Liane Simmel

Dance Medicine in Practice

ANATOMY
INJURY PREVENTION
TRAINING

Translated by
Jane Michael and Liane Simmel

ROUTLEDGE

Dance Medicine in Practice

Dance Medicine in Practice is the complete physical textbook for dance, written specifically to help dancers understand the anatomy, function and care of their bodies.

Specific chapters focus on the spine, pelvis, hips, knees, feet, shoulders and arms. Each of these covers the following key aspects:

- Anatomy: Bone structure, musculature, and function. How each part of the body moves and how it responds under pressure;
- Pitfalls: Common examples of bad practice and the effect that these can have on the body;
- Self Analysis: How to become aware of muscle groups and the capacity of each joint;
- Injury Prevention: Tips and advice on how to best avoid and prevent injury both in training and everyday life;
- Exercises: Simple and effective methods of strengthening, mobilising and relaxing joints and muscles;
- Checklists: Dos and Don'ts for the best dance technique.

The best dancers know that looking after their bodies is the key to their success, and *Dance Medicine in Practice* also covers how to ensure the best nutrition, how to plan and manage training schedules, and ensure that injuries are kept to a minimum both in frequency and impact. It is the best possible companion to a life in dance.

Liane Simmel is a medical doctor, osteopath and former professional dancer. She studied dance at the State Academy of Music and Theatre in Munich, Germany and at the Cunningham Studio in New York, USA. Today she runs her own medical practice in Munich specialising in dance medicine, osteopathy, spiral dynamics and sports medicine. As the director of the Institute for Dance Medicine "Fit for Dance" she offers dance-medical supervision for dancers and students. She is also a lecturer in Dance Medicine at the Palucca University for Dance in Dresden, the Academy of Music and Theatre in Munich and the University of Arts in Zurich.

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Anatomy, Injury Prevention, Training

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Dance can and should be a physically and psychologically healthy practice. This perspective, the cornerstone of this publication, establishes a valuable paradigm for dance practice in all its manifestations at all levels of accomplishment.

William Forsythe

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Many people were involved in the production of this book, some were not even conscious of their contribution. My special thanks go to all the dancers with whom I have worked, whose questions and problems continue to prompt me to rethink, to experiment and to investigate further and further.

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My husband Hans-Klaus, who has always supported my passion for dance. His patience, his open ear and his love gave me the necessary strength to write this book.

Dear Reader,

Here, at last, is a book aimed at the prevention and treatment of occupational injuries of dancers. You have in your hands a standard work that was long overdue, and one that, I am sure, will form an essential part of the repertoire of professional dancers as well as students and teachers of dance from now on.

In teaching, training and rehearsals, a study of and awareness for the medical basis of movement, together with an analysis of its sports-scientific background, form the basis for responsible behaviour for dancers and teachers alike, both individually and within the group. Knowledge of the physical contexts will permit broader access to the perceptual processes which are becoming increasingly important in today's dance practice. With *Dance Medicine in Practice* Dr Liane Simmel has produced a textbook that will make an important contribution to the improvement and adaptation of learning processes in a rapidly-changing dance culture, whether in the field of classical, modern or contemporary dance.

Based on her extensive experience in this field and her exchange with dancers, teachers, choreographers and doctors, the author presents with this publication the first book dedicated to applied dance medicine. It is another important contribution to the linking of practice and theory in dance training which is currently being widely discussed.

By providing support for relevant publications, Tanzplan Deutschland aims to extend knowledge in the field of dance and to make working materials available to an interested public for the encouragement of dance and especially the wide field of dance education. I am delighted that we were able to contribute to this important work. I hope you will enjoy reading it and that it will provide you with new insight and experience.

Ingo Diehl
Director of Educational Projects, Tanzplan Deutschland

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Introduction

I first had the idea of writing this book many years ago, when I was a young dancer and needed help with pain I experienced while dancing. One of the doctors I consulted dismissed me with the comment: “If you carry on dancing you’ll end up in a wheelchair.” No further explanation, no support, and no suggestion as to how I could continue to dance with, or perhaps in spite of my physical limitations; how I should possibly change or modify my dance practice in order to avoid injury. Nor could my teachers offer me much help in my search for a better way of managing my body. Even at that time of my career I wished there had been a practical book of medicine for dancers. But I never dreamed that I would finally be the person to write it.

Some years later, when I was bold enough to attempt the balancing act of studying medicine while at the same time continuing to work in the theatre, I discovered first hand just what can happen when you understand the physiological and anatomical relationships within your own body. I spent the mornings dancing, training and rehearsing, and then went off to my anatomy lessons. The result was amazing. The pain disappeared; my extension and balance improved. I had “grasped” what was happening within my own body.

Today as a doctor and lecturer of dance medicine, I experience every day how helpful it is for a dancer to understand his or her own body. The aim of this book is to make knowledge in the fields of medicine, movement analysis and sports science, in spiral dynamics and osteopathy easily comprehensible, practical and useful for dancers.

How to Use this Book

Dancing is more than the mere learning and execution of steps and movement patterns. Dance cannot be reduced to the purely physical aspects alone. Yet: the body is the dancer’s instrument. In order to be able to dance for a long time without pain, it is essential to keep your body healthy, to recognize strain at an early stage in order to avoid injury. Whatever your style of dance may be: classical, contemporary, hip hop, jazz, salsa, tap dancing (to name but a few), there is a great deal that dancers in all fields can learn from dance medicine that will provide them with essential support during their careers.

At first sight a theoretical book for dancers appears to be a problematic undertaking. Dancers are practical people who accumulate their knowledge on the dance floor; they want to transfer their knowledge directly into movement. Far be it from me to stop them! What you feel within your own body can become part of your practice during training sessions. What you have experienced yourself can be passed on to other people. With hints for self-analysis, numerous exercises and training tips, this book provides ample opportunity for the practical application of your newly-discovered theoretical knowledge.

A few words about how to work with the exercises: in most cases the exercises should be executed on both sides. It often makes sense to begin with the more “difficult” side. But there are always exceptions to this rule. If the exercise is painful when carried out on a particular side, or if the movement sequence is not clear, it can be helpful to practise it first on the “easier” side. Movement awareness and fine coordination are usually sensed more clearly, and therefore can be trained more effectively, on this side.

Try as we may, exercises are often very difficult to understand without the presence of a teacher. So be patient with yourself when trying out these exercises! Some movements may feel very unusual; time and patience are required to abandon long-established movement patterns and to train new ones to become automatic. Try imagining the movement. Forming a picture of what is happening within your body will help you in your search for the "ideal" form of movement.

In order to build up muscle, movements must be repeated several times. As a compromise between muscle strengthening and practicality in the dance studio, 25 repetitions are recommended for the majority of exercises. This number should be taken as a rough guide only since, particularly at the beginning, less is often more.

Exercises can help to prevent strain and counteract disadvantageous movement patterns in a targeted manner, but they cannot replace a medical examination. If you experience severe pain, or if pain continues over a longer period you should always consult a doctor or physiotherapist who is specialized in dance medicine.

Depending on the style of dance in question, dance steps are often called by different names. In order to avoid misunderstandings, the nomenclature and vocabulary used in this book is that of classical dance. This is not intended to exclude the other forms of dance; it was selected because many dancers are familiar with the terminology of classical dance as many of them have studied ballet, even if they perform in other dance disciplines. Furthermore, dance movements and descriptions from the field of classical dance are also often used in other dance styles.

Each reader may well use this book in a different way, depending on his or her own specific needs. If you read it from cover to cover you will get an overview of the most important aspects of dance medicine. If you need specific help for training problems, pain or injury, you will quickly find the relevant sections by referring to the chapters on the different parts of the body or dealing with specific subjects or by consulting the numerous cross-references and the index. If this book piques your curiosity and you wish to explore the various topics in greater detail, at the end of the book you will find a list of tips for further reading that will provide a good introduction to pertinent literature in the field of dance medicine.

Despite all the knowledge presented in this book about anatomy and the science of movement, about injury prevention and training optimization, we should not lose sight of the fact that the body possesses its own specific intelligence when it comes to movement, and in dance, it is a question of using it.

Before you get started...

The medical nomenclature in this book does not follow a strict scientific system. The first time an anatomical structure is mentioned, its Latin name is added in brackets. In the text, however, Latin terms have been dispensed with as far as possible in the interest of readability. Some anatomical terms have nonetheless become part of the dancer's everyday vocabulary. The sacroiliac joint, for example, is referred to as just that.

In the description of movement, I have also followed general usage and in most cases have deliberately adopted an active form of the verb. Thus we say "the bone moves" although strictly speaking the bone is not capable of moving of its own accord. It is the muscles that move the bone. However, it is often helpful to imagine the movement originating from the relevant bones; the appropriate muscles will then expand and contract automatically.

In most cases the comments in this book apply equally to dancers of both genders. The linguistic problems arising from the need to write "he and/or she" as well as "his and/or her" cannot always be solved in an elegant manner. It seems clumsy to refer to "he and/or she" or to use the impersonal "one" each time. And so, in the interests of readability, it has been decided to use the masculine "he" and "his" for dancers of both genders when necessary. Since more than two-thirds of dancers are women, it might have made sense to adopt the feminine form throughout the book. However, this would merely have supported the widely held prejudice that dancing is primarily a female occupation. And that is not the aim of this book.

1. The Body: The Basis for Dance

Everything Needs a Name – the Anatomical Nomenclature of Movement

It is not easy to describe dance movements clearly and precisely. Different parts of the body often move completely independently of each other in different directions, and usually several joints are involved. A systematic approach is the best solution here: a clearly defined starting position and the observation of the movements in each joint separately. The anatomical nomenclature of movement, as it is used in medicine, provides exactly this. Independently of the direction in space, it permits us to precisely describe the positions and movements of the body. This is a tremendous help for the dancer. Although dance steps are laid down and are clearly named, at least within the different styles of dance, nonetheless, any attempt to describe movements in a way which is valid for all styles of dance can easily lead to discrepancies and misunderstandings. Anatomical nomenclature, with its clear system, provides a good basis for discussing and analysing dance movements across the borders of all dance genre.

The Neutral Stance – the Starting Position for Movement

The so-called *neutral* or *zero stance* serves as the starting position for movement. The movements of the individual joints are described starting from this position. This is what the neutral stance looks like: an upright standing position; the feet are parallel and pointing forward, the arms hang beside the body with the thumbs pointing outwards and the fingers extended. It is from this rather unnatural position that all movements with the same name occur in the same direction. It makes no difference whether the movement takes place in the shoulder, elbow or hip: if we speak of bending (flexing) and straightening (extending), the joints of the body are always moved in the same plane of the body, in the case of flexion and extension in the plane which runs through the body from back to front.

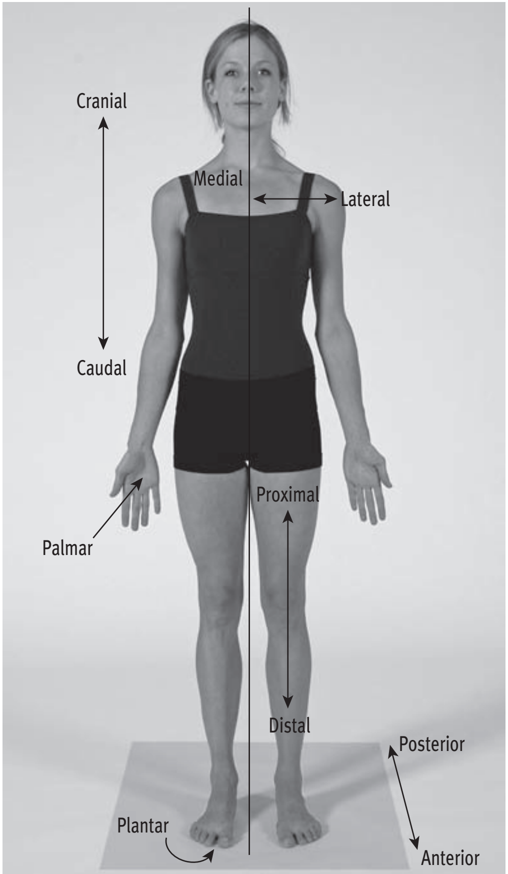

Figure 1.1 The neutral stance, with helpful terms for directions of the body.

Body Axes and Body Planes – the Geometry of the Human Body

The system of body axes and body planes is used to describe movements, from large movements within space down to small joint movements within the body. Imagine three axes running through the body. They are at right angles to each other and correspond to the three dimensions within space: the *sagittal axis* (Latin: sagittum = arrow) runs from front to back, the *horizontal axis* from one side to the other and the *vertical axis* from top to bottom.

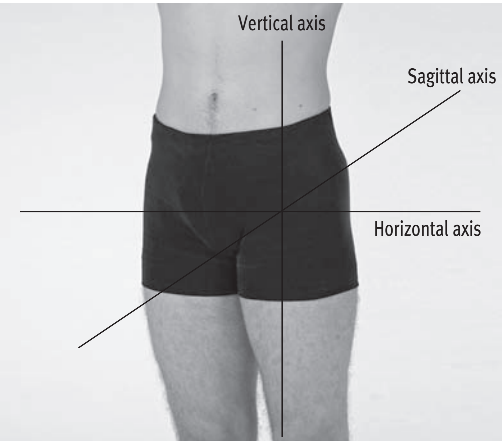

Figure 1.2 The hip joint, demonstrating the three movement axes.

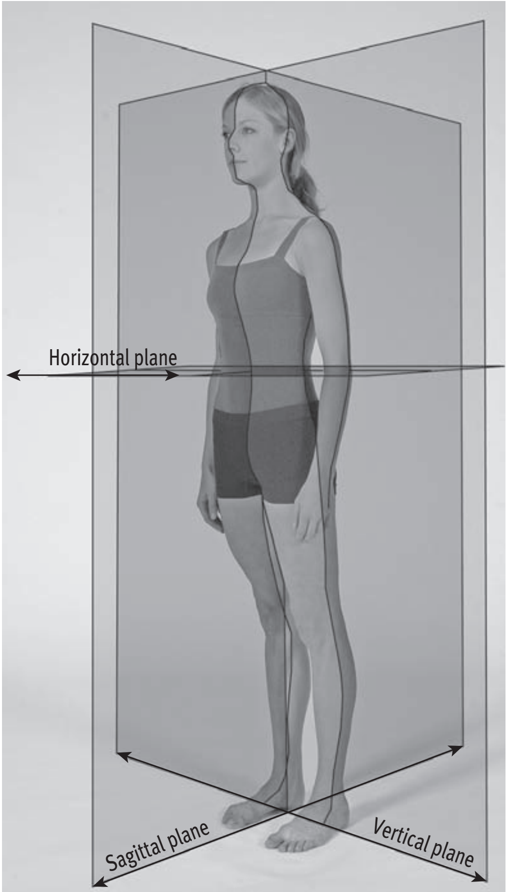

Figure 1.3 The three planes of the body.

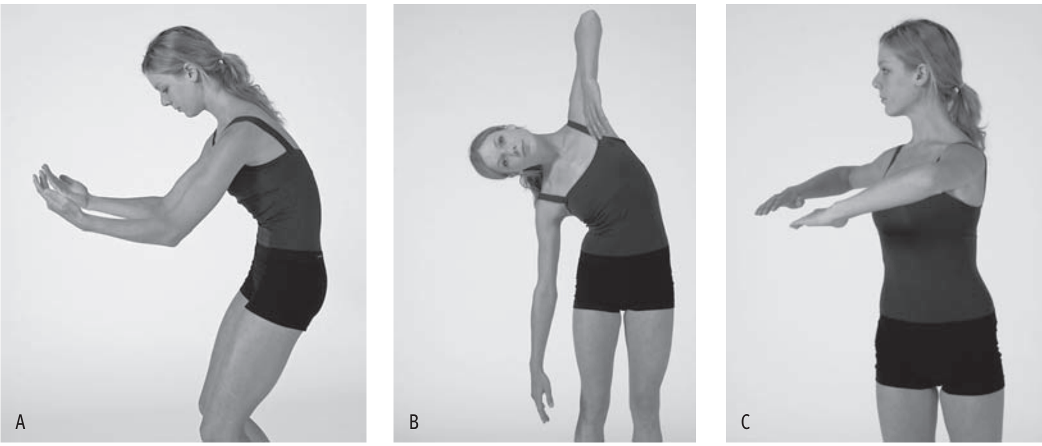

Figure 1.4 Dance movements of the upper body along a physical plane: A) in the sagittal plane, B) in the frontal plane, C) in the horizontal plane.

The three planes of the body are also at right angles to each other. The *sagittal plane* runs through the body from front to back, the *frontal plane* from side to side, and the *horizontal plane* runs transversely across the body (see Figure 1.3). Movements can run exactly along these planes of the body or can consist of a combination of the different planes, for example, when the leg moves forward at an angle towards the diagonal.

The axes and planes of the body always refer to the body itself and not to its direction within the space. If the entire body or a part of the body moves within the space, then the system of axes and planes moves with it, regardless of the newly-selected direction in space. A battement devant is a movement of the leg forwards in the sagittal plane, regardless of whether the body is directed towards the front of the space or towards the diagonal.

The Nomenclature of Movement

If a part of the body moves, the movement takes place around a clearly-defined axis in the relevant plane. The axis around which the movement occurs and the plane in which the movement takes place are thus prescribed, but the direction of the movement is not. Movements around an axis can always be carried out in two opposite directions. Turning around the horizontal axis permits *flexion* and *extension*. Rotation around the sagittal axis permits *abduction* (moving away from the midline of the body) and *adduction* (moving towards the midline of the body). Movements around the

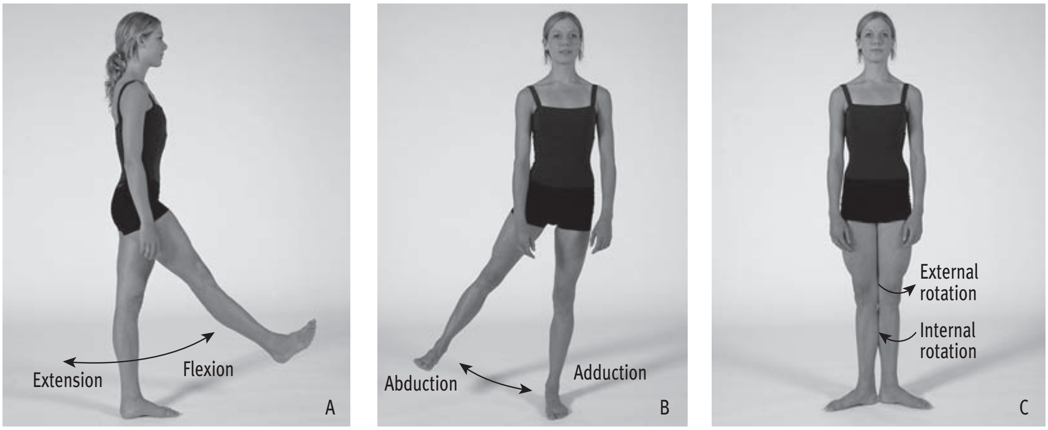

Figure 1.5 Movements in the hip joint: A) flexion and extension – around the horizontal axis, B) abduction and adduction – around the sagittal axis, C) external rotation and internal rotation – around the vertical axis.

Table 1.1 The nomenclature of movement

Axis around which the movement occurs	Name of the movement	Plane on which the movement occurs
Horizontal axis	Flexion – Extension	Sagittal plane
Sagittal axis	Abduction – Adduction	Frontal plane
Vertical axis	External rotation – Internal rotation	Horizontal plane

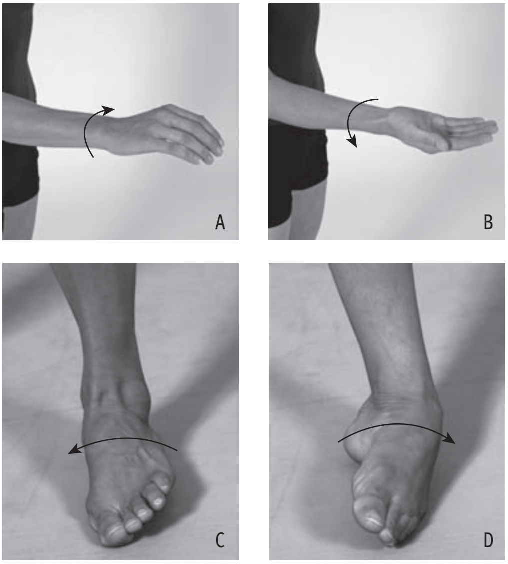

Figure 1.6 Movement of the hand:
A) pronation, B) supination.
Movement of the foot: C) pronation, D) supination.

vertical axis are described as *external* and *internal rotation*. Depending on its anatomical structure, each joint can carry out at least two of the six described movements.

The forearm and foot have a special movement nomenclature. Here the inward rotation is described as *pronation*, in which the back of the hand is on top (as if grasping for **b**read), or the outer edge of the foot is raised. The opposite movement is the outward rotation, known as *supination*. Here the back of the hand is underneath (like a **s**oup bowl), or the inner edge of the foot is raised.

The precise naming of the direction of movement not only helps with the description of the movement itself; it also supplies the name of the corresponding muscles and muscle groups. Thus muscles which are involved in the flexion of the hip joint are known as hip flexors; the muscles involved in the extension of the hip are known as hip extensors. Understanding this clear system simplifies the classification and naming of the numerous muscles.

The Organization of the Body

Regardless of the position of the body within the space, and regardless of whether one is lying, standing or suspended, the anatomical nomenclature clearly defines the different areas of the body in relation to each other. This is useful because, for example, the description "this joint lies above the knee" could lead to various, possibly confusing, conclusions depending on the position of the body and its position in space. In anatomy we therefore use terms that may seem unusual at first, but their clear definition permits us to describe structures in the body and their position in relation to each other, regardless of the actual body position.

Table 1.2 Location descriptors – useful pairs of terms with opposite meanings (see Figure. 1.1)

anterior = front	posterior = rear
ventral = towards the abdomen	dorsal = towards the back
caudal = towards the coccyx	cranial = towards the head
medial = towards the midline	lateral = away from the midline
proximal = near the centre	distal = away from the centre
plantar = on the sole of the foot	palmar = on the palm of the hand

The Composition of Tissues

Training changes the body. Every dancer knows that from his personal experience. The body stature is transformed; certain areas become slimmer and others develop more strongly. The body reacts to the stress of dancing by adapting to the dance training. What can be seen externally in the body shape also takes place inside the body within its smallest building block, the cell. Its ability to divide not only serves growth but is also the basis for regeneration. Thus the body can replace used, damaged or lost cells with newly-formed ones. At the same time it adapts to take into account the current training load. By enlarging an individual cell or increasing the number of cells, the body equips itself to meet the growing demands. This adaptation is reversible. If the load is reduced, the number of corresponding cells or their size is also reduced; the body responds to the reduced workload.

Composition – the Principle is Always the Same

One uses the term "tissue" to describe a collection of similarly formed cells with similar functional tasks. Regardless of the type of tissue, its basic structure is the same: the cells are embedded in a homogeneous amorphous mass (Greek *amorph* = formless), the intercellular substance (matrix). Depending on the tissue type, various fibres run between the cells. The tissue type is determined by the cells; its characteristics are influenced to a considerable degree by the embedded fibres.

The **intercellular substance** consists of a thick liquid in which various substances are dissolved. In quantitative terms it is composed mainly of water, protein particles, sugar, hormones and electrolytes.

In the body we distinguish between three types of **fibres**. *Collagen fibres* occur nearly everywhere within the body. It is virtually impossible to stretch them lengthways and thus they give the tissue a great deal of tensile strength. *Elastic fibres*, on the other hand, indicate a high degree of elasticity. They can be stretched to up to 150 per cent of their original length, but immediately after completion of the traction they return to their original length. *Reticulin fibres* are the finest fibres in the human organism. They usually form microscopic nets or grids and thus provide general stability to the tissue.

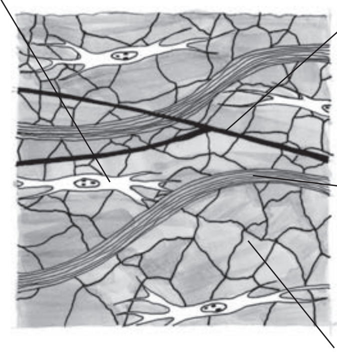

Figure 1.7 An example of typical tissue structure. In this case, connective tissue.

The Different Types of Tissue – the Difference is in the Detail

In the human body, we distinguish between four basic types of tissue: epithelial tissue, connective and supportive tissue, muscle tissue and nerve tissue. All four differ as to the type of tissue cells, the precise structure of the intercellular substance and the number and composition of the fibres they contain.

Epithelial tissue serves to cover the inner and outer surfaces of the body. The most important example is the skin, which, depending on the size of the individual, can cover an area of up to $2m^2$. Thus, it is considered to be the largest organ of the human body. Its job, apart from protection and temperature regulation, also includes immune defence, regulation of fluid balance through perspiration, and perception of the surrounding environment, for example, of pressure and temperature. It is also an important organ for communication. When we blush, go pale or get goose bumps we unconsciously send important messages to others.

Connective and supportive tissue is needed for the structural maintenance of the body. The **supportive tissue** includes bones, cartilage and tendons and is extremely important for the dancer as part of the movement apparatus. It is described in greater detail from page 9 on.

Connective tissue can be found everywhere throughout the body. It extends around and between the organs, vessels and nerves. Depending on the consistency, quantity and arrangement of the intercellular fibres, we distinguish between the taut *collagenous* and elastic *connective tissue*, which has a large number of fibres, determining its shape, and the looser, soft, *reticular connective tissue* which is easily movable. Connective tissue has a number of tasks to perform: these range from the protection and cushioning of the body and the storage of water and nutrients to transport and immune defence. Its metabolism is sluggish; the transport of metabolic products occurs quite slowly. Thus connective tissue is often referred to as the body's "rubbish bin". Through the increased concentration of waste products, its normally long regeneration time, is extended even further.

Fatty tissue is a special form of connective tissue. Here, fat is stored within specialized fat cells. These special storage cells have thin, elastic walls and are thus especially flexible. In this way they can adapt their storage capacity to suit requirements. It is important to distinguish between *structural* and *storage fat*. Structural fat takes on important tasks at many locations within the body: below the heel bone it serves as a "heel cushion" which pads the foot and absorbs shock. The structural fat around the kidneys secures the kidneys in place and protects them from shock and impact. Storage fat is found in particular under the skin, where it is important as an energy reserve and for temperature regulation. It is well supplied with blood vessels and is constantly being renewed. Structural fat, on the other hand, is only made use of in times of extreme hunger. For example, in the case of eating disorders – a problem which unfortunately occurs frequently in dancers (see Chapter 9, p. 189) – the structural fat around the kidneys is partly destroyed. This has permanent consequences, as it is impossible to completely rebuild structural fat once destroyed, even with the aid of ideal nutrition.

Muscle and **nerve tissue** are essential for the performance and control of movement. They are described in more detail starting on p. 13.

Regeneration and Adaptation – Tissue is Constantly Changing

All tissues in the body are constantly changing: since all tissue is alive, old cells and fibres are destroyed and new ones are formed. The process of renewal takes place at different speeds depending on the type of tissue concerned. Muscle cells regenerate quickly in a matter of days, but ligaments, tendons and cartilage tissue need considerably longer. The regeneration process takes months or even years. The quicker a tissue can regenerate, the quicker it can adapt to external stimuli.

"Biological adaptation" is what is known in sport and dance as "trainability". The different types of tissue react very differently to the influence of training; their adaptability varies from hours to years. For instance, muscles can be trained relatively quickly; however, the growth of additional connective and supporting tissue, of bones, tendons and ligaments, takes considerably longer.

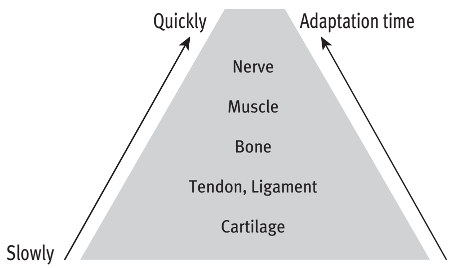

Figure 1.8 Different adaptation rates of tissues to strain.

The Skeletal System: Bones, Cartilage and Joints

The human skeleton consists of more than 200 bones. The skeleton supports the body, protects the organs and at the same time serves as attachment points for muscles, tendons and ligaments. Through its joints, it significantly influences the flexibility of the entire body. The skeleton gives the body its form and stability, although it is quite light itself: all the bones together only account for about 15 to 20 per cent of the total body weight.

Bones

Bones are characterized by their great resistance to pressure and their tensile strength as well as their breaking strength and their – often forgotten – elasticity. In addition to their obvious tasks such as support and protection, bones are also important for the production of blood cells and the storage of important mineral substances in the body. Bones owe their relatively low weight to their intelligent physical structure.

Bone tissue – bone is alive

Together, bone cells (*osteocytes*) and basic substance form the bone tissue. Ten per cent of the basic bone substance consists of water and 20 per cent of organic materials, such as protein and collagen fibres. The collagen fibres are responsible for the elasticity of the bone and for its ability to resist tension. 70 per cent of the basic substance consists of inorganic substances, minerals which are stored in the tissue – a special characteristic that occurs only in bone tissue. Calcium plays a very important role here: the calcium salts stored in the bones account for two-thirds of the bone weight; they give the bone tissue its great stability and strength.

The bone cells are supplied with nutrients and oxygen by their own system of blood vessels. A functioning metabolism is essential for the bones, as they are constantly being remodelled. Every week, 5 to 7 per cent of our bone mass is renewed; therefore, every five months our bone tissue is completely replaced. In spite of its stability and hardness, bone is a living tissue; in a healthy person bone resorption and bone formation balance each other out. The formation is not just a matter of replacement of the bone substance; at the same time it is used for adapting bone structure to load. An increase in stress leads to an increase in the mass and density of the bone, and a decrease in stress results in loss of both strength and bone density. This shows that stress forms the bones. The function determines the form.

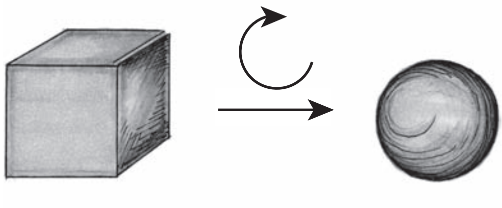

Figure 1.9 Form follows function: when a square bone rotates for a long period its corners wear out and it becomes round.

An impressive example of this is the thickening of the second metatarsal bone, which occurs frequently in dancers. On demi-pointe or pointe, the line of gravity runs between the first and second metatarsal bone. In order to adapt to this high degree of stress, the body increases the amount of bone tissue precisely where it is needed: the metatarsal bone becomes thicker (see Chapter 6, p. 123).

The "typical" bone – the structure of a long bone

The global structure of a bone will be demonstrated by the femur, a typical example of a long bone.

The long shaft, the *diaphysis*, consists of a tube-like casing (**corticalis**) of compact bone material (*compacta*). The centre of the bone is hollow. This construction provides two advantages, making the bone both more elastic and lighter in weight.

The hollow space, or *medullary cavity*, is filled with bone marrow. Both ends of the bone, the *epiphyses*, are covered with cartilage. Their interior is made up of a lattice of fine columns of bone, which, due to its sponge-like appearance, is called the **spongiosa**. This is a lightweight construction, which saves even more weight. The spongy bone tissue is very important for bone resilience. Adapting to the load, the columns of bone align themselves along the main stress lines. Thus they form a supportive structure with a high capacity for bearing loads and withstanding stress: the so-called *trabecular system* (see Chapter 4, p. 76).

The **periosteum** is a fibrous, elastic sheath surrounding the outside of the bone. It is criss-crossed by numerous blood vessels and is responsible for the nutrition and regeneration of the bone. If the periosteum is removed, the bone will be destroyed. Through its dense network of nerves, the periosteum has an important function in protecting the bone. If subjected to unaccustomed stress or excessive loads, the periosteum may become inflamed; the associated pain warns against further excessive stress. In some places the periosteum lies almost unprotected directly underneath the skin. These areas are especially sensitive to pain; most people are familiar with the sharp unpleasant pain caused by a blow on the shin.

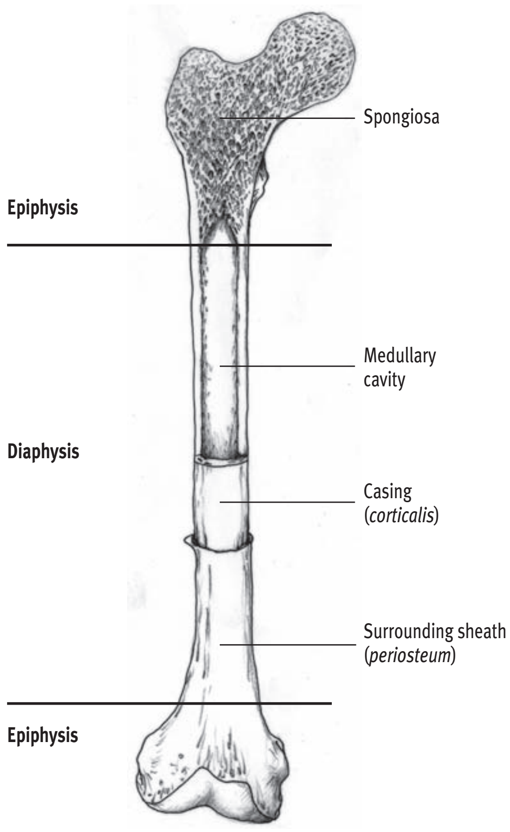

Figure 1.10 Shape of a long bone.

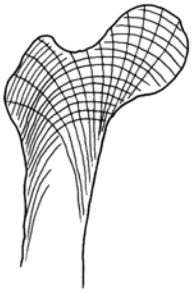

Figure 1.11 The trabecular system at the ends of the bone: the trabeculae align in order to evenly distribute the load.

Bone marrow is found in the medullary cavity and within the spongy bone tissue. In addition to filling out the cavities, its main task is the formation of red blood cells.

Cartilage

The main qualities of cartilage are high elasticity of compression, resistance to shearing forces and traction, and the ability to absorb shock.

Cartilage tissue

Cartilage tissue consists of cartilage cells and a substance in between the cells that holds water and proteins (the "intercellular substance"). It contains neither nerves nor blood vessels. Its nutrition occurs via diffusion, through the direct absorption of nutrients from surrounding tissues or from the synovial fluid. This explains the slow metabolism of cartilage and therefore its reduced ability to regenerate itself. Ideally, the alternation between weight bearing and relief on the joints