air quantity

measurement for the combustion engine). The measurement of the output of oxygen and carbon dioxide then enables the determination of metabolic processes (fat and sugar burn).

Fig. 14: Ergospirometrical diagnostic compared to the modern engine management of a car

4.2 Heart rate and workout

Today, heart rate measurement devices, also known as pulse watches, are already standard equipment for all sporty people. The most important functions are the ECG-precise measurement and the stop watch.

There are two principles related to the pulse controlled workout:

On the one hand, it's possible to derive strain intensity in percent from the maximum heart frequency (estimated by the age formula). However it is necessary to note that the heart frequency depends on further factors such as temperature or personal mood, thus this measurement only provides us with an approximate value.

Alternatively the results of a performance diagnosis can be used along with lactate analysis or ergospirometry in order to determine the individual workout heart frequency:

If the heart frequency is known within the range of the individual lactate threshold or in relation to the capacity to absorb oxygen, it will become a more precise control factor. In this case a pulse watch is a useful and handy tool for the daily workout.

4.3 Lactate diagnostic and workout

A few years ago, performance diagnosis using lactate measurement was mostly an exclusive privilege for elite sports. However, today, particularly amateur athletes, personal trainers, gyms and clubs are discovering the promising options of this method, simplified by newly available and affordable pocket devices.

As a reference value for lactate values in „rest", measured from a healthy test person without any stress or strain, 1 to 2 mmol/l (millimol per litre) are considered to be normal. Values below 1 mmol/l are found in well trained endurance sports people because of their more efficient energy-metabolism. However low rest values may also be caused by significantly reduced glycogen reserves as a result of a diet or an intensive strain in advance of the lactate test. An extreme example is marathon running where the body needs days to weeks before its recovery.

On the other hand, meals rich in carbohydrates (such as toffee pudding, a banana or a glass of coke) may increase the rest value up to some hours after consumption, depending on the individual „burn rate". Without these influences, continually high rest values above 3 mmol/l can also provide evidence of infections causing „body stress".

Random or „single point" lactate measurements only allow rough statements to be made and require knowledge about the „case history", i.e. workout duration

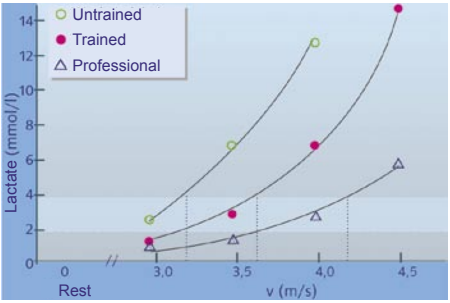


Fig. 15: A lactate curve indicates the oxygen debt of the metabolism at different performance levels

and intensity as well as the physical condition of the test person. The lactate concentration increases in a range of 2 to 5 mmol/l during moderately rising strain. At this level, lactate production and lactate exhaustion are balanced („lactate steady state"). If the strain is increased further, the proportion of anaerobic metabolism will also increase. More lactate will be produced than eliminated at the same time. Lactate values over 6 mmol can already limit the performance.

For beginners with a lower endurance, the „lactate balance" can already be exceeded at a lower strain, and values of up to 10 mmol/l can be reached quickly if stress is continued. This is a high value, normally only reached by well-trained athletes at a much higher level of stress.

In order to determine the individual physical capacity, a so called „step test" is performed. In pre-defined time intervals (2 - 5 min), the running velocity on a treadmill is increased e.g. by 0.5 m/s, or the Watt rate on a bike ergometer is enhanced in 25 W steps.

The lactate values measured after each step are then illustrated in a „lactate curve" (Fig. 15) in relation to running speed or Wattage. The more the test person is trained, the less the lactate production increases per step (and the better is the elimination rate). This results in a „flat" lactate curve, shifting the crossing point of the threshold to the right.

4 mmol/l are said to be the determined „anaerobic threshold" according to Prof. Mader, but this doesn't always meet the individual metabolism ratio. In general, the determination of the individual anaerobic threshold (IAT, slightly higher or lower) is an established and successful method in order to manage different workout strategies.

Normally, a basis endurance workout (also called „fat burn" workout) should be carried out at an intensity of 60% to 80% of the lactate threshold strain. This percentage corresponds to a lactate value of 1.5 to 3 mmol/l. At this range, the aerobic energy metabolism will be best stimulated. This is also interesting for recreational athletes who want to lose weight along with their fitness workout: Our fat reserves will be ideally consumed if the aerobic energy metabolism is activated and if the physical strain lasts for a minimum of 30 to 60 minutes.

Sports scientists have developed a wide range of different methods to calculate the IAT, adapted to different kinds of sports. Software solutions are available for data management and threshold calculation, including target time prognosis and the creation of suitable workout schedules (see page 36).

Recently, the interpretation of lactate curves (their kinetic) has become more important. In order to ensure a reliable training management it is necessary to select a test method that is easy to use and suitable for the sport in question.

4.4 Ergospirometry and workout

Ergospirometry combines two different testing methods - ergometry and spirometry. Ergometry means strain examination, i.e. physiological reactions of the cardiovascular system are recorded, for instance during a step test. Spirometry is the supplementary measurement and recording of the lung- and respiratory volume.

This combination allows the evaluation of the cardiovascular behaviour as well as the lung function during physical strain.

Spiroergometry offers the best option to obtain a complete overview of physical capacity, individual limits and their allocation to a functional system of the body, including musculature and metabolism.

As a high-end diagnostic tool it helps to figure out special methods and treatment steps individually. Spiroergmoetry not only provides a total result (fit or not fit) but also the cause and starting point for an optimised workout scheme.

5. WORKOUT TYPES

5.1 Welcome to the heroes

Everyone is special in his own way! We decided to pick three different "hero types" with typical characteristics, preconditions and expectations in their particular workout to provide a clear link between the theoretical background knowledge and reality.

Katie, Bill and Colin are not real people, but their performance data, workout experiences und their different situations are based solely on reliable studies, which we have undertaken with similar sportspeople in real life.

Perhaps one of our „heroes" is quite similar to your type. If so, you are welcome to use the particular workout programme for yourself. It is also important to consult experienced athletics and trainers who can help you to get your workout in shape: Enjoy it!

5.2 Bill's way to the top

A typical workaholic, Bill loves his job in the senior management of a rapidly expanding company. He is 51 years old, married and has two grown-up children, who have already left home.

Until now, Bill has never gone in for sports in his life - apart from on TV. Time is money and he doesn't like to waste anything. This is revealed by Bill's figure: 1.78 m body height and a weight of 85 kg. This is a Body Mass Index (BMI, body index=weight/body height^2) of 26.8: Slightly over the normal boundary of 25.

Bill feels fine but not really fit. He became especially aware of it when the lift stopped working and he had to walk up to his office on the third floor. When he finally reached his office, sweating and gasping, it was almost impossible for him to unlock the office door.

Thus, Bill made an appointment with his doctor for a complete medical check up. The result was disillusioning and the bicycle ergometer test showed the following: His physical capacity reached only 150 Watt with a heart frequency of 170. (PWC - the physical work capacity - 170 corresponding to 1.7 W/kg).

At rest the lactate test showed a passive state value of 1.8 mmol/L, which is normal and gives no indication for serious health problems. However, after Bill started the test on the bicycle ergometer the lactate value climbed upwards in a straight line and quickly hit the 3 mmol/l mark.

Bill's personal impression of not being really fit had finally been confirmed by the doctor: His fitness was equal to zero! But after all, there had indeed been one good piece of news – Bill was not suffering from any serious health defects (not yet...) The doctor's advice was clear: "Get exercising!" Get exercising? After a 30 year period with no exercise - how should he do that?

After the first shock Bill started to think about his situation. He thought about the problem in the same way as he went about working on projects at work. Finally, he came to the conclusion that he could not succeed without the professional help of an expert. The first competent dialogue partner was found quickly: His wife!

She had been in „Nordic Walking fever" for the last three years. She and her group regularly went out for a walk in the nearby forest. They were not motivated by competition but just enjoyed exercising in the fresh air, talking and doing something together.

After Bill told her the doctor's diagnosis she gave him a lot of motivation by telling him several interesting facts. She was aware of Bill's aversion to long and boring lectures so that she promptly recommended a qualified partner – a diagnostic institute that she also used for regular personal tests.

No sooner said than done: One week later Bill had an appointment. He felt relieved by the first meeting. Apart from the few "Schwarzeneggers" in the next door gym, most of the people coming to the institute looked very similar to Bill.

He and his coach talked in detail about his everyday life, the numerous meetings and business dinners, business trips and the mental pressure. Clearly, they had to find a solution to fit Bill's professional life.

Fortunately, he was in good hands. They scheduled another appointment for a complete performance diagnosis. This time, Bill was wired up and was given a breathing mask for the test on the bicycle ergometer. Everything was connected to a strange box and a computer and Bill began to pedal again.

The coach changed some settings on the ergometer and entered Bill's data onto the computer. Curves and numbers now started to appear on the display. The coach ensured Bill that he did not have to beat any records. It was important that the test should provide an extensive overview about Bill's condition.

In addition to his individual endurance values the test also determined his body fat percentage. After the ergometer he was asked to perform some power- and mobility tests.

The final result was quite clear: Bill had a lot to do! His body fat percentage was 30% above average, the capacity to absorb oxygen was 20 % less than that of a healthy, untrained man of the same age, but the coach bolstered him up again immediately:

With all the data of Bill's current state of fitness laid out it was now possible to define targets for him. The targets should be suitable and get him motivated, without making him feel that they were unachievable. They should get Bill in good shape through suitable exercises in a manageable time.

Objective workout targets

The priority, short-term target was quikkly outlined: Bill wanted to be able to climb the stairs to his office easily without the need for an oxygen tent at the top! In sports science terms, this means his „aerobic performance capacity" needed to be improved, at least

Abb. 16: Ergospirometer by ZAN, featured by a special analysis software

up to the average level of a healthy man of the same age – best accomplished by very low intensity training at a low level.

Since Bill doesn‘t yet know how much time he can really spend on his new „hobby“, the coach first suggests the following schedule: Bill sets a time-frame of three or four months to achieve his first target. The first step is the most difficult, he knows. Bill has to increase his performance capacity by 20% but at first Bill is not sure that he can invest more than one hour a week in his training.

Through this type of training the musculature’s capability to utilise oxygen for sufficient energy support will be re-established. Remember the metabolism test with lactate measurement and ergospirometrical analysis had shown Bill’s main problem: The transformation of energy aerobically at low and medium strain intensities.

This includes the fact that his untrained body shifts too quickly to alternative, exhausting energy sources, limiting his overall performance. His fat burn rate is also very underdeveloped. These deficits in metabolism processes can be recognised from the analysis graph in fig. 17:

The green dotted line indicates a maximum relative fat burn rate of 40% at 50 Watts, the „low end“ setting of the bike ergometer. The absolute maximum is reached at 75 Watts, when roughly 120 kcal per hour are burned. At higher performance levels this decreases significantly again - the body has to consume available energy more quickly:

Pedalling with a power of 150 Watts, 100% of the required energy is already delivered by carbohydrates (red dotted line). This marks the transition of Bill‘s metabolism to the „anaerobic“ energy support, generating lactate and exhausting the body very quickly. Thus, in his current condition, Bill isn’t able to perform with 150 Watts continually.

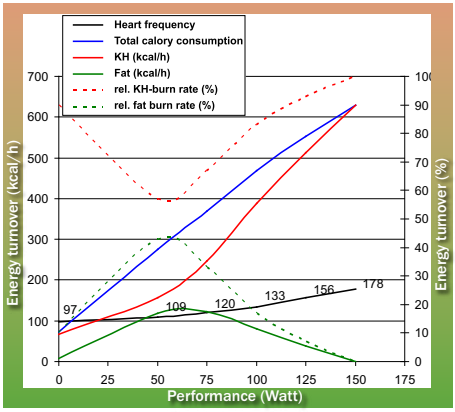


Fig. 17: Analysis of energy metabolism of Bill, 51 years old, untrained

In Bill’s case these are not the only deficits. Of course his total performance capacity is very restricted, which is shown by a high heart frequency and his uneconomic respiration.

The next workout targets are discussed as well - it wouldn‘t suit Bill’s ideas to focus on an „average“ level only! If Bill achieves the required state after three or four months, it will be possible for him to undertake more intensive regular training as he wants to improve the capabilities of his cardio-vascular system. Another three or four months will be required to achieve this goal. The exercise frequency and intensity (or heart frequencies, lactate values and durations) of this workout will be worked out in detail shortly before the training period.

Bill doesn’t have high flying goals or want to go in for competitions. His goals are:

1. to improve his aerobic basic condition and fat burn rate

2. to improve his cardiovascular abilities, to achieve more economical respiration

3. to lose 5 kg in weight and improve blood values, followed by long-term weight control without any special diet.

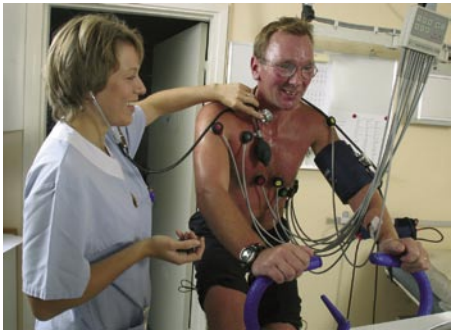


Fig. 18: Performance diagnostic running on a medical accredited bike ergometer from MONARK

Performance under control

Bill was conducting a lot of meetings already, he had dinners with „big shots" in politics and business and handled reasonable sums of money every day - but he hadn't felt this strange feeling in his stomach for a long time:

He was nervous, because his very first workout lesson lay ahead! To avoid any mistakes in the beginning, he used the institute's equipment, under the coach's eyes. There was a range of different ergometers for cycling, rowing or running – the latter being called „treadmills", probably for good reason.

Following additional recommendations, Bill had bought himself comfortable sports wear, solid running shoes and a pulse watch, type „Polar F4" - this „entry level model" was the cheapest item of all, but was good quality and fulfilled all the requirements and essential functions for Bill's needs: Frequent control and display of his heart rate as well as individual settings for upper and lower limits. A good deal!

Even though Bill isn't even able to jog slowly at the moment, he's convinced he will be able to do something like that later, perhaps in the second part of his workout schedule. However now he had to come back to reality after all the shopping and scheduling:

Bill looked reverently at the bike ergometer. „It's over 25 years ago", he thought, „since I last sat on a bike." The coach repeated the main target again: „Better condition, improved fat burning."

The coach painted a stairway on a piece of paper. „Always imagine this", he encouraged Bill. „It's a symbol for the stairs to your office - and for the levels of your health and well-being, if the workout is continued steadily". The essential workout data were noted on the other side of the paper (fig. 19).

As a result of the performance and metabolism analysis in advance, the recommend maximum heart rate for the aerobic workout was clear: 115 beats per minute should be the limit, in order to achieve an optimum degradation of body fats.

This pulse rate was very close to Bill's regular heart frequency, but this time it wouldn't be caused by too much coffee or too many phone calls: This time, „good stress" by his body's activities would replace the „bad stress" of work.

Further information given was that he would burn 300 kcal additionally during his first one-hour-workout.

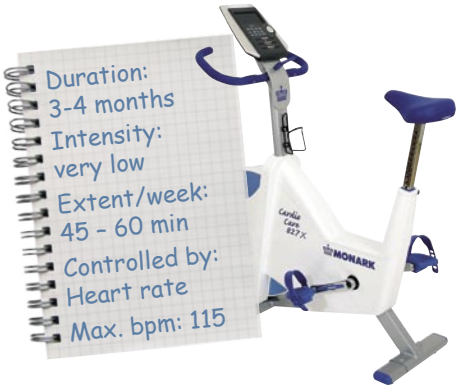


Fig. 19: Bills workout schedule and his new workplace: A CardioCare ergometer from MONARK

Not much, but not bad for a start, especially when one thinks that the daily consumption of one little piece of butter (15 g) too much may cause an increase of 5 kg in weight in a year.

Now Bill was sitting on the bike ergometer. Saddle, handlebars, everything was perfectly adjusted for him, and he started to pedal. Instead of looking at a speedometer, he looked at the heart rate on his new Polar-watch. It wasn't difficult but very soon the watch displayed 110 beats per minute.

The coach became aware of this and quickly corrected some settings on the ergometer so that Bill could easily keep on pedalling without any stress.

His pulse continually kept between 110 and 115 beats per minute so that Bill didn't have to permanently look at the pulse watch and could let his eyes wander to the wall-mounted TV and to the special offers at the food bar. Besides, he was reminded in time by a loud BEEP, if he exceeded the maximum heart frequency.

„How are you? " Bill's reply particularly surprised himself: „Fine, thanks" - and in fact, it was fine! That was also the most important finding of this first workout unit: it didn't hurt, and the hour was over much faster than he had expected.

For the next workout dates he planned to bring along something to read. Professionally equipped, Bill appeared week after week in the institute. He wasn't sure if what he was doing was really fun, or if he was only driven by the feeling that he had to do something.

However, the first small success did not pass by him or his wife: He seemed fresher and less tired in the evening when he came back from work. The one hour per week had already made an impact and very soon Bill would see how big the sporting improvement had been:

Fig. 20: Heart rate monitoring is a basic feature of many ergometers - the Cyclus 2 offers additionally a data interface to lactate analyzers

The elevator went on strike again. This time Bill was very curious about his first climb up after the disgrace two months ago. He didn't even notice the first floor, perhaps for this reason he gained energy and spurted up to the second floor without realising it.

He had succeeded, since the third floor was the gauge of his fitness. He arrived

at his office door and could make a positive summary about his first seven weeks of training. Even though the stairs were still a challenge (which was to be expected), he noticed an improvement in his whole body.

With this motivation Bill was able to enjoy his training more and more, often with the saying he enjoyed citing “even the longest journey starts with the first step” – and he had done it.

During four of the remaining nine weeks he even managed to finish two units. And whenever he had the choice between stairs and elevator, he chose to go on foot - as long as he didn’t have to climb to the fourth or fifth floor. Phase one came to a close.

Meanwhile the workouts became second nature to Bill. He noticed another thing, which hadn’t yet been mentioned:

Somehow, his trousers were looser, although he didn‘t see any real weight loss on the scales. He had to tighten his belt!

Abb. 21: Treadmill (h/p/cosmos pulsar) featured with safety frame for professonial sports analysis

This was a good sign - and time to switch to phase two. Bill fixed the next consultation with the coach, which was to be accompanied by another performance analysis.

In order to have the results of phase one in black and white and be able to precisely plan the next stage of training, he had to perform another ergospirometrical test: This time not on the bike ergometer, but on a treadmill.

It was still very fresh in Bill’s and his coach’s mind how flat Bill’s respiration was the first time and how quickly his heart rate and lactate concentration increased. The next target was to further enhance his cardiovascular abilities and develop a more economic breathing rate.

After the improvement of his basic performance at low intensity levels and his muscle’s metabolic capabilities, the focus should now lie on the heart-circulatory system as well as training the lungs and breathing.

In future, Bill should try also to master some more workout units on foot – the test result would help the coach decide if it would be walking or slow jogging.

This test only took 20 minutes, since a maximum load is not required to define the workout parameters using ergospirometry; these can also be read precisely at moderate performance levels.

The test began with a low walking speed of 5 km/h, and increased by 1 km/h every three minutes. Using this method it was possible to fix the optimum, heart rate balanced speed which would provide the basis for Bill‘s future running/walking units. Now, the new workout guidelines could be defined exactly:

Bill has to attempt to continue his cardiovascular training on the bike, and to walk one hour on the treadmill or, if possible, outside. Real running or jogging would be too intensive for him at the moment. The coach used the test results to figure out the recommended workout limits:

The performance of the cardiovascular system can be stimulated with a heart frequency of up to 140 beats per minute. The test also showed a lower increase of Bill‘s lactate values at the second and third test level. His breathing frequency and the respiratory volume were also optimal at the moment at this heart frequency, which means he will be able to breath economically (for his condition) at this performance level.

Bill had no problems entering phase two. He had already trained a bit more than planned now and again during phase one. The first treadmill walking exercise was no problem at all, in spite of the fact that this was a totally different load!

For the next session he arranged to meet his coach at a parking place close to the forest. Bill had the idea of taking up his wife‘s walking sport, but without sticks. The coach explained a lot of rules to him, correct movements, how to put his feet down and so on - goodness, can‘t humans walk normally anymore?

Okay, it was a little bit more than „walking normally“: The biggest difficulty was to move smoothly whilst swinging his arms, which was totally strange, but this kind of activity was required to achieve the required heart frequency. In addition, the movement should help to loosen Bill‘s tense neck muscles, which did occur after a while.

Meanwhile he made more and more workout experiences in different situations. More casually his wife asked him what about packing sportswear for business trips. Maybe some hotels are equipped with fitness rooms? She was right, once again - and since then Bill‘s standard baggage always includes a tracksuit and sports shoes.

Only the walking remained a problem. No matter what the coach said, Bill just didn’t enjoy it - the weather didn’t help either.

He found no satisfaction is rushing through the forest alone in the rain. On days like these he also noticed increasing pains in his hips, which made him feel even less motivated.

All in all, Bill needed help from a professional. The following day, when he went for his ergometer workout again at the institute, he told his coach immediately about the problem.

The coach inspected Bill‘s new running shoes, but he couldn‘t find any faults in their quality, so he recommended an orthopaedic examination of Bill‘s feet. This revealed that Bill had straddled flat feet.

He learnt that many people suffer from this condition in modern society and it is caused by simple reasons. Our feet muscles are no longer activated sufficiently or properly. The problem often starts in childhood and leads to an unsustained arch - thus the pain that Bill felt during his walks.

So, happily, it wasn't really fatal! Of course, he couldn't continue as before: The pain in his hip would worsen and cause serious damage, not only to his hips but also to his knees. Bill got orthopaedic insets, individually adapted for his sport shoes. An affordable investment to be able to continue his walking exercises without pain.

However, „no pain" didn't automatically mean loads of fun and Bill had to fight mightily with himself. 10 weeks (out of the scheduled 14 weeks) were gone, and, yes, he recognized that his endurance was improving through this kind of workout. Twenty-eight days and at least four workout units to go: Then, finally, phase two would be finished, and he would able to enjoy the well deserved (and highly desired) holiday.

By recommendation of his coach, these remaining four weeks should be used to give a competitive edge for the holiday. They all knew that Bill was keen to have some relaxing, peaceful days on his holiday, so he wouldn't spend so much time working out.

Bill intensified his ergometer workout. Now he rode the bike for one hour, keeping his heart frequency between 135 and 140 beats, and his lactate values at about 3 mmol/l. At this level, his performance was about 140 Watt: A significant improvement compared to Bill's poor condition seven months ago!

The walking exercises had to be adapted as well. As Bill performed the more intensive workout on the ergometer, he was free to walk more quietly. This suited him better and gave him the opportunity to walk together with his wife - she with sticks and he without.

Their walking speed was optimally tuned now. Neither of them had the feeling of wanting to go faster, or being pulled along by the other.

Three days before the holiday, Bill met his coach once again to discuss phase two and to get some additional hints about how to manage the vacation. Both issues were quickly straightened out: Bill had bravely followed the given guidelines. This was honoured now by a visible success: On the one hand by the objective data in the form of Watt performance on the bike, heart rate and lactate levels, and on the other hand through Bill's overall appearance.

Now the good impression should be confirmed by the scales and a body fat measurement. His weight had fallen to 82 kg (from 85 kg). Bill was disappointed;

Fig. 22: Don't make compromises on sport shoes - orthopaedists and qualified dealers can help

He had hoped to achieve more, or rather less! His body fat measurement currently showed a percentage of 22. All in all not a bad result for seven months training without having to renounce too much and having the opportunity to learn about many new possibilities. Anyway, it still wasn't enough to impress friends and colleagues.

Thus the aim for phase three was fixed without further ado: Weight loss, 5 kg at least, and continually optimised blood values, followed by long-term weight control without the need for dieting.

As an experienced number-juggler, Bill effortlessly understood the coach's calculation. In the beginning, his body fat percentage was 26%, which means 22 kg „stored fat" in relation to 85 kg weight.

Now he weights 82 kg, with body fat percentage of 22%: Bill is now storing only 18 kg fat, which is a loss of 4 kg during the seven months of his continual workout. What has he lost then: 4 kg (lost body fat) or 3 kg weight (85 minus 82)? Both values are correct, because 1 kg of newly developed muscle mass, water and blood volume has to be added to his overall weight. However this is "good weight" instead of the 4 kg of "bad" fat. Expressed in energy terms, Bill lost 30.000 kcal with this body fat. This volume wasn't replaced by the ingestion of food, so Bill's body had to revert to its stored energy.

Let's take a quick flashback to the workout and its effects on the calorie budget: In phase one Bill performed a total of 19 workout units with a duration of one hour each at a very low level and expressly focussed on the improvement of his fat burn rate. Every workout unit consumed 300 kcal (or 6.000 kcal altogether).

Then the second phase followed, performed every week with a low level unit again and a medium level workout in addition. Bill's additional energy demand of 850 kcal per week (45 minutes on the bike with 300 kcal and 60 minutes walking with roughly 550 kcal) could be clearly seen through the energetic evaluation of the ergospirometry.

This amounts to 22.000 kcal, transformed exclusively by active and healthy movement. It comes along with another, exciting effect - an essential benefit, not only for Bill's holiday, but also for his long-term targets of phase three:

By the activation of the existing muscles and the light development of additional muscle mass, Bill's basic energy turnover has been increased by 80 to 100 kcal per day.

So in the last three months of workout he had an additional calorie consumption of 7.000 to 9.000 kcal – just like that!

Incidentally, such a „basic turnover“ describes the individual minimum of one‘s daily required energy to maintain the most elementary life functions: Functioning of internal organs, including heart and brain, as well as the generation of warmth.

Physicians calculate the basic turnover of a man by 1 kcal per kg per hour. „Loaded“ with 82 kg for 24 hours, Bill can expect a burn rate of roughly 2.000 kcal per day.

When we‘re getting older, this turnover is slightly lowered due to the naturally reduced muscle mass - as seen in Bill‘s evaluated data of „only“ 1.800 kcal per day. Only? Bill is plainly excited about it, and also his coach is aware of the permanent grin on his face.

Without any fights (well, almost), but in any case without cramps or big sacrifices, Bill was impalpably approaching his third target in huge steps. He had to keep tightening his belt and the printout from the institute’s analysis software provided him with the hard facts on paper.

According to his coach, Bill would only suffer a small decline in his endurance and a light weight increase on holiday if he didn’t get too carried away. What a nice prospect as he really wanted to be able to relax with his wife during the holidays.

Bill had understood that a well balanced energy demand is important in order to keep one’s weight stable. Daily physical activity plays an important role here:

People who don’t do any sport (or are not very active) do not need so much energy and thus less food. Without his previous training, Bill would have had to do without some tasty delicacies in holiday: But now he can enjoy his food with a clear conscience, thanks to the good basic training he has gained.

This should also remain true for the future as well, and an appointment for the next performance test with metabolism analysis was fixed for a few days after the holiday. Bill wanted to lose another two or three additional kilos of his fat reserves, since he has been won over by this method, compared to the diets he had tried before.

Of course, nutritional aspects must be taken into account in each case: As a general rule a balanced diet is important taking care not to ingest excess calories.

Bill was already well served by his knowledge of a few basic principles: Not too much fat or sugar, but lots of whole

grain products and vegetables. It was also possible to abide by this at business dinners, without having to stick to the side salad, water and dry bread. On the contrary, it is better to be happy and well-fed than to stay hungry and risk the typical „little sins“ through snacks, mostly loading the body with foods full of highly-concentrated fat and sugar.

Bill also took more care when going shopping: The „fat-finder“, a kind of round sliding rule helped him to choose the most suitable foodstuffs. Sometimes it was surprising to see what‘s „behind“ the promises on the labels and wrappings...

One didn’t find the specially made (and specially priced) „light“, „low-carb“ or „fitness“ products in his basket: Instead he chose products which are naturally low in fat. Instead of sugary lemonade, Bill now mixes mineral water with unsweetened fruit juice. What a discovery: A healthy lifestyle saves money! When Bill went to the company on the last day before his holiday, he was astonished by the uproar in the entrance hall. Due to the lift’s frequent defects, the technicians had finally decided to give it an overhaul. Fine, but it meant that all the employees were forced to climb the stairs.

Humming happily, Bill strolled to his office. Arriving on the third floor in a cheerful mood, he noticed the state of his colleague next door: Sweating, gasping and not able to manage the door keys.

Bill remembered: His own crucial experience wasn‘t so long ago! He smiled and walked over to his colleague: „My dear Phil, shouldn’t you start doing something for your health? What do you think about sports? I know a good institute in town...“

5.3 Katie, the fitness sportswoman

in a health and wellness oriented sports studio. She has been coming here several times a week for just over a year. She takes part in various courses, in order to get rid of the little tummy that has remained after her pregnancy.

Her daughter is now 4 years old and goes to Kindergarten. The 32 year old mother thus has some spare time for training.

She especially enjoyed the courses "fat burner" and "kill your calories", although at 1.72m and weighing 67kg she was within the normal BMI evaluation scale (22.5). However, Katie had her own ideas and wanted to finally work on herself a bit more.

After finishing school she hadn't done sport regularly, a bit of cycling, but more as a recreational pursuit with friends. In the past few years she had sometimes done some in-line skating in the park, but also more to improve her mood than with a certain goal.

The fitness studio was thus an exception. Here she was able to take on something, try out various pieces of equipment and really put herself to the test. One wants to make a good impression in a place where so many people meet each other!

The trainers don't have much work with her. She works very independently, allows new functions on the treadmill to be explained, but then gets on and shows what she can do.

She ignores the pulse readings on the display, the colourful graphics and the calorie tables and trusts her body's feelings as a "power woman".

"165 bpm" and more blink on the display but she thinks: „One has to feel something in training, otherwise it doesn't do anything" - and many other people in the studio share this opinion.

However, her training hasn't done much for her yet. Sometimes she is a few pounds lighter but then they are soon back. She doesn't seem to be getting anywhere and she is slowly becoming dissatisfied. It all costs time and money!

She gets hold of a trainer and relates her problem: How she is so diligent, which courses she has taken part in etc., but when the trainer asked about her real goal, she can't think of an answer.

Hmm, to be somewhat slimmer and fitter. She is unable to answer the question about the training plan and heart frequency. Now the trainer asks another question: „Do you want to trust me or your feelings?"

What follows is a painful parting from old habits. Mondays in the beginners group, Wednesdays in the advanced group (but only because the timing was better) - that has to stop, like the extreme workouts which brought her out in a real sweat and put her on a high. The trainer took a piece of graph paper and started to explain the basics to her. He is like a boring old teacher, Katie thought.

But the more she listened and looked, the more it became clear what had been wrong with her training up to now.

Pulse, body performance, energy availability and use: Katie had heard that before somewhere but didn't think it applied to her. She had probably achieved her goal and beyond it through her intensive training in the past months, she thinks!

The most important thing now was to determine which basic parameters Katie currently had. When the trainer asked whether she can stand the sight of blood and gives her a small instrument - she laughs:

She knows about this lancing device from her grandmother who had diabetes and often had to measure her blood sugar level. A little prick in the finger is hardly going to hurt.

The trainer carried on and explained the background to her. The fitness studio had been working for a long time with lactate diagnosis in order to determine the optimal training heart frequency of the customers. Many people still think that the rule of thumb "pulse 130" or "180 minus age" is sufficient orientation. Katie realised that she hadn't oriented towards anything up to now.

She saw 2 curves on the graphs that were shown to her: „Those are the performance data of the Wright-twins, who train here" said the trainer.

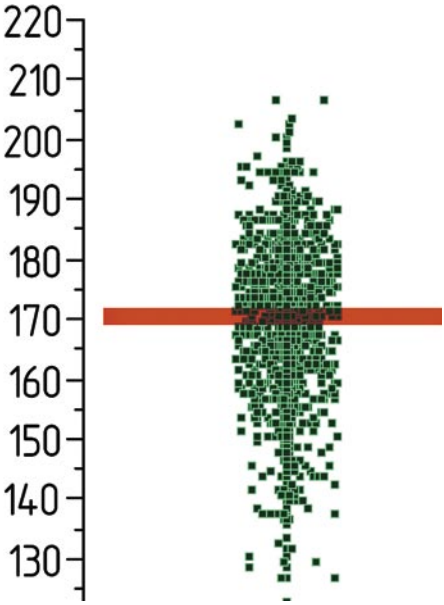


Fig. 23: Heart frequencies of 30-years-old men at the lactate threshold (red line = „200 minus age")

Anita and Beatrice Wright: Same age, same weight, same sporting ambition and the same "ideal pulse" – one thinks! The lactate test showed, however, why the two of them were not getting ahead:

Whilst Anita's pulse always remained under her potential at 140, Beatrice's lactate values increased considerably at the same pulse rate. During training Beatrice used almost only carbohydrate and her fat metabolism was not used sufficiently.

Now with a training pulse of 128, Beatrice has become slim and Anita now jogs on the treadmill with a pulse of 145.

The trainers were also impressed with

the results. The handy “Lactate Scout”, which was used for lactate diagnosis in the studio, was soon followed by a piece of proper laboratory equipment, an EKF Biosen. More and more studio guests wanted to have a lactate test made for a diagnosis of their performance as well as to calibrate their pulse watch.

Fig. 24: Lactate lab analyzers are preferred where many analyses has to be performed

For a first impression a simple method was sufficient for Katie, a good value fitness check for 40 Euro. Instead of the usual step tests she had to pedal on the ergometer for 15 minutes at a stable rate - using the old formula “pulse 180 minus age”, minus 10 strokes for cycling.

Katie worked it out, noted pulse 138 and started pedalling - the first 5 minutes at a pulse rate of 125 to warm up, before building it up to 138. Then came the lactate test.

Katie’s finger was washed thoroughly clean, disinfected, dried and then - well, Katie was supposed to prick herself! She had seen how professionals were pricked on the ear to give blood on TV. But the “Lactate Scout” only required a little drop of blood and Katie should be able to measure her own lactate value without outside help.

She held the lancing device with her fingertips and “click” – that was it! Her trainer wiped away the first drop of blood in order to collect the second small drop with the Lactate Scout.

It didn‘t hurt and was an easy, clean process! After a few seconds the analyzer beeped and the value was shown: 2.2mmol/l. Aha, and what does that mean?

Varying with the general condition the lactate value should lie between 1 and 2 mmol/l without stress - after a meal, in the case of a small infection or stress it can be somewhat higher. When the body is then put to the test, the lactate value increases slowly or quickly, depending on the strain applied and the performance capacity.

At around 2mmol/l the strain is obvious but not critical. At 2.2 Katie lies slightly higher - and that at a “boring” pulse rate of only 138 beats per minute! Katie thinks about the information on the treadmill display. With a pulse of 165 she must have been extremely “sour“!

The trainer’s assessment and his recommendations are very clear. Katie’s goals:

1. Improve her condition (basic endurance)

2. Improve her aerobic energy availability (fat burn)

Training in hand

Katie wants to keep on taking part in the courses. The trainer thus advises her to select the courses depending on their grade of difficulty and strain intensity.

After the test results and taking into account her aims, it won't make much sense for Katie to carry on going to a course where she trains with such a high pulse. Her training plan for the next 3 months is as follows:

1x per week spinning beginners' course, maximum pulse rate 140

1x per week aerobic or step at a medium level and maximum pulse rate 150

When she has time then she can go to the "style your body" beginners' class with a maximum pulse of 140. In this course exercises with light weights are practiced, accompanied by gentle music in order to strengthen the muscles.

Since participants in the spinning class are required to have a pulse measurement device, the studio offers a range of Polar-watches, including special "ladies" models. These watches are not only chic and well-made but also incorporate all the functions, which are sensible and useful for Katie's training. My husband has a suitable birthday present for me after all, thinks Katie...

Oh, yes, her birthday is in 4 weeks time! Whether one will already see the first changes? The trainer has to disappoint her: In this time period her condition will improve and the fat burning will increase but the external effects are only revealed after a few months. One has to be patient, there is nothing to be won by being over-ambitious.

So, three months, the lactate test should show the first improvements by then at the latest. The result should also provide the basis for the new training season in spring when the in-line skates can be put on again.

Fig. 25: Heart rate monitors from POLAR are available in various designs and colours

However, first the current training plan has to be put into practice. In the beginning Katie is unsure and has to keep looking at her pulse watch; she slows down as soon as her pulse nears the desired level. She completely loses the rhythm.

Her pleading look for help is noticed by the trainer, who has a good idea. He attaches the watch to the handle so that Katie doesn't have to keep turning her wrist to look at it. Her heart frequency is also re-programmed.

She had programmed the upper level exactly but had not put in a lower boundary level. Thus the pulse watch had noted this with an energetic beeping, which she had turned off to refrain from annoying other people in the studio. Once set up properly Katie is able to really enjoy her Spinning class: She is able to go at her rhythm - no, that is not quite right,

she goes at the rhythm of the music of course, but at her own level of difficulty. This is selected so that her pulse stays in the goal range of up to 140.

Even when her pulse goes slightly above the range aimed for she no longer gets worried since it normally falls back on its own. Otherwise it helps to regulate the resistance of the bike.

She also tested the selected aerobic and step courses using her pulse handicap. She can use her pulse watch to improve the management of her own performance and is also no longer completely exhausted after the courses.

Strangely, she also notices that in the rather calmer “style your body” class her pulse goes up, sometimes over 150. Her pulse remains in the upper levels, even with the lighter weights.

She learns that this is normal for weight training and in the beginning she can leave out a few exercises. Thus her body will be able to recover and her pulse will sink.

Katie now takes more notice of what the other people in the fitness studio are doing and often is reminded of how she first trained. Should she give them a tip? No, the trainers are there for that...

Someone passes by her, also with a small Lactate Scout in his hand and stops near a rather large woman who is walking slowly on a treadmill: Not really the type for professional performance analysis?

That is exactly what it is about, explains her trainer later. It is especially difficult for very overweight people to find the right line between under and over challenging themselves, just by using a pulse test.

The heart beat frequency is dependant on a range of factors and when health matters also come into the equation a lactate test is the suitable method in order to establish a suitable individual training pulse.

The winter passes quickly and with the first warm days of April comes the next test for Katie. Katie, her friend and her trainer have organised a special meeting (initiated by the studio). Other in-line skaters from the studio have also heard about it and want to come too.

The group meets at a nearby car park which can be reached by two routes of varying length and difficulty. Two trainers have also come along, each armed with a Lactate Scout.

The skaters are sent off at short time intervals. Each should skate for 15 minutes at their usual speed and then come in for a short pit stop.

Katie skates together with her friend, each with their own pulse watch. Katie tries to keep to the handicap given, which proves difficult as her friend wants to speed ahead.

When they come in for their check it is nearly like at the beginning of her training:

Katie's pulse is 152 and her friend's is 158. Their lactate values show a similar pattern with 3.1 and 3.6 mmol/l.

„I am better" boasts Katie's friend, but is quickly admonished by the trainer: "Take the speed down, skate more gently and then come for a test again." 15 minutes later the all-clear comes. Katie's pulse is once again in the green zone as is her lactate value at 2.2 mmol/l.

It is a good sign when the body recovers so quickly. Katie's friend's values did not sink so quickly (and she also doesn't look so good around the hips, thinks Katie to herself).

Satisfaction, amazement and interest: The group's reactions are as varied as their values, which most of them did not know the meaning of. For most of the hobby skaters the test clearly showed that they move mainly in a very intensive stress region at the upper levels of their aerobic energy availability.

„What is your goal?" - to think about this question is the last task that the trainer gives to the group.

There were also some records made: The "winner" had a lactate value of 6.3 mmol/l after 15 minutes and felt "absolutely great" with a bright red face and puffing hard...

and already started with intensive endurance sports as a fifteen-year-old boy. He caused some sensations in the middle and long-distance athletic disciplines as a young boy from time to time. Many certificates and cups still decorate his office today. He would have got what it takes to be professional!

Since he did not want to commit himself to a certain discipline, he consciously took part in a variety of sports. Not only cycling and running but also soccer and tennis were on the schedule. Let us start at the beginning so that we can see how one (almost) turns into a professional athlete:

At that time Colin evolved into a perfect all-rounder with excellent endurance abilities. At the age of 26 he took part in a triathlon (1000 m swimming, 60 km cycling and 15 km running) for the first time and completed it in about three hours, with the swimming causing him the most problems.

Colin was nevertheless fascinated by triathlon so that he worked on participating in the „King's discipline", the Ironman (3.8 km swimming, 180 km cycling, 42 km running). This was his aim! In order to achieve this Colin trained in a very disciplined manner and according to a strict plan.

Of course a diagnostic investigation to determine his actual state was carried out before the training began. He undertook an ergospirometry on the bicycle ergometer to obtain information about his body's energy consumption.

Lactate values were tested at the same time to give him a complete correlation between his maximum performance and his aerobic and anaerobic energy supplies.

The diagnostic investigation was completed with a running test on the 400 m track the next day. The test results:

No question: Colin was already pretty fit - but with his 1.83 meters and 75 kg it would not yet suffice for the Ironman's high requirements!

Colin was ambitious, but he did not go over the top. He concentrated on increasing the amount of training at a constant intensity bit by bit. The running and cycling units became longer. If he was preparing for a competition in between, he changed his training.

Intensive units were added in the area of the aerobic/anaerobic threshold. Supplementary speed training and interval-running formed part of his training.

Colin attended some 10 km runs, took part in half marathons and 100 km bicycle tours. Normally he regarded this as a varied workout unit under competition conditions - but sometimes his ambition spurred him on!

The good time and the high placement then demanded an appropriately long break of two to three weeks, in which exclusively relaxed regeneration training was possible. Colin devoted up to 23 hours per week to the training now and also mastered long distances without being exhausted for days afterwards.

Now it was time to combine the performances and disciplines and also to exercise the changes. Still two months to go to his greatest challenge!

Regular performance diagnoses had helped him to be able to evaluate his current potential precisely and hence to draw up weekly and monthly training plans. The time passed by quickly. Colin intensified the training once again for two weeks to be able to regenerate completely afterwards for the last few days before the competition.

One thing was also important aside from the sports training: At all periods of strain during the competition he would need to remain loose and take in extra energy at regular intervals.

Colin would use up 10 to 12.000 kcal during the Ironman, provided he crossed the finishing line.

Certainly, a considerable part of this energy would be delivered by the body's glycogen-(sugar-) and fat depot. If, however, he wanted to avoid hitting the wall, then he must supply himself with a lot of carbohydrates through gels and energy bars. Colin invested in a whole package ahead of time: „Apple-vanilla" was his favourite taste...

Fig. 26: „Power bars" are providing the required amount of carbohydrates for long distances

Saturday August 31st, 1996 8:30 am: Starting signal for the 3.8 km swim in the lake. Colin jumped into the water. After an hour and 24 minutes he got out of the water. Transition area, hectic rush, he cannot find his towel and his changing stamp. He looks around, disoriented, blow - this costs time! There, it must be that: Get into the cycling clothes and go. Cycling is a discipline which he is good at.

But somehow everything is different from during training. He does not get into gear and get going. His pulse is also far too high; actually he had a target of 148 for the bike. Okay, breath deeply once again, reduce speed and find a little group to cycle with.

This fortunately did not last too long – he was getting going now. Colin felt good. He even could enjoy the competition now.

He drank regularly and consumed his gels and muesli bars and everything went well. After 5:13 hours he reached the transition area once again, this time without being disoriented. Change shoes and then his best discipline: the marathon as a highlight of his first Ironman competition.

Fig. 27: Running, swimming, cycling - the triathlon is a matter of versatility

The transition into running was better now. He went at a good speed. The endorphins bothered him at times, but in a positive sense. Now, just don't get too excited, keep going according to your pulse! 155 and no beat beyond.

The kilometre details on the sideline flew by. Now had already been going for more than eight hours and the end was coming into reach - however the thought of stopping seemed to be nearer sometimes when Colin's motivation hit rock bottom.

„Why do I do this to myself?" This question buzzed around his head. A „downer", absolutely typical, and also for Colin nothing new - and nevertheless it was incredibly hard for him to fight against the inner resistance. Gradually Colin's will prevailed, and the answer to the „why" came soon.

The finish was almost in view now. One more turn around the corner in the village and then the endless home stretch. Simply keep on going, no final spurt. Ten thousand were at the line, cheering and applauding. The answer rushed into his mind: This was it!

The feeling was incredible. He was having an inner conflict: Go slower to savour the moment or give everything and sprint to the line? The moment he reached the finishing line with sparkling eyes and arms in the air is resplendent as a photo behind his desk. This was the answer...

He had found the answer at 18:44, that is ten hours fourteen minutes (and eighteen seconds) after he had jumped into the 21°C cold water in the morning. Even if he had hoped to be able to be under the ten hour mark - this did not temper his delight and his success in the least.

Colin is not somebody who rests on his laurels: At the age of 30 he managed to qualify for the Ironman on Hawaii - the „Mecca of the triathletes"! Colin had perfected his training already and his dream finally came true in Hawaii with a personal best time of 9 hours, 21 minutes.

This is some time ago now. Profession and family came to the fore and at some point he had lost the contact to sports completely. Four years break - then the old ambition came back.

The Ironman had taught him respect, despite his success, but a triathlon should remain a realistic aim for somebody like Colin.

Goal of the training

Colin has planned exactly one year's preparation for his triathlon comeback - if the time is not sufficient, he will postpone the competition deadline.

He knows from experience that the training does not always go according to plan and that aims cannot always be adhered to, due to injuries or illness.

He remembers well the preparation for the Ironman. At that time, he was probably so successful with his training (rarely getting ill, no injuries), because he had regularly carried out a performance diagnosis and kept exactly within the specifications. So he wanted to do it this time, too.

As Colin already has concrete ideas about his training and his training methods (in the beginning mainly basic endurance and thus optimisation of the lipo/fat metabolism), he first goes to a sports medical institute.

The full program is passed through: Endurance performance diagnosis for running and cycling, heart frequency, breathing gases (oxygen intake and carbon dioxide output) as well as lactate analysis.

The lactate values can be used to define different training intensities e.g. basic endurance training until 3 mmol/l, competition range 3 - 5 mmol/l and top level range above 5 mmol/l lactate.

These statements are, however, rough standard values and differ according to sport and discipline. For each sport, an individual diagnosis is necessary because the respective intensity ranges of the training methods deviate from one sport to another.

Since he wants to improve his swimming technique and train less intensively in this discipline, he does not want to carry out a diagnosis for this.

He carries out the performance diagnosis in running, as well as in cycling, under two aspects: On the one hand he would like to test his current performance and on the other hand his individual training ranges.

Therefore he can even use his own racing cycle now: With dismounted wheels, it is easily to clamp into the new Cyclus 2 and to convert in a high-professional bike ergometer.

Colin gets precise details about the running speed or bike wattage as well as the heart frequency ranges of the different training methods as results of the performance diagnoses. The lactate va-

lues are again an important tool for him - not at the beginning stages but during the further course of the training.

In a detailed conversation with a specialist the results of the diagnoses are analysed and the future planning of training co-ordinated with regard to Colin's limited time budget.

An ambitious plan - if Colin gets through the training sections according to plan he will make progress quickly. In the course of his twelve month preparation at least one further performance diagnostic test is necessary, in order to

a) control and to test Colin's development, whether his training is being successful or if it requires any adaptation, as well as to

b) re-determine his individual training ranges to guarantee that he continues to train within his optimum intensity ranges.

Fig. 28: The CYCLUS 2 converts the own bike into a very individual and very professional ergometer

However despite his very professional planning Colin realises that his body does not always react as he wants. Frequently injuries or problems of the muscoloskeletal system are caused by increasing training too quickly and by overstraining.

Excessive training loads can lead to a weakening of the immune system as a result of over-acidification, which makes the body especially susceptible to infectious diseases. This explains why in an internet-survey of triathletes one-third complained about having permanent colds!

Therefore Colin plans to react prematurely to signals from his body. He will clearly reduce his training or take a break as soon as he notices warning signs. Only that way can he be sure that nothing happens to set him too far back in the training.

Performance under control

The body has a good memory, and the brightness of Colin's glorious days is not clouded at the beginning of the training. Although Colin has gained 6 kg in the last few years, he has still retained his good pre-condition and is in top condition compared to a „normal-mortal".

What he can read already from the data, (apart from the naturally strongly reduced absolute performance) is the clear movement of the active lipo-metabolism downwards, into lower intensity ranges. Improvement of that part therefore will form the priority aim of his training units.

Through a so-called basic endurance-training Colin specifically improves his lipo-

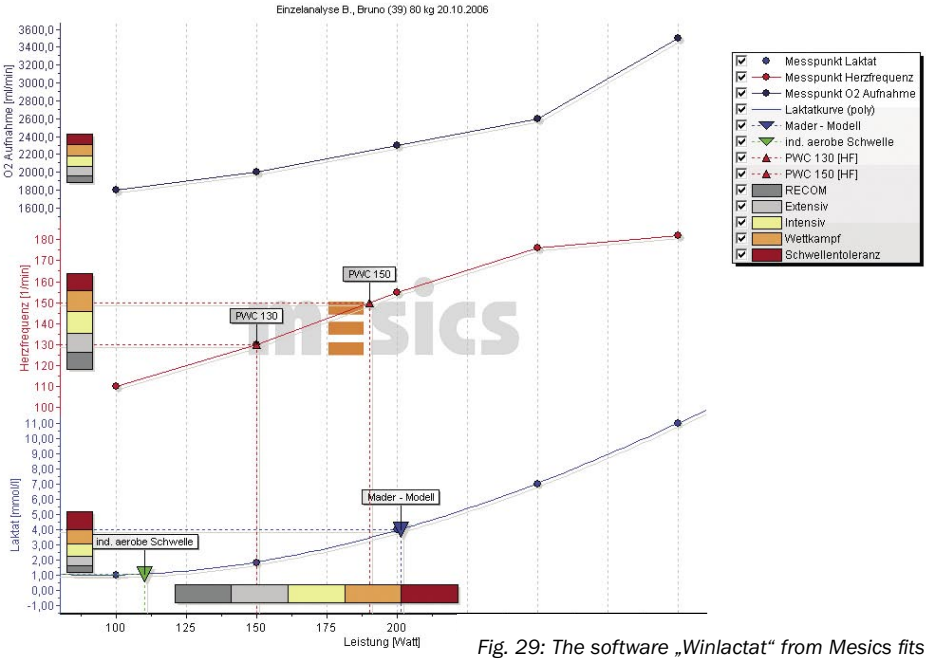


Fig. 29: The software „Winlactat“ from Mesics fits to a wide range of analyzers and ergometers

metabolism, which is of great importance for very long endurance disciplines. As already described in the physiological basics, the lipo-metabolism is involved decisively in the provision of energy through the limited carbohydrate supplies or glycogen supplies and is therefore also a decisive performance factor in the triathlon.

The aim is thus to utilise the body‘s stored energy „fats“, which, even in a slim person amount to some 10.000 kcal, and optimise this use into the high intensity ranges, so that the carbohydrate stores are not consumed so fast.

Colin will start with a very moderate training: One hour of running once a week in the optimum lipo-metabolism range with a maximum heart rate of 129, one hour of swimming (without specification, only to get into it again) and 90 minutes cycling at a heart rate of 120.

He can take it easy. Athletes, who intensively practiced endurance training over a long period in the past, find that training progress and performance development takes place more quickly after long breaks from sport than in untrained people.

It is to be expected that Colin will reach a performance level within ten to twelve weeks, which permits him to carry out four to five training units per week with an increasing amount of training.

During this period, he set himself the target for the first time to train in each of the three sports at a constant, relatively slow speed.

In the further course of the training plan-

ning the development of sport specific skills and the training of the cardiovascular system at increased intensities then take centre stage. According to the current test results, his heart rate target for intensive basic training in running would be between 129 and 141.

Colin manages the initial training stages well. He gets used to the slow running speed, even if it is unusual for him. He really enjoys it!

Above all he also enjoys evaluating his results on his new heart rate meter, a Polar RS 800 SD, with the computer. The possibilities available to make a detailed picture of the training carried out are very impressive. Also the bike accessories are excellent: Speed, cadence, altimeter and a wattage display can be combined with the RS 800. As an „old timer", Colin is amazed: There has clearly been progress in the last few years!

The pulse watch (or better: The wrist training computer) is even able to exchange data with his mobile phone and Colin has also heard of special training software.

During the first basic phase there are no problems at all. Now he is starting phase two using increased intensities. For a specific training heart rate determination, Colin buys something else, which is new to him:

The Lactate Scout provides him with a lactate meter that he can operate simply in his hand. During his training he often takes it out of the belt case in order to get his values within 15 seconds, after a small prick in the finger, and thus can determine his optimum heart rate zones; again it is a device with a PC-connection!

Colin becomes curious and after a short internet search he found a low-priced software that works very similarly to the

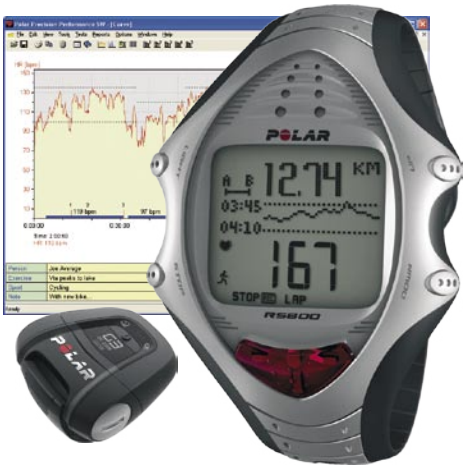


Fig. 30: Everybody tells a story - Polar's high-end heart rate monitors look deeper than others

professional system in the institute. Just geared to his needs and his budget! The „Lactate Express" software can select readings directly from the memory of both the Polar-watch and the Lactate Scout and can generate training plans - Colin's wife had already warned that now he would spend more time at the computer than doing his training...

Yet the warning is unfounded. Colin can run his 15 km within 1 ¼ hours without getting a reading of more than 2 mmol/l lactate.

The occasional step tests reveal another strange effect, which is sometimes observed in very well trained endurance athletes: During the first load steps the lactate values first decline and then rise only at higher intensities as expected. Such a „lactate buffer" occurs if the available lactate is metabolised for energy production in low load.

To rephrase it: Colin isn't stressed at these low levels yet. Vice versa, running or cycling slowly just shifts his metabolism to regular activity, including an elimination rate of lactate higher than at „rest". It's vaguely to imagine like a sports car: With a „cold" motor it needs more fuel than later with a „warm" motor, even if it's driven more slowly before.

At the beginning of phase „two" Colin changes his training somewhat - not least because the autumn had come with wet leaves and rain. Cycling on the roads now has become too dangerous and is no longer fun. For the coming months his plan is as follows:

1x per week swimming in the indoor swimming pool - technique and about 50 minutes slow swimming.

1x per week about 90 minutes with the mountain bike on the forest path, for as long as possible at a pulse of 125, above all after inclines and temporarily high heart rates.

2x per week spinning or treadmill training in the gym, in the intensive range up to a pulse of 141.

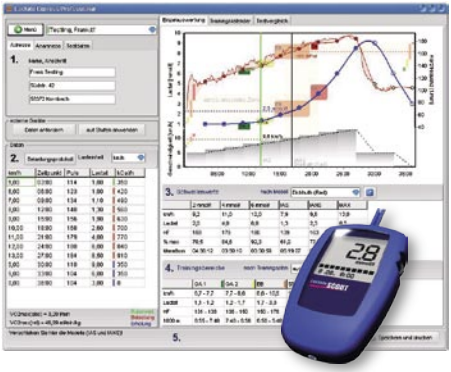


Fig. 31: The „Lactate Express"-software fits at best for personal use and ambitious amateurs

1x per week running training in the forest, long and slow, 20 km in almost 2 hours not over 2 mmol/l and a pulse of 130.

So Colin comes through the autumn well and the beginning of winter. His training now amounts to a good six hours per week. During the New Year Colin is on skiing vacation with his family – he has a break from training during these two weeks. Colin only insists on the morning lap on the cross-country ski run.

From mid-January it is becoming serious again and from February the amount of training increases to eight hours. The summer comes and the triathlon should finally be a full success!

That means an increase of up to nine or ten training hours per week in the spring. His colleagues at work shake their head sometimes - however Colin has the certain feeling that envy plays a little role...

He will train his specific power skills, e.g. through training units on slopes or in hilly areas, in cycling as well as in running. Colin also wants to integrate speed changes and high loads into the further preparation - at least, that is his plan.

The MP3-Player had just played his favourite song („We are the champions", what else) - he has to hear it again! Where was the right key ...? Colin suddenly stumbles and falls - nothing serious, but it aches.

Above all what hurts is the diagnosis the next day: Torn ankle ligament! The plan could not be kept. And the triathlon?

Colin discusses the changed situation with his sports scientist. Now it's essentially to stay trim - in its literal sense! Of

course, there are some physiotherapy appointments planned, as well as an unpleasant conversation with Colin‘s boss - but how can the training be arranged during the next six weeks? Running and cycling are not possible for the moment. However, there are alternatives:

1. Twice weekly aqua jogging to maintain his endurance performance – which seems to be rather below the Ironman-finisher...

2. Twice weekly one hour swimming to improve his swimming skills – however, without using his legs (they play a rather subordinated role in the swimming part of the triathlon anyway).

3. Complementary strength training for body and leg musculature in the gym.

Colin’s disbelieving gaze had not escaped the sports doctor. How soon can he become fit again with this plan? How will he manage to strengthen his leg musculature further in this time?

Colin gets a slip of paper in his hand, with which he should go to a special pharmacy. „Special“ means its additional portfolio for sportsmen: Besides band-aid and the newest kinds of power-bars and energy food there are also some preparations free of hormones available. They help to stimulate the metabolism and supports the body‘s regeneration. He can really do with that!

His second station is the sports shop, where he bought his other equipment before. When Colin asks the specialist supplier for the keyword „Compex“, he is immediately told about a special offer, running to the end of the month: Each device will be supplied with a set including electrodes and gel free of charge. „Sorry, what did you say?”

Colin has never heard about this and he does not like the thought of electrical surges at all. However, the specialist supplier calms his doubts. Electric muscle stimulation has been an approved procedure for more than 20 years to stimulate certain muscle parts, to strengthen them and to prepare for a higher load, also during training breaks.

„Without all this technology I would probably have had to forget the triathlon!” imagines Colin, hobbles home and familiarises himself with the device.

He feels a little bit queasy while putting on the electrodes and pressing the “Plus” key. This is how the Compex muscle stimulator is switched on and the same key is used to raise the stimulation current. Colin gets a fright: His muscles twitch as though they are „remote-controlled“ – this needs getting used to, but it is not really painful. After reading the instructions he manages quickly with

Fig. 32: Electric muscle stimulation helps to keep the muscles active even during training breaks

the different programmes and learns a lot. No question: Even when he is recovered he will still often use the Compex device.

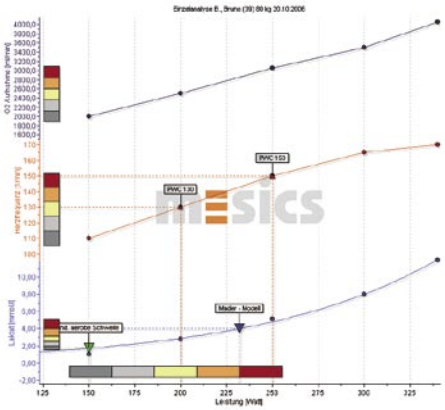
Although no training can really take place with this injury, Colin is still fully active – just differently. He puts into practice the tips of his adviser, makes progress in swimming and, thanks to the Compex, his leg musculature shows no weaknesses, despite the mandatory break.

The pump iron workout also contributes to his good overall state. The achievement losses caused by the fall seem to have had very few consequences! Now the last phase begins for the preparation for his competition. The date is fixed and four months remain. For safety‘s sake an entire achievement diagnosis with a lactate test in the lab and ergospirometry is carried out once more. The values are again top (see below).

The final spurt can begin. The training is raised to nine hours per week, 80% of it still in the basis area. For cycling the heart frequency increases from 120 to 135, and for the running from 127 to 138. Meanwhile Colin has increased his speed substantially, namely by an average of 0.5 m/s, related to the lactate values or heart frequency boundaries. He has also improved by about 15% in cycling.

Now there is an additional intensive cycle or running unit in weekly alteration. Then, two months before the competition appointment the main focus is laid on interval training and speed.

The intensity increases, and Colin thus reduces the amount of training. A unit per week in the very low intensive area serves the regeneration process and during the last week before the competition complete rest is required - again to the surprise of his colleagues: Why doesn’t Colin continue, has he suddenly lost interest?



However, a last-minute panic and the wrong ambitions would have spoilt everything. Supported by modern technology, well advised and optimally prepared Colin runs masterfully and is tenth in his age group through the finish. This inner happiness again, to have finished it, the applause and, yes - what a comeback!

Now the second photo hangs behind his desk. Visitors sometimes ask him about the pictures and whether he used to be a professional sportsman. Then he shows them with pleasure the date of the last photo...

Fig. 33: More than metal and memories - a good endurance workout safes top condition for years

6. TO CONCLUDE

6.1 Basic rules

Bill, Colin and Katie - three individuals with different goals and preconditions. The examples can be extended indefinitely, however the following rules and recommendations will apply to all of them.

6.2 Training is scheduled practice

Think about the type and method of your training. It is important here to define goals for yourself and plan the path to these goals.

Indispensable for this is the definition of your own individual pre-conditions: Not only in terms of time, but also finances, and most importantly in physical terms.

Carry out a performance diagnostic test with heart frequency and lactate values at the beginning of each new phase in order to be able to relate your goals appropriately with your current condition.

Many Polar watches have an integrated test possibility, like the “Ownzone” determination for recreational training. The use of goal zones such as this require, however, a certain degree of experience.

The same is true for performance diagnosis software for mobile lactate measuring devices. If you are unsure, it is better to get advice. Specialist dealers can explain the use of the various functions and carry out individual adjustments on the equipment. Ergospirometry examinations through a performance diagnosis service centre can provide you with further training data.

Using individual values to plan is decisive for successful training. These can be used to improve the planning of the regenerative phases, in which the body is able to adjust itself to the training strain. No break - no success!

6.3 Alone or in the group?

This question is often asked - and a reply that will suit everyone is difficult. In the end it is a question of personal preferences, although some of the following aspects should also be considered.

Have you got a sporting (ambitious) goal? When yes, then you will probably be rather restricted to certain amounts and intensities through your training plan. It would be a big coincidence, when this plan also suits several other athletes just at the same time.

However, there are possibilities to meet up for training. When two or three sports persons want to carry out their low intensity basic training on the same day, then it is also possible in a group.

The prerequisite is that the sports person with the lowest intensity sets the pace, independent of whether or not the others have already reached their own zone. A basic rule is that beginners should not train in a group with advanced sports people, as their advisable training zones lie too far apart.

This piece of advice is particularly valid for cyclists: Often ambitious group members tend to race against each other. When a beginner or less-well trained athlete is part of the group, they are often pushed quickly over their own limit. The group dynamic results in something

quite different: Goodbye basic training! Intensive units or speed training are difficult to carry out in a group, since the initial training stimulus varies from one person to another.

At this point a word about the courses offered in fitness studios: The experience and newest scientific studies show that impressive names such as “fat-burner” do not often include that which they promise. In many cases the intensity is too high. This is particularly true for so-called “indoor cycling” or “spinning”.

Reasons for the often incorrectly chosen intensity for a single participant are, on the one hand, a lack of information and, on the other hand, the inviting dynamic of the music and the trainer.

It is a special art to be able to influence each participant and to allow each person to keep going within his/her optimal strain intensity, which only few studio trainers manage.

When you want to train successfully in a dynamic group with an animated atmosphere then you have to be clear about your training zone from the start.

When you cannot or don’t want to determine this yourself, let an experienced trainer draw it up for you and then keep to it. If in doubt, it is better to decide go down a gear for a training unit...

6.4 Good health takes priority

This should be obvious! Unfortunately there are always cases where sporting activities start badly and cause health problems.

We don’t mean the potentially dangerous sports here, which pose a health risk (and which are also named on a certain list by health insurance companies). Incorrect ambition, lack of knowledge and recommendations from so-called specialists can also pose a health risk.

The same is true for unhealed illnesses or injuries. For instance a dragging cold can, in the worst case, lead to a life-threatening heart-muscle infection.

Pulled or torn muscles, sprains or pulled ligaments need specialist treatment. Allow yourself time!

As an ambitious athlete, you probably cannot risk a serious illness, which might affect your job. The wrong training does not promote good health and can cause long-term ill effects.

6.5 Listen to your body

The human body is a marvel of nature. Only with trouble (or force) is it possible for us to get around its self-preservation and protective mechanisms.

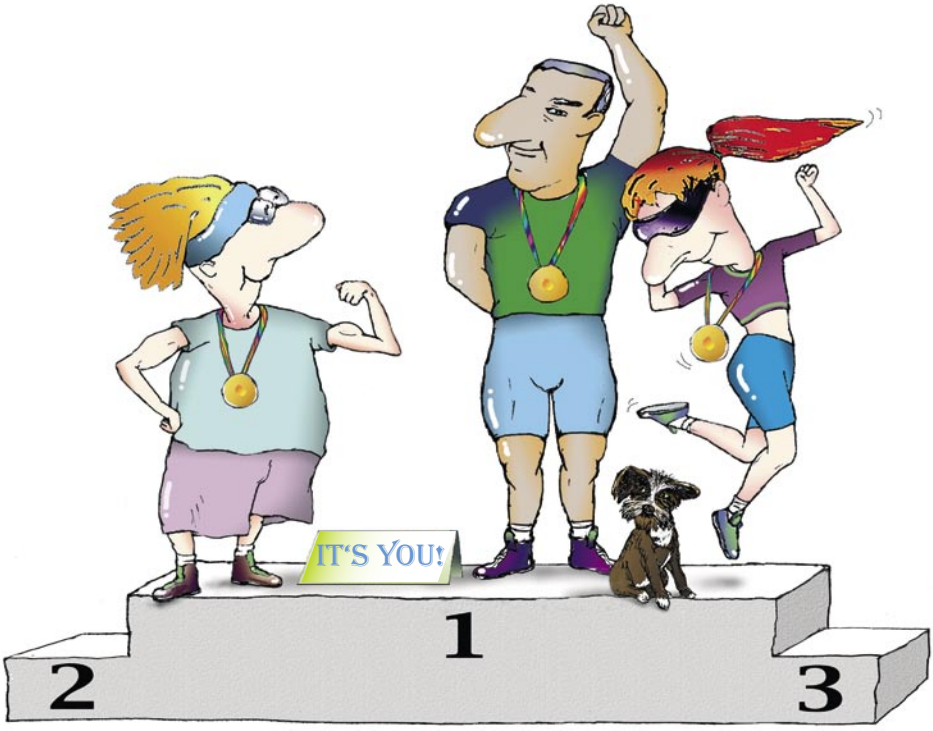
Training is a sensible method to keep the body in form, in line with its natural conditions, and to move it towards a positive development. Here the basic rule applies, as overall: The dose alone makes the poison.

Weakness, tiredness, lack of energy and pain, as well as being side effects of a real illness, these can also be signs of too frequent and too intensive training.

Don’t try to do your best each time. Also enjoy a training unit in which you recharge your batteries. Listen to yourself and learn to understand your body. It provides you with the important signs.

Use the modern technical aids to “translate” your body’s signs. The possibilities have never before been so varied nor the performance diagnosis so easy and cheap and usable in a wide varieties of sports.

Get informed and use your chance to take the upper hand in your training - we wish you the best of luck!



6.6 Your personal training plan

You don't yet have a training plan and also no expert around? Then you can work first of all with an easy training plan as described here: you will find an example to copy on the last page of this brochure.

A „3-week-plan" like this is recommended in order to avoid setting the training goal too high at first - and possibly to lose sight of it at the end. Two or three of these plans should suffice in order to work out a previously defined training phase.

Consider which sport or type of training fit your goal and are easy to access: Is there a fitness studio or swimming pool near you, or are there suitable running courses and bike paths? Can you install a stationary bike in your house or flat? The more work it is, the less chance you have of keeping up with the training!

For each plan put down a low, medium and high intensity type of strain and time period. The medium intensity should be chosen so that it can be carried out „on good and bad days".

Depending on your personal situation and estimation you can of course combine several units on one training day. It is then advantageous to combine different types of sports/loads, for instance to jog to the swimming pool or to carry out a few exercises with a dumb-bell before you use your home trainer.

The more varied the training stimulus is, the more comprehensively the individual muscle parts and the whole metabolism will be strengthened.

Apart from the regularity of training, your personal impression is also important: Did one of the training units suit you well or very well, or was it rather an unpleasant strain? Make small notes in order to document the development: The plus or minus on each separate day shows you whether you are on the right path or not.

A simple comparison of measurement data at the beginning and end of each training phase helps here: Test yourself with a moderate strain level, for instance half an hour on your stationary bike, remaining at 100 Watt, or less when you don't feel so fit.

The main thing is that the test conditions and strain are identical so that they can be compared with one another.

As soon as the test has finished note your current heart frequency and carry

kg / height	160	165	170	175	180	185	190	195	200
50	20	18	17	16	15	15	14	13	13
55	21	20	19	18	17	16	15	14	14
60	23	22	21	20	19	18	17	16	15
65	25	24	22	21	20	19	18	17	16
70	27	26	24	23	22	20	19	18	18
75	29	28	26	24	23	22	21	20	19
80	31	29	28	26	25	23	22	21	20
85	33	31	29	28	26	25	24	22	21
90	35	33	31	29	28	26	25	24	23
95	37	35	33	31	29	28	26	25	24
100	39	37	35	33	31	29	28	26	25

Fig. 34: The „Body Mass Index" (BMI) indicates if the relation of body height and -weight is in the „green" standard range or if there are critical disproportions.

out a lactate test, carefully and without stress. Reliable lactate levels can be measured within the first 3 minutes after the end of the period of strain before the breakdown of the lactate becomes noticeable in the results.

If the lactate level lies over 5 mmol/l at the beginning of the training phase, then the strain has been set too high: Reduce the Watt level (or running speed or distance, depending on the type of strain) and repeat the test at this level on one of the following days.

Take care that you don't eat any snacks or rich meals before the test. Diet or exhausting training before the test can affect the values as well.

When everything is carried out properly, you will already notice an improvement in the test results within three weeks of a training phase:

At the same strain your heart will beat more quietly, the lactate values will rise more slowly and you will feel less exhausted than at the beginning of the training. This serves as motivation and you can build up your training further step by step.

It is fascinating to experience how your own capabilities change, slowly but surely.

In order to share this fascination, as well as the experience and specialist advice with others and to improve the evaluation there are now solutions available for mobile phones and the internet. The measured values flow into a personal training diary and can be transferred, for instance, to a personal trainer.

Name: Patrick Callander Date: 7. Feb. 2008

BMI: 22 Target: Better endurance Phase: 1 .2

Weekly workout times:

Low level: 45 min, kind: Stationary bike

Medium level: 45 min, kind: Jogging

High level: 30 min, kind: Weight training

When did you perform the workout, and how did you feel („+" good, „-" bad)?

Intensity/date:	10.2.	12.2.	15.2.	19.2.
Low	++		++	
Medium		+	o	+
High				

Intensity/date:	21.2.	24.2.	28.2.	1.3.
Low		++		++
Medium	+		++	
High	--	o		+

Control check on the ergometer with: 100 Watts after 30 minutes

At the beginnig of this phase: HF 151 bpm, 2,9 mmol/l lactate

At the end of this phase: HF 142 bpm, 2,5 mmol/l lactate

Target definition for next workout phase: Increase duration

© Training in your hand, Society for sports and performance analysis (SOSPA.net)

Fig. 35: For the beginning fits a simple training sheet (Master copy in the appendix). Additionally, modern websites offer various options for a professional documentation of workout and analysis data by PC and mobile phone.

6.7 From my practice as a trainer

Mathias Kummich, born in 1963, is a founding member of the Light Athletic Centre (LAZ) in Leipzig and has worked successfully for many years as a running trainer. He trained many people, including his daughter Juliane, who won the 1500 m Youth Championship in hurdles. Apart from other medal placings in the German Championships and the European Cup win in shot-put by Peter Sack, one of the many references of the LAZ is also the Vice European Championship title of the hurdle sprinter Thomas Blaschek. Apart from the best athletes, the LAZ also concentrates on building up young people. Due to the costs involved the equipment available remains modest: Some Polar watches as well as two Lactate Scouts comprise the tools available for the accompanying performance diagnosis.

Most people, who come to us, are full of ambition and highly motivated. We trainers are thus seen as spoil-sports when it comes to being realistic and working on long-term goals: A significant improvement in performance, e.g. in only 4 weeks is not possible, and, almost always, other goals such as weight loss, economy of breathing and general endurance have to be brought to the forefront first of all, before one can think of partaking in competitions.

We are very strict that the fixed training plans are also carried out. Too much enthusiasm in the beginning phase usually leads to the body becoming used up too quikkly: The training becomes increasingly uncomfortable, training is disturbed, breaks in training occur and frustration sets in, which is difficult to get out of and get going again. “Less is more” is the golden rule - it is better to carry out short training units of low and medium intensity, but more frequently and more regularly. One should plan three days in the week for training, in order to assess oneself better.

The measurements of pulse and lactate levels are helpful, and provide us with supplementary information, when it comes to the judgement of the strongly different performance levels of individuals. When for one athlete the heart frequency hardly rises, but the lactate level shoots up clearly, the pulse of another athlete can rise to over 160 without the lactate levels rising much at all. These measurements are decisive for us, since the selection of the correct strain level requires a fine feeling: On average each higher strain level should cause an increase in lactate level of 0.5 -1.5 mmol/l as well as 10-20 heart beats per minute, if this is not the case then the steps, or the test raster selected, is too big or too small.

Especially with amateurs we often come across the phenomenon that is rarely mentioned in sports medicine: At the beginning of a step test we measure a high value over 2 mmol/l, which then sinks after the first strain and first in the further course of training builds a typical lactate curve. Phases are also common in which, despite the increasing strain, the lactate values remain stable in the lower boundary levels for some time: This signalises a good condition and is often the first sign for successful training. A computer performance prognosis then delivers the last kick for the further training goals!

6.8 Fit recipes

Can the menu become part of a training plan? Suitable nutrition certainly belongs here if health, fitness or performance ability are to be improved. However, not everything which is taken as healthy or "typical" sport food is automatically the right choice:

For instance a marathon runner would have to eat 400 lettuces instead of partaking in a high energy "pasta party" in order to obtain the required energy store for the competition.

The training phase that one is in and the goals being followed are also vital for assessing the correct, or appropriate composition of meals.

Basically athletes require more energy than less active people: One can obtain energy easily from carbohydrates instead of from sugar, for instance from potatoes, rice or fruits.

Fig. 36: Potatoes provide perfectly with carbohydrates for energy-intensive competitions

One can help a lot by drinking enough: Often people drink too little and the wrong sorts of liquids (such as coffee, black tea or alcohol). Two litres of mineral water a day sounds a lot but is important for a healthy metabolism. Have a go and see what happens!

Fig. 37: The tasty „Low Carb"-pizza feeds the muscles but not the hips

Low-Carb pizza:

200 g turkey breast in slices, 100 g tomato paste, 70 g mushrooms, 1/2 red paprika, 2 hearts of artichoke, 30 g grated, low-fat cheese, oregano, salt and pepper.

Lay out the turkey breast slices closely on a baking sheet, butter it with the tomato paste (spiced in advance). The mushrooms, paprika and artichoke have to be washed, cutted and overlaid, added by the grated cheese. To bake 15 - 20 minutes in the oven at 250 degree Celsius.

Nutritients 367 kcal, 10 g fat, 7 g carbohydrates, 58 g protein, 13 g fibers and 0,6 BU.

Oven potatoe with poultry salad:

100 g chicken breast fillet, 1 big oven potatoe, 1/2 green onion, 1/8 pineapple, 1 tablespoon maize, 1 cm ginger root, 4 tablespoons yoghurt, 1 teaspoon oliva oil, 1 teaspoon curry, salt and pepper.

The potatoe has to be buttered with oliva oil and to bake 60 minutes in the oven. Wash and cut the fruits and vegetables. Cut the chicken fillet and fry it 5 min. Fill fruits, vegetables and fillet with the meat juice into the dish. Peel the ginger root and hash it up (or use a garlic press). Mix it with yoghurt, curry powder, salt and pepper and add it to the dish finally. Put the dish into the fridge for 30 min. Cut the baken potatoe along and serve it with the refreshing poultry salad.

Nutritients 400 kcal, 7 g fat, 50 g carbohydrates, 29 g protein, 7 g fibers and 4 BU.

7.1 Products in practice

Most sports equipment manufacturers offer different product series for the respective target groups. Here it is not a matter of the number of features, or the price but rather combining the equipment to suit the required usability.

For a beginner like Bill it would be a mistake to choose the cheapest and simplest model. Instead care should be taken that it is easy to use, has a clear and comprehensible display and comes with understandable instructions. The first steps in training are often the most difficult and a cheap product is also a waste of money if it is inappropriate and remains unused.

Unlike Bill Katie can make use of a considerably larger „basket of goods“, since she knows now what she requires and which advantages certain functions offer. Since she is doing sport in the studio and in a group more frequently than Bill, she uses the different possibilities for on-site tests more regularly. She uses the equipment with friends and attaches great importance to compatible accessories and attractive design.

Colin is technically very well prepared with the newest technology, and he is also familiar with their proper operation - however the most important factor for an athlete is his constitution. Recreational activities and computer based training planning help him to succeed, despite time limits.

Here are our recommendations:

Exercise bike

A stationary bicycle is the favoured solution for training at home. It is important to have a speed-independent ergometer with an eddy current brake and adjustable saddle, pedals and handlebars. Pulse watches with a chest strap are more suitable and reliable for monitoring heart frequency than earclips.

Running shoes

Never purchase these without a „test run“! Particular attention has to be paid to sufficient cushioning for the protection of the musculoskeletal system. Good shoes provide the foot with the required stability. Qualified dealers offer running analyses and orthopaedic shoe lifts.

Electrical muscle stimulation

Whether for tensions, pains after training or to simply keep the muscles in shape: There is a wide range of muscle stimulators e.g. from Cefar-Compex with various stimulation programmes for everyone‘s need. A doctor or qualified specialist dealer can provide advice on their optimal use.

Heart rate monitors

The “hidden” qualities are particularly decisive here. One could not expect to be able to carry out a precise ECG measurement of the heart rate or the determination of individual training ranges („own zone“) with a watch from the supermarket. Attention has to be paid to a coded transmission of the heart rate signal so that no outside waves disturb the signal. There are now textile chest straps available which are pleasant to wear and easy to wash, too!

Sports trips

Mix business with pleasure - sports trips are becoming more and more popular and offer various programmes from Nordic Walking beginner courses, running training and bicycle-programmes up to professional triathlon preparation.

Performance analysis

Go to the sports’ physician or „measure it yourself“: Why not both? Devices like the Lactate Scout are easy to operate and the professionals will help you with the detailed evaluation.

You are a doctor, coach or head of a gym and would like to offer or improve your performance diagnostic tests? We have some advice here for professional equipment:

Treadmill

Which applications do you plan for which target groups? If you also want to test ambitious athletes, you need a treadmill that is of sufficient size (1.70 m x 0.65 m) and has a well cushioned tread. The adjustable speed should be more than 20 km/h. On the website of the treadmill manufacturer h/p/cosmos it is possible to compile individual configurations using a qualification profile.

Whenever you as a doctor intend to balance diagnostic performances with cost units, such as health insurance, you should use a treadmill that is authorised by the Medical Device Directive (MDD IIb). This regulation is also valid for a:

Bicycle ergometer

Here attention has to be paid primarily to individual settings so that the efficiency is not limited by unfavourable handlebar or seating positions. As an worldwide established full-line supplier for bicycle ergometers the Swedish manufacturer Monark offers a wide range for GPs, gyms, sports institutes and top-level performance test centres.

A very special ergometer tool is the Cyclus 2 from the German company RBM: It converts everone's bike to a professionally equipped ergometer, including all individual settings and manifold analysis options in addition.

Abb. 38: Performance analyses are performed not only by doctors, but also by personal coaches

To be able to evaluate these meaningfully and be able to put these into practice in training the use of

Ergospirometry

makes sense for sure, especially to show the energy consumption. Besides decisive criteria such as running costs (due to regular replacement of the oxygen sensors) or maintenance, reliability, precision and the amount of software supported analysis options are also important economically for successful diagnoses. For many years the medical-technology accredited equipment of ZAN has set standards in quality and comfort use, particularly in sports medicine.

Lactate analyser

Try to estimate how many tests you will carry out. You can reckon with 5 -10 lactate measurements per person per step test or with over 50 measurements per person per year.

With a regularly large throughput of 40 frequent customers or 200 tests per month, the use of a compact laboratory device will make more sense economically compared to test strip systems. Due to its high precision and low follow-up costs the BIOSEN C_line and S_line devices from EKF have successfully proved itself in practice.

BIOSEN can be combined very well with the Lactate Scout hand-held meter, which is perfectly suitable for field tests and other on-site tests, as well as for the customer's self-test.

Analysis software

is available from different suppliers. Besides the most comprehensive and thereby flexible evaluation procedures, the possibility of integrating measuring and training technology also plays a decisive role. For professional use „Winlactat" from Mesics is worthy of consideration and has been approved by many performance diagnostic facilities:

Many treadmill and bicycle ergometer can be accessed directly via the respective PC connection, heart frequencies can be transferred by means of Polar technology and recorded as well as lactate values can be evaluated from Lactate Scout and Biosen directly.

Also available as update from the budget "Lactate Express" software, a special advantage of both software solutions is the opportunity to compile customer-specific test profiles and to analyse the individual performance development, as well as to have meaningful protocols and complex training plans drawn up.

Any questions?

All named manufacturers carry out regular training and information events or workshops, which provide you with detailed insights into the respective technology and its practical use. At their websites you will see announcements of such events as well as useful documents, tools and downloads for further information.

In addition to visiting the appropriate trade fairs and conventions it may also be advisable to look closely at existing performance diagnostic offers and to communicate with future colleagues. The dealers listed in the appendix can help you to find suitable adresses.

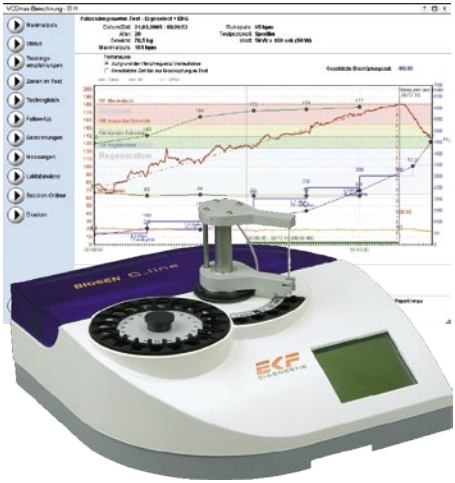


Fig. 39: Established manufacturers like EKF/SensLab, Monark, h/p/cosmos, Polar, Mesics and ZAN provide high connectivity between their products

7.2 What does it mean?

Adiposity - obesity: unnatural increase or build up of fatty tissue.

Aerobic energy metabolism - energy delivery processes, which only take place when sufficient oxygen is available (complete burning of fat and carbohydrate to CO2 and water. Very efficient, allows stress times of many hours at low to medium strain intensities).

Anaerobic energy metabolism – energy delivery processes, which are carried out without using oxygen (incomplete burning, thus inefficient, but allow very high performance for a short time. Burning of carhohydrate produces lactate).

Active movement apparatus – includes the whole skeleton, musculature and their tendons and ligaments.

Anaerobic threshold – strain intensity in the transition region between solely aerobic to partly anaerobic energy production. Shows the maximum possible intensity, where lactate production and lactate breakdown are balanced (max. lactate steady state). This is individual and does not conform to any strict rules, should be regularly re-determined.

Anti-Ageing – measures to positively influence the ageing process (not only externally, but also biologically and physiologically - see also arteriosclerosis, diabetes, blood pressure, cholesterol).

Arteriosclerosis - most common negative changes to the arteries, shown by hardenening, thickening and loss of elasticity of arteries. In advanced stages life threatening. Counter measures e.g. moderate endurance training and change of diet.

Arthritis - degenerative joint illness, mainly caused by imbalance between the requirements and constitution or performance ability of the separate joint parts and tissue. Regular individually suited movement can prevent or reduce arthritic problems.

Blood pressure – the pressure in the blood vessels and heart chambers, which causes the blood circulation and is dependant on the heart's performance and resistance of the blood vessels (e.g. elasticity of blood vessels.

Body-Mass-Index (BMI) - is calculated by dividing the body weight (measured in kg) by the square of the body height (measured in m). It is used to judge the body weight.

Cardio training – describes the training of the heart circulatory system, mainly

through endurance sports, also in sports groups or in the fitness studio.

Cholesterol - is made by the body itself and is also absorbed through food (mainly through animal fats). It is an important and vital building block for the construction of many hormones. In a high concentration it is seen as a risk factor for heart-circulatory diseases. However, the concentration of the so-called "good cholesterol" (the HDL - high density lipoprotein) to the LDL (low density lipoprotein), which is the main cause of blood vessel diseases, should be taken into account (recommended: HDL > 35 mg/dl, LDL < 150 mg/dl).

Coronary heart disease - the result of circulatory problems around the heart ring vessels. Main cause of heart attacks. Can be influenced by activity and moderate endurance training.

Dehydration – reduction of body fluid, caused by increased water loss (e.g. heavy sweating) without sufficient new intake. The flow properties of the blood are thus worsened and affect performance. Serious dehydration can lead to a circulatory collapse.

Diabetes mellitus - – sugar illness or damaged insulin sensitivity and thus leads to a disturbance of the body's metabolic processes. The most common type of diabetes (type II) can be caused by incorrect diet and a lack of activity.

Ergometry - measurement of the body's performance under dosed strain with an ergometer as well as the determination of various parameters of the heart-circulatory functions.

Ergospirometry – measure of the physical performance under dosed strain with an ergometer as well as determination of various parameters of the heart-circulatory functions and breathing.

Fat metabolism training – shows a very low intensive training for the optimisation of fat metabolism capabilities of the musculature. This vital basis is required in order to be able to build on it and be able to burn fat at higher strain intensities. Only in this way is it possible to obtain energy from fat during long lasting endurance strains (e.g. marathon) and at competition speeds.

Fat burning training - intensive training with a reduced percentage of the proportion of fat for energy availability. Overall, however, more calories are used.

Liquid balance - term for the water uptake processes, water distribution and water expulsion of the human body.

Glykogen - a type of sugar (polysaccharide), which portrays the stored form of carbohydrates. It is found mainly in the liver and muscles. During intensive endurance strain with almost 100% carbohydrate usage the stores supply an averagely trained sports person for a strain period of max. 60 - 90 minutes.

Heart frequency (HF) - gives the number of beats per minute, independent of age, sex, training condition, body temperature, stress and other environmental factors.

Heart frequency variability – measurement of a temporal gap between two consecutive heart beats in milliseconds. The grade of the temporal changes can enable information about the individual training condition to be determined. In many Polar models this is integrated **as** a so-called "Ownzone".

Hitting the wall – sudden drop in performance during sporting stress. It can be traced back to complete use of the body's carbohydrate reserves.

Hypertonie - High blood pressure.

Hypertrophie - Increased size of tissues or organs (e.g. muscle growth).

Lactate – salt of milk acid; lactate is the end product of glycolysis and is formed through the incomplete burning of glucose. This is the case when there is not enough oxygen available for the muscles during physical activity. The lactate concentration increases rapidly, e.g. during intensive muscle work (see anaerobic metabolism).

Maximum lactate steady-state (maxlass) - see anaerobic threshold.

Maximum oxygen uptake - the maximum amount of oxygen that can be taken up and used by the body during periods of strain.

Metabolism - the whole process of metabolism; build up, breakdown and transformation of nutrients.

Mitochondria - the „power stations" of the cells. The body's aerobic energy production takes place here.

Preventive – mainly prophylactic health measures to escape illness and negative changes.

Respiratory quotient - described as the relationship of exhaled CO2 to inhaled O2. Allows conclusions to be drawn about the amount and relationship of the burned fats and carbohydrates.

Stiff muscles - microscopic tears in the muscle tissue occur through over exertion, which cause inflammation and pain. Stiff muscles are a pre-step to pulled or torn muscles and should thus be seen as a sport's injury. If time for regeneration follows by giving the affected musculature a rest, beneficial blood circulatory measures, Reha-training and sufficient liquid intake, then a full recovery is to be expected.

Stitch - the inner organs emit a substance that causes pain due to the reduced blood circulation. Some possible causes are a reduced circulation of the diaphragm, training on a full stomach, too high a strain or irregular breathing. It is also possible that pains occur in the spleen and liver due to the increased blood flow in the body.

Wellness – currently an overused term, also used for various daily products. The word actually means processes, which increase the physical, mental and spiritual well-being of a person and thus also benefit conscious activities and suitable sporting training.

7.3 Here you get help

In this directory you will see a selection of qualified international dealers where you can ask for most of the products as mentioned in this brochure. To get a full overview of available products and useful adresses we recommend to visit directly the homepages of the various manufacturers, introduced in the appendix.

Australia

Pursuit Performance

www.pursuit-performance.com.au

Austria

Fitness Company

www.myfitness.at

Chile

Asiprod Ltda.

www.asiprod.cl

China

Competitor Beijing

www.competitor.com.cn

Denmark

BlumLab, Stensved

www.blumlab.com

Estonia

AS Mefo

www.mefo.ee

Finland

Oriola Oy ProLab, Espoo

www.prolab.fi

Fenno Medical Oy

www.fennomedical.fi

France

Matsport

www.matsport.fr

Germany

Gemar GmbH

www.gemar-celle.de

CardioFitness GbR

www.cardiofitness.de

Israel

International Medical T&C

www.imtc.co.il

Italy

InfraTec

www.lattato.it

Cosmed

www.cosmed.it

Mexico

SpofiTec

www.spofitec.com.mx

Netherlands

HCS-Systems BV

www.sports-systems.nl

New Zealand

BM&S Imports

www.lactate.co.nz

Norway

AkuMed

www.akumed.no

Poland

Sport Konsulting

www.sportkonsulting.pl

Russia

Praktika FK

www.lactate.ru

EKF ooo

www.ekf.ru

South Africa

Impressions Fitness & Health

www.impressions.co.za

Healthcare Technologies

www.healthcaretechnologies.co.za

Spain

Biolaster

www.biolaster.com

Sweden

Fysioett AB

www.fysioett.se

Switzerland

Instrumenten AG Zürich

www.igz.ch

United Kingdom

BodyCare / GAIAM

www.gaiamdirect.co.uk

USA

Sports Resource

www.lactate.com

CefarCompex Group
Tel. +41 21 / 695 63 0
info.intl@compex.info
www.cefarcompex.com

Cyclus 2
Tel. +49 341 / 47 83 95 00
cyclus2@rbm-elektronik.de
www.cyclus2.de

EKF diagnostic GmbH
Tel. +49 39 203 / 785 0
sales@ekf-diagnostic.de
www.ekf-diagnostic.de

h/p/cosmos sports & medical gmbh
Tel. +49 86 69 / 864 20
email@h-p-cosmos.com
www.h-p-cosmos.com

Mesics GmbH
Tel. +49 251 / 534 997 3
info@mesics.de
www.mesics.de

Monark Exercise AB
Tel. +46 281 / 59 49 40
info@monarkexercise.se
www.monarkexercise.se

Polar Electro Oy
Tel. +358 8 / 5202 100
helpdesk@polar.fi
www.polar.fi

ZAN Messgeräte GmbH
Tel. +49 97 36 / 818 10
info@zan.de
www.zan.de

LITERATURE & SOURCES

Stellenwert der Laktatbestimmung in der Leistungsdiagnostik. Clasing, Weicker, Böning, Gustav Fischer Verlag 1994

Das kommt vom Laufen. Butz, BLV Verlag, München 2007

Richtiges Ausdauertraining. Kuhn, Nüsser, Platen, Vafa. BLV Verlag, München 2004

Ausdauertraining. Grundlagen, Methoden, Trainingssteuerung. Zintl, Eisenhut, BLV Verlag, München 1994

Sportphysiologie. de Marées, 9. Auflage, Sportverlag Strauss, Köln 2003

Leistungsphysiologie, Stegemann, Thieme, Stuttgart 1991

Spiroergometrie. Kardiopulmonale Leistungsdiagnostik, Hollmann, Strüder, Predel, Schattauer, Stuttgart 2006

Fig. 2, 7: Georg Thieme Verlag KG, Stuttgart, Germany

FIg. 3, 9, 27, 33, 36: Leipziger Triathlon e.V., Germany

Fig. 4: Bikes in Motion e.V., Germany

Fig. 5, 8, 26: Butz & Friends GmbH, Euskirchen, Germany

Fig. 10, 21: h/p/cosmos sports & medical GmbH, Nussdorf-Traunstein, Germany

Fig. 11, 25, 30: Polar Electro GmbH Deutschland, Büttelborn, Germany

Fig. 12, 15, 22, 24, 37, 39: EKF-diagnostic GmbH, Barleben, Germany

Fig. 13: Herbst, R.: Der Gasstoffwechsel als Maß... In: Dt. Archiv für klinische Medizin 162:33, Germany

Fig. 16: ZAN Messgeräte GmbH, Oberthulba, Germany

Fig. 18, 19: Monark Exercise AB, Vansbro, Sweden

Fig. 20, 28: RBM Elektronik GmbH, Leipzig, Germany

Fig. 23: Dr. K. Röcker, Universitätsklinik Freiburg, Germany, www.ergonizer.de

Fig. 29, 31: Mesics GmbH, Germany

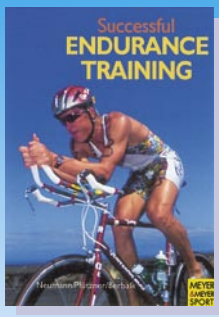
Fig. 32: Compex Médical, Swiss

Fig. 35: Carbon Consulting GmbH mit DeinSport.net, Germany

Fig. 36, 37: Degasport, Germany

Other pictures: Society for sports and performance analysis (www.SOSPA.net)

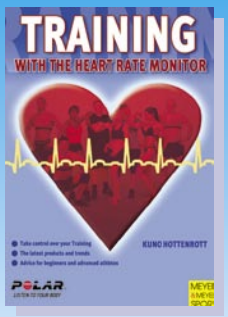
Successful Endurance Training



Neumann/Pfützner/Berbalk
Successful Endurance Training

Athletes, trainers, coaches and medical supervisors will find ideas for their own fields in the detailed presentation of the training environment from the point of view of both sports medicine and sports methodology. Effort and benefit in training should be balanced according to the individual ability of athletes and the amount of time available. The requirements for increasing training effectiveness are discussed in detail.

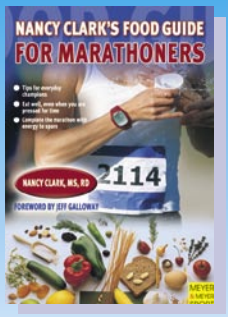
320 pages
25 photos, 119 figures, 75 tables
Paperback, $5^{3}/_{4}$" x $8^{1}/_{4}$"
ISBN: 978-1-84126-004-4
$ 17.95 US/$ 25.95 CDN
£ 12.95 UK/€ 18.90



Kuno Hottenrott
Training with the Heart Rate Monitor

Heart rate monitors have made rapid advances in recent years. As well as accurately measuring heart rate, they can now be used to run tests to determine individual training areas, fitness or stress levels. There are also many programs that are able to structure training more effectively. The book gives competent answers to all the questions you may have concerning training with a heart rate monitor. It aims to make you more autonomous so that you can plan your own training.

152 pages, full-color print
31 photos, 60 illustrations, 2 charts
Paperback, $6^{1}/_{2}$" x $9^{1}/_{4}$"
ISBN: 978-1-84126-213-0
$ 16.95 US/$ 24.95 CDN
£ 12.95 UK/€ 16.95



Nancy Clark
Nancy Clark's Food Guide for Marathoners

In Nancy Clark's Food Guide for Marathoners, you'll learn how to eat well, even when you are pressed for time, and how to effectively balance carbohydrates, protein and fat into your diet. After reading Nancy's book you will be able to choose the best snacks for before, during and after long runs, lose weight and have energy to exercise, and even complete an entire marathon with energy to spare!

168 pages, full-color print
27 color photos
Paperback, $6^{1}/_{2}$" x $9^{1}/_{4}$"
ISB: 978-1-84126-206-2
$ 16.95 US/$ 24.95 CDN
£ 12.95 UK/€ 16.95

Please order your copies at your local bookstore or online at

www.m-m-sports.com

The Sports Publisher

MEYER & MEYER Sport | www.m-m-sports.com | sales@m-m-sports.com

MEYER & MEYER SPORT

IMPRINT:

Publisher:
Martin Kusch, Society for sports and performance analysis (SOSPA.net)

Chief editor and layout:
Christian Weyer, EKF-diagnostic Sales GmbH, Germany

Illustrations:
Jürgen Mesik, Artware Berlin, Germany

Print:
MEYER & MEYER Verlag, Aachen, Germany

ISBN-Nr. 3-935185-42-1
ANTONYM Ressourcenmanagement Verlag, Leipzig, Germany
2nd issue 2008

Master copy for your personal workout schedule (according chapter 6.6):

Name: _____ Date: _____

BMI: _____ Target: _____ Phase: _____

Weekly workout times:

Low level: _____ min, type: _____

Medium level: _____ min, type: _____

High level: _____ min, type: _____

When did you perform the workout, and how did you feel („+" good, „-" bad)?

Intensity / Date:				
Low				
Medium				
High				

Intensity / Date:				
Low				
Medium				
High				

Control check on the ergometer with _____ Watts after _____ minutes

At the beginning of this phase: HF _____ bpm, _____ mmol/l lactate

At the end of this phase: HF _____ bpm, _____ mmol/l lactate

Target definition for next workout phase: _____

Already available in 2nd edition, „Training in your hand“ offers handy information for health-conscious people as well as recreational and ambitious amateur athletes. It aims to help explain the many different workout methods and target their implementation. In addition to the basic theories the brochure also includes reports from „typical“ amateurs, demonstrating typical mistakes and success stories.

Leading manufacturers of well established devices and workout systems continuously supported the publishers in their work. Thus it was possible to combine knowledge from sports sciences, practical experience and technical know-how to focus on the target of a healthy and individual workout.

We hope to be able to put you on track so that you can realise your full potential!

Martin Kusch, born 1966, studied Sports Science at the German University of Sports, Cologne. Graduate studies in performance analysis and biomechanics. Long-term experience in sports diagnostics as well as consultant, advisor and coach in the health care business.

Stephan Nüsser, born 1970, studied Sports Science at the German University of Sports, Cologne. Director of the Competence Center for Performance Analysis (ZeLD) in Cologne, manages his own diagnostic centre for professional and amateur athletes since 2008.

ISBN 3-935185-42-1
9 793935 185423 >