1 Prologue: the framework of this book

Already as a young man, I was fascinated in Nature and the complexity of Life. Consequently, I began to study human anatomy in 1981-1982. I did this study in a library as well as in a dissection room. And I am still doing so ever since.

Sure, it is possible to learn a large part of the anatomical nomenclature by studying standard authors. But my experience from doing numerous dissections myself, led to the awareness that all these books do not cover specific features of that same anatomy. **The 3-dimensionality of the Form** is one of the specific anatomical features that you cannot find in a book. Even the best pictures of the best illustrators cannot give the student the same insight. Neither can students get a real picture of **how all the different structures are (positionally) connected,** when they are not doing the dissection by themselves. Moreover, we should not forget that all pictures, even made by the best illustrators, are already a distortion of reality – what is it that the dissector wants us to show, and what did the dissector have to remove in order to demonstrate? In their book "*Objectivity*", Lorraine Daston and Peter Galison make it clear that **all illustrations are essentially a perfect representation of what is not Nature**.

> *"... objektiv sein heist, auf ein Wissen auzusein,*
> *das keine Spuren des Wissenden trägt ..."* [1]
>
> (Translation: *being objective means, searching for Knowledge that bears no traces of the Knower)*

Without any exception, every illustration gives us an incomplete and sometimes even false representation of what really is. With other words: every picture is a representation of what the author or illustrator wants us to see. He or she wants us to see what is in front of us, through their eyes. So, we should not wonder that even the best student in (theoretical) anatomy is lost during the first moments of his/her first dissection – he/she does not recognize of what is present in his/her head.

> As an example: the beautiful picture of the *Tractus iliotibialis* is a perfect representation of what participants without practical experiences fail to see and find in the dissection room. Unless they "shape" this structure by themselves when they dissect in a very specific way. So, to reshape their mental picture, they must cut away some of the structures in front of them. And in doing so, they can notice that for some of these structures (such as fat) it is easy. Whereas for others (such as fascia) it is more difficult. In doing so, in performing the dissection, the students receive an additional and very important characteristic related to the structures of a Form. An insight that they do not acquire by simply studying anatomy from books only. This characteristic is called **the texture of a tissue or organ**. The fact that different structures have different textures is – to my opinion – a very important insight. Especially for persons who have a physical (manual) approach to the human Form.

By studying anatomy, I tried to understand the relationship between Form, Structure and Function. And it became clear to me that if I truly wanted to understand, I had to study **anatomy in all its dimensions**. This means that besides classical anatomy, I also had to study histology, cytology, and even (bio)chemistry. In fact, we should study **Morphology**.

By doing a dissection by yourself, one of the first things that you truly understand is that **every form is built by many different structures**. Moreover, each of these structures has a form of its own. So, when we study anatomy by dissection, we are separating each part from the rest. And by doing so, we get a notion of the proper Form of each individual part. When we continue this dissection, we become aware that there are many different dimensions in our anatomical study. And in each dimension, we encounter new structural components.

Form is built up by structures. This insight may not be so revolutionary new. But during my dissections, I became much more conscious of it, and it led to the notion that certain questions always came back. One particular question always popped up, again and again. It was the question about the origin of anatomical structures: where do they come from? Consequently, I began to study **embryology as a part of the morphological study**.

[1] L. Daston, P. Galison, Objektivität, page 17.

Almost immediately at the beginning of studying embryology, I encountered several difficulties. One of them was the notion that all standard authors use a rather **chemical approach** to explain why a certain form is changing. In most books, development is explained as the result of a genetic expression. According to these authors, the information for development is apparently somewhere stored in the DNA of each cell. Using the DNA as a starting point for every change of form, we describe development as an inside-outside-phenomenon. This is one way of describing and explaining transformations. However, it does raise some questions. One of these questions is: how does the cell know what it should become? And last but not least: how does it happen? Moreover, if we study embryology in the contextual frame of a chemical inspired DNA concept, what can we do with this information when we have a physical approach to Form in daily practice?

Studying standard authors of embryology who use the "DNA wild card[2]", it leaves us all too often with too many fundamental questions unanswered. This changed for me somewhere in the late eighties when I received the copy of a book written by Prof. E. Blechschmidt[3]. This opened a completely new perspective and was the beginning of a completely different approach.

Unlike his colleagues, he does not use chemical parameters to explain development. He is aware of the presence of a chemical context, but he also emphasizes that there are specific physical features to the process. So, unlike most of his colleagues, he uses **physical parameters.** Parameters such as space-time, dimension, position, direction, etc. to explain the phenomenon of differentiation. In a complete and logical way – no gaps or jumps in the way of reasoning – he explains **not only how but also why** a Form changes.

> **The "HOW".** By using the physical parameters, Prof. Blechschmidt describes every smallest detail of change in position, structure, or form. He describes each of these changes as a so-called **developmental movement**. We can describe these developmental movements as **morphokinetic patterns**.
>
> **The "WHY".** Describing development as a morphokinetic pattern makes it clear that this phenomenon takes place under very specific **environmental circumstances**. It becomes crystal clear that the environment plays a significant role in the phenomenon "development". It becomes obvious that the changes that take place are a response to the environmental pressure on the form, and all of its structural components. And this means that unlike his colleagues, he does not speak of an inside-outside but of an **Outside-Inside-Phenomenon**.

And there is more to it. Not only is he speaking about the how & why, he also explains us "**where & when**". Using physical parameters as conditions, it becomes obvious that a certain morphokinetic pattern is repeated over-and-over-again. We can compare it with a repeated **algorithm** that leads to an increasing **complexity**.

From an anatomical point of view, we are often looking at the result of a developmental process. In most cases, we notice the enormous complexity of its result. But at the same time, we often fail to see the simple algorithm of the morphokinetic pattern and the related (same and simple) circumstances. Wherever and whenever (in a certain part of space and at a certain moment) specific physical circumstances are present, it is possible that under these circumstances a form will change. When this is the case, when the form does change, we should keep in mind that in the end **nothing new is created, it is all about transformation**. With other words, development does not lead to something new but much more to a different way of appearance – a different way of spatial (re)arrangement.

"... was sich während der Entwicklung ändert, ist nur das Erscheinungsbild, nicht aber das Wesen ..."[4]

(Translation: *what changes during development is the way of appearance but not its essence*)

Transformation is a phenomenon that we can observe in all dimensions. But neither necessarily in all dimensions at the same time, nor in all parts of that dimension. We should keep in mind that in the end, this transformation will only take

[2] The DNA is all too often used as a "deus ex machina" (see also footnote 344) to explain development/differentiation in a sense of "we do not know exactly how it happens, but it must be somehow genetically related". Is this assumption correct? And if so, in what context, in which reference frame?!

[3] Blechschmidt, Humanembryologie, Prinzipien und Grundbegriffe, 1974.

[4] Blechschmidt, Anatomie und Ontogenese des Menschen, page 13.

place in a specific dimension of certain part of space. It will be that part of space where we encounter the specific environmental conditions that will lead to that change. And this brings us to the term **metabolic field** or **morphokinetic field**. The term "Field" indicates that we can distinguish a very specific part of space where a transformation takes place. The physical parameters enable us to determine a morphologically delimitable area. This area indicates the specific location of the transformation.

The fact that this morphokinetic approach is a physical and not so much a chemical description has a direct consequence for our anatomical study. Because it does not only explain where the different structures come from, it also shows us the physical traces of the developmental pattern. Meaning: if we study anatomy, we can notice not only many anatomical relationships between different structures, but we can also notice what unifies them. The latter is the morphokinetic pattern. Structures are "spatially aligned" by these developmental changes. We are looking at Form and see how these patterns represent circumstances. We can notice how patterns have turned circumstances into "living pictures of anatomy"[5]. These patterns are showing us the large number of possibilities of how structures can interact. **Looking at a Form and seeing the morphokinetic pattern turns every anatomical relationship into a functional relationship**.

In the attempt to describe and understand human development, we will study the specific circumstances for these transformations. And with the help of physical parameters, we will describe how these changes take place. Moreover, we will be able to formulate a large number of principles behind the phenomenon of any morphokinetic pattern. When we study these principles, we acquire an insight that will bring us far beyond the borders of human development. We will go back to the origin of the concept of Morphogenesis. Consequently, a profound insight in these principles will become a solid foundation for an understanding of the relationship between *Form, Structure* and *Function* of the Human Being.

The fact that we speak of an Outside-Inside-Phenomenon (environmental circumstances quantified by physical parameters) will make it clear that a morphokinetic pattern does not only occur during the embryological stage of a Human Being. It will become clear that this phenomenon also occurs during our complete lifetime. Being able to observe this in all life forms even leads us to the conclusion that the presence of a morphokinetic pattern is a **universal phenomenon**. It even goes this far to say: an understanding of the principles behind the phenomenon of development helps us to understand any kind of transformation. **Beyond the period of 9 months of pregnancy, terms such as development, growth, transformation, differentiation, specialization, and many more (such as symptom and pathology) can be seen, described, and even understood by applying these principles.**

This book is written for all of you who are fascinated by the beauty and complexity of the Human Being. This book is written for all of you who are trying to find answers about the origin and nature of what is Form & Function. Within this book you can find hidden answers of Nature. But to be able to find them, you have to **think-out-of-the-box**. For instance, one of the first things that we need is another awareness. The awareness that if we want to study Form, we always need to **study Form in (at least) two different dimensions at the same time**: the dimension of the form itself as well as the (underlying) dimension of its structures.

To help the reader in the exercise of studying Form by looking into two different dimensions at the same time, this book contains a chapter for each dimension. Starting with the dimension of the atoms and molecules, the book will follow the **chronology of evolutionary transformation** that will lead to the very first cell – the next (overlying) dimension. From there the chapters continue chronologically by describing the dimension of tissues and then organs, and finally a complete organism. In each new chapter, the reader will become aware that the content of the previous chapter contains the ingredients to understand the form of the next dimension. Like sand and cement build the bricks, the bricks build the wall, the walls will build the room and finally, the rooms will build the house. If we want to understand the house called "Human Being", we need an insight into all its parts, in all dimensions and in respect to the chronology of their appearance. So, let me take you on **a journey of 13,8 billion years** to discover a universal **Mechanism** that we can use every day again, in theory and practice.

[5] Still, The Philosophy and Mechanical Principles of Osteopathy, page 9.

Note about Embryology

Embryology is a relatively young science. Nevertheless, there are many scriptures indicating that already a long time before we talk of embryology as such, we have asked ourselves questions about our origin. In the sixth century BC for instance, Plato came up with the idea of the (perfect) archetype of which we (and all other subjects) are merely copies. A thought that somehow came back during Christianity when it was believed that we are human since the beginning (we are merely a reflection of God's own image; the theory of preformation – see also Nicolaas Hartsoeker 1656-1725). In the 18th century things started to change. A new concept is presented: Epigenesis (see also Friedrich Caspar Wolff 1734-1794). This concept rejects the idea of preformation and rather describes all the observed changes that take place during a process called differentiation. Epigenesis (NOT epigenetics: the concept of genetics comes later – see Gregor Mendel 1822-1884 and Watson & Crick 1955), this concept describes accurately what can be observed but does not necessarily explain the why of the changes. In the attempt to find an answer to the questions about the why and how, different concepts were developed. Concepts such as the idea of "effectiveness" or "repetition of phylogenesis".

At the end of the 19th and beginning of the 20th century, the Russian medical scientist Alexander Gurwitsch and the German biologist Hans Driesch came up with the "Morphogenetic Field Theory" (published by Gurwitsch in 1912). Although the German Professor Erich Blechschmidt does not make direct references towards this theory, there are several indications that he seems to have been inspired by this approach. For instance: Blechschmidt does not deny that the DNA has a meaning for the phenomenon of development, but he emphasizes that it is not so much about *genetics* but much more about *genesis*. To explain this with an example: The cell is a cooking pot, the DNA is the cooking book – so who is the cook? Although the concept of morphogenesis does show its value, unfortunately it became pushed into a corner. It almost became forgotten because of the revealed (metabolic) importance of chromosomes and genes in the 1930's. In the late 20th century, the field concept was "rediscovered".

Note about Physics and Chemistry

In this book, we will use physical instead of chemical parameters. But please keep in mind that one does not exclude the other automatically! It should be clear to the reader that every chemical reaction is characterized by several physical features and vice versa. We can use both scientific languages to describe one and the same natural phenomenon. Each language is valid and does not rule out the other. In the context of this book, we have chosen specifically for the physical language. A language that suits a person who has a more physical (manual) approach of the Human Being rather than a chemical. But nevertheless, I am convinced that for every developmental movement, as described in this book, there might exist a specific chemical reaction as well (as for instance described in physiology).

16 Columna vertebralis

The spine is a structure that surrounds our so-called central nervous system in the region of the trunk. The spine is a derivative of the inner tissue and is composed by many different structures of many different densities. We will discus each of these structures individually in the following sections.

16.1 About somites

In section "*12.2.1. The process of metamerisation – Segmentation*", we have studied the transformations of the inner tissue that lead to the so-called somites (**Fig.16.1.**). When we look closer into the details of a single somite, we can observe different regions. In the dorsolateral region we can distinguish the dermomyotome. In the ventromedial region the sclerotome[178]. Each of these regions has a specific configuration and is characterized by specific environmental conditions. Both are contributing to the development of the spine as a whole.

Please keep in mind that somites are developing from the somitomere and the segmentation influence of the transversal blood vessels.

16.2 Vertebrae & Disci intervertebrales

Note: the content of the following sections regarding vertebrae and intervertebral discs is also used in the chapter "*39. About anatomy*" as an example of anatomical studies from a different perspective.

16.2.1 The Influence of the Pachymeninx

The vertebrae of the spine as well as the intervertebral discs develop from the slerotome. The cells of the sclerotome have one thing in common with those of the dermomyotome. The cells are standing perpendicular to the surface of the somite. The difference between them is their appearance and their localization. The cells of the sclerotome (ventro-medial localization in inner tissue space) have a much looser appearance, whereas the cells of the dermomyotome (dorso-lateral localization in inner tissue space) are standing much closer text to each other. When we look even closer into the details of the somite, we can distinguish a small fluid chamber in the center. This gives the somite all characteristics of a cyst. A clear indication for the strong metabolic content in that region of the inner tissue (see section "*11.1.2. Canalization zone*") (compare microscopic cross-sections in Fig.12.11. & Fig.16.1.!).

Changes in form and behaviour of the sclerotome cells are a consequence of the expansion growth of the neural tube and the restraining influence of blood vessels and Pachymeninx. It is in this context of restraining influence that Prof. Blechschmidt disagrees with most embryology books. In those books, the changing in position of the sclerotome cells is described as an active migration of the cells towards the anterior location around the axial process (Chorda dorsalis or notochord in those books). He observes no indications of such developmental movement. He sees more indications of a "pushing-into-position" under the influence of a changing environmental condition (contusion field, cells appear compressed and not elongated as expected in case of an active migration). We have already studied this developmental movement in relationship with the Pachymeninx (see section "*15.2.2. Compressing the space*"). In fact, we can continue our observations and notice the ongoing influences of this Pachymeninx.

As previously described, the region of the Pachymeninx is characterized by the morphokinetic field of retension. Increasing the forces within this retension field will squeeze the fluid out of the space. Fluid that is situated in between the fibers. The matrix of the inner tissue fluid is captured by the fibers like a fish in a net. This increases the density of the region and turns it into a bony structure. Please keep in mind that the fibers maintain their continuity. With other

[178] The terms sclerotome and dermomyotome are chosen by the knowledge of their future derivatives.

words: trabeculae of the future bone and fibers of the Pachymeninx are in their essence the same[179]! (see section "*4.2. Inner tissue*")

However, the process of densification is not only a result of forces related to the development of the spine! At least not everywhere. A deeper insight in the conditions that lead to this spine development even urges us to change our Nomina Anatomica (see next).

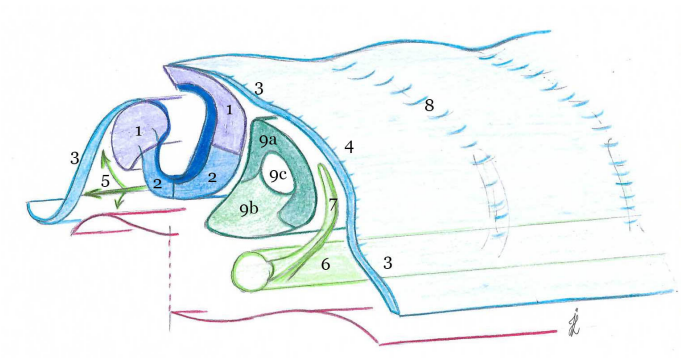
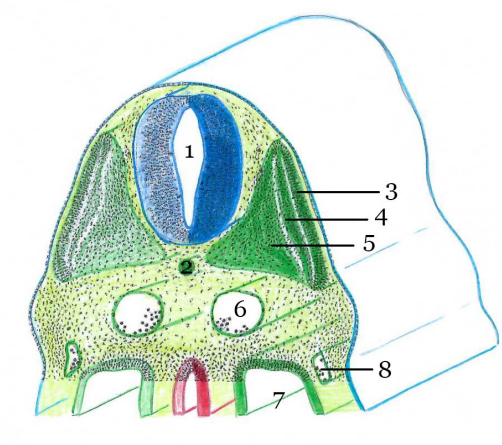


Fig.16.1. Somite

This illustration shows two different stages: left side = early stage, right side = later stage.

1. Dorsal bulge. 2. Neural groove. 3. Epiblast. 4. Ectodermal ring. 5. Fluid trajectories (longitudinal and transversal). 6. Dorsal aorta. 7. Transversal branch of dorsal aorta. 8. Segmentation furrow. 9. Somite. 9a. Dermomyotome. 9b. Sclerotome. 9c. Fluid chamber inside somite.

The fluid trajectory is not only responsible for the development of the dorsal aorta and its branches. Inner tissue cells in the region of the canalization zone also show an increased metabolism, which becomes apparent by the numerous cell cleavages. This leads to a new structure called somitomere, which is in fact a green sausage of cells on either side of the neural groove. A next step in increasing complexity leads to the appearance of a structure called somite. This structure is characterized by the presence of a fluid chamber (cyst development!) and the characteristics of segmentation furrows (8). The latter happens under the restraining influence of the lateral branches (7). See also Fig.12.12..



Compare this microscopic cross-section with Fig.12.11.. 1. Neural tube. 2. Axial process. 3. Dermatome. 4. Myotome. 5. Sclerotome. 6. Dorsal aorta. 7. Intra-embryonic cavity. 8. Cardinal vein.

The somite is also characterized by two different cellular regions: sclerotome and dermomyotome. The region of the sclerotome shows a loose organization of cells compared to the more dense-like region of the dermomyotome where the cells are closely packed together. The dermomyotome will continue to develop into a new cyst-like structure, which is characterized by a second fluid chamber-like part that separates the dermatome from the myotome.

The changing angle between the neural tube (groove and bulge) and the epiblast repositions the cells of the sclerotome. The cells of the sclerotome are pushed into the region ventral to the neural groove.

[179] It is for the very same reason that we can say that there is no such thing as an Origo and Insertio of a muscle. The fibers of the muscle tendon do not interrupt their trajectory when the tendon meets the bone. The fibers are in continuity with the trabeculae of the bones. It is merely a difference in density (concentration gradient of matrix!). Osteophytosis is a typical so-called pathological expression of an increased tension within the connective tissue that leads to a densification.

16.2.2 The influence of the periphery

According to the anatomical literature, we distinguish 7 cervical, 12 thoracic, and 5 lumbar vertebrae. The vertebral column is last but not least completed by a sacral and coccygeal bone. This caudal region, together with both iliac bones is referred to as the Pelvis.

Looking more closely to that region, we can notice that the sacral and coccygeal bone are ossifications of respectively 5 sacral and 4 coccygeal vertebrae (some authors speak of 3 coccygeal). Although it looks on the outside as one bone, in a sagittal cut it becomes clear that the sacrum remains 5 individual vertebrae because the ossification mainly appears in the cortical part of the bone. This is more difficult to observe for the coccygeal bone. Nevertheless, its origin is also still observable. So, why not speak of a vertebral column consisting of 7 cervical, 12 thoracic, and 5 lumbar vertebrae, and completed by 9 pelvic vertebrae?

Although rare, it does happen that the 5th lumbar vertebra ossifies with the sacral bone. This phenomenon is known as the sacralisation of L5. In most cases it appears only on one side of the vertebral column. Looking more closely into this phenomenon of sacralization, it becomes obvious that it is not such a strange idea to define the presence of 6 sacral vertebrae (L5 + 5 sacral). Consequently, we could alter our nomenclature by redefining that 5th lumbar into the 1st sacral vertebra. And this leads to the possibility of defining 10 pelvic vertebrae: 6 sacral + 4 coccygeal. This me sound like a juggling with anatomical terms. However, it is not because there is (even) an embryological argument to support this different point of view.

DEVELOPMENTAL MOVEMENT OF ORGANS

Developmental movements of organs and even complete organ systems can and will cause an increase of a physical strain within the fibers of connective tissue. Hence, also on the future vertebral column. Because the development can be described as a movement, one of the characteristics of that movement becomes apparent within the characteristics of the fibers: the fibers receive a spatial orientation. Fibers in a retension field show a clear direction. This becomes quite evident in structures such as ligaments and tendons where fibers are trajectorial aligned. A densified form of these fibers is also present in bony structures. We call them trabeculae. They also have a distinct spatial orientation! It is an orientation in continuity with the fiber direction of neighbouring and less dense connective tissue, the fascial system. Traces of developmental movements related to organs are eminently present within the structuration of bones (**Fig.16.2.**)!

> When we study thoroughly the movements of the organs that are involved in the urogenital development, it becomes obvious that the directional strain of this event extends far into the so-called lumbar region. Structures such as the Ligamentum suspensorium ovarii extend fan-shaped into the region of vertebra lumbar 5. Within that same region, there are other changes of textures as well. Ligaments such as the iliolumbar are clearly densifications that appear from strain, partially caused by the developmental movements of the urogenital organs. In later life, these structures are put under additional strain by gravity as soon as the individual comes into an upright position.
>
> About the Sacrum and Os coccyges: we should emphasize that the developmental movements of the urogenital system and pelvic floor are (to a large extend) responsible for the ossification process between the individual segments in this region – see chapter "*34. The pelvic inner tissue space"*.

16.2.3 The influence of gravitation

Once we are born, one of the most confrontational changes in our environment is gravity. It puts an immense strain on our body. This strain has an enormous impact on our connective tissue. In the attempt of dealing with this physical stress, forces are guided into the direction of less resistance. With other words: the fibers of our loose connective tissue become even more organised by alignment (along the direction of the force). And what about those who are already spatially, trajectorially organised? Well, these fibers become "reinforced"[180] by an increasing number as well as by a

[180] The term "reinforced" is maybe not well chosen. Because it is not so much that the fibers become stronger, but it is more that the number of fibers increases. This is also valid for the impact of our physical activity. Physical activity, like gravitation, causes a strain

push-out of fluid. Clearly we can notice a shift from permeability towards density (see also section "*4.2. Inner tissue*", **Fig.4.3.**).

A distinct characteristic of the increasing number of fibers as well as their densification is that their direction of less resistance (direction of ease) corresponds with the direction of a developmental pattern. A pattern that is "already pre-installed" by the developmental movement of organs and organ systems! This leads us to the conclusion that our behaviour under gravitational circumstances enforces the existing characteristics of structuration (configuration) and texture (density) resulting from prior developmental movements.

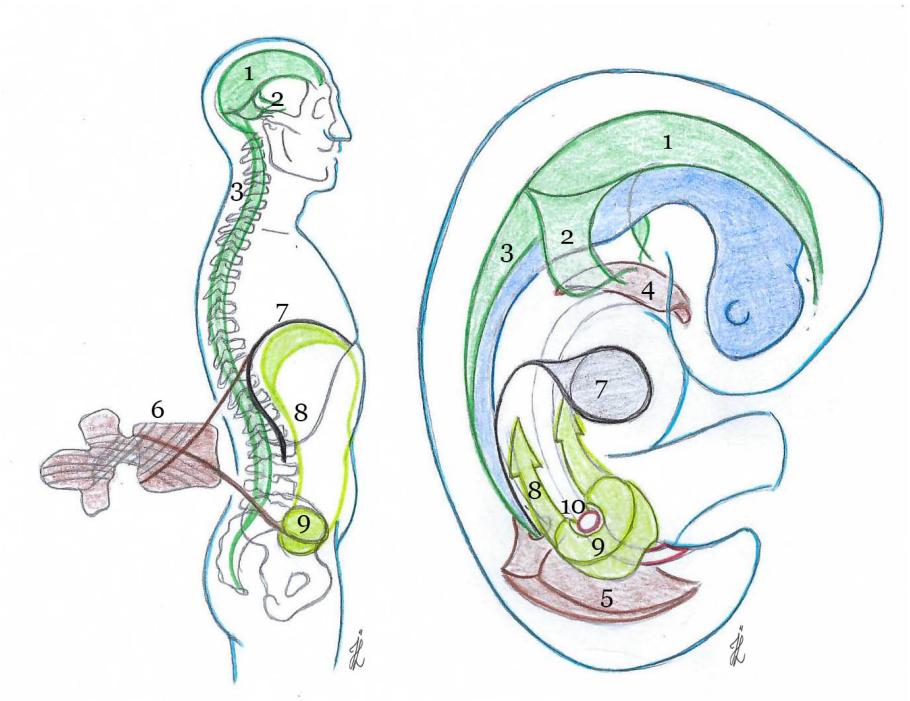


Fig.16.2. Relationships of strain

1 Falx cerebri. 2. Tentorium cerebelli. 3. Dura mater spinalis. 4. Basis cranii. 5. Os sacrum. 6. Vertebra. 7. Diaphragma abdominalis. 8. Peritoneum parietale posterior (or Fascia of Toldt, or Ligamentum suspensorium ovarii, ...). 9. Peritoneum parietale pelvis (or Ligamentum latum, ...). 10. Tuba digestivum. (see also Fig.36.5.-6.)

In this illustration, we observe several possible relationships between different regions of the body as well as different systems (cranio-vertebro-sacral system, visceral system, urogenital system, locomotor system, …). These relationships can cause a strain on the inner tissue that leads to densation. This densation becomes apparent in the appearance of bone, which is the densest form of inner tissue. Please notice the continuity of the fibers that eventually become the trabeculae of the bone.

on the inner tissue space. A strain that is counterforced by the positional relationships between the different structures that are present in that inner tissue space. And although the texture of these structures is different (fluid-viscosity, cell-turgor, fiber-tension), they are all characterized by the same trajectorial alignment that corresponds with the direction of the strain.

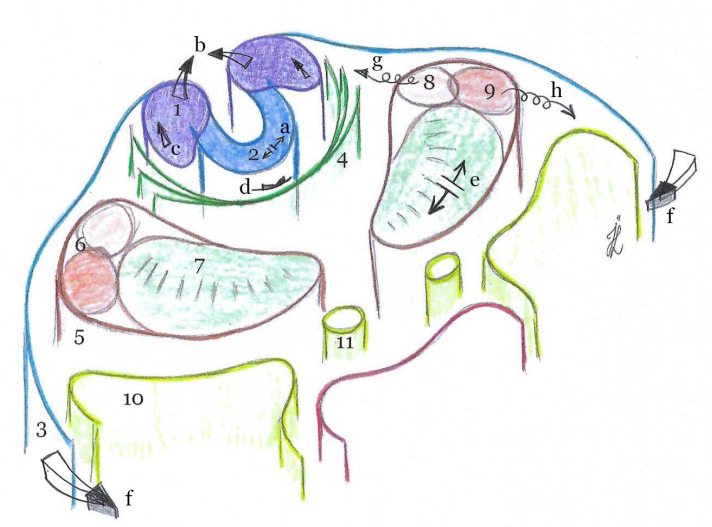


Fig.16.3. Muscle development (striated)

1. Dorsal bulge. 2. Neural groove. 3. Epiblast. 4. Fibers of Pachymeninx. 5. Somite. 6. Dermomyotome. 7. Sclerotome. 8. Epimere. 9. Hypomere. 10. Intra-embryonic coelom. 11. Dorsal aorta.

a. Compression forces resulting from cell cleavage.

b. Closure of the neural groove under restraining influence of lateral branches of dorsal aorta.

c. Part of dorsal bulge that remains relatively behind and becomes the future spinal/cranial ganglion.

d. Restraining influence of fibers belonging to future Pachymeninx.

e. Compression forces that originate from a closing angle between epiblast and future neural tube.

f. Beginning of developmental movement that results into the closure of the trunk under the influence of a closing angle between epiblast and future neural tube

g. h. The opposite direction of forces in the region of the dermomyotome. The cells of the myotome become elongated (dilation field) in opposite direction. One part is under the influence of the closure of the neural groove (g) and the other under the influence of the closure of the future trunk (h). The first becomes the epimere and the second the hypomere.

16.3 Musculi paravertebrales

16.3.1 Opposite forces of development

The dorsolateral part of the somite is called the dermomyotome. In the early stages of development, this dermomyotome appears as one package. It is not until later stages that we can distinguish a fine line in between the two layers of this dorsolateral part (**Fig.16.1.**-bottom and **Fig.16.3.**). This fine line indicates the presence of a small fluid chamber in the heart of the dermomyotome. This is another indication for the strong metabolic activity in that region (see section "*3.5.2. The appearance of a cyst*").

As the development continues, the cells of the myotome receive a distinct appearance. They look elongated, extended. Prof. Blechschmidt describes in this context the presence of a morphokinetic field called dilation field. A dilation field is a biodynamic field in which forces within the inner tissue space elongate cells. Eventually, these cells become muscle cells.

In relationship to the trunk, we can distinguish two groups of cell clusters that transform into striated muscles. We call them epimere and hypomere. The epimere is the Anlage for the future paravertebral muscles. The hypomere is the Anlage for the muscles of the trunk (ventrolateral wall of the trunk).

It is most likely that the elongation of the cells (dilation field) as well as subdivision into the two muscle groups is a result of opposite forces. Based on the trajectorial characteristics of the muscle from the epimere, we may conclude that the dilation fields in that region are related to the closure of the neural groove. Within the muscles that develop from the hypomere, we see the same trajectorial characteristics as those related to the closure of the trunk (see part 3).

16.3.2 Layers of age and length

When we study the anatomy of the paravertebral muscles (epimere), we can notice a certain pattern of appearance. The shortest muscles are lying in the deepest layer. These muscles are also less longitudinally organized. This corresponds with the local transversal pattern of closing the groove into a tube. The longest muscles of the spine have a distinct longitudinal orientation and are positioned more superficial. This pattern shows many characteristics with the regional and systemic bending of the embryo towards ventral. What we can observe, is a same pattern as in the nervous system: older layers in the depth, younger layers more superficial; older layers short, younger layers long.

Please keep in mind, that muscles should not be seen as isolated structures. Always look at them as local or regional derivatives of several dilation fields with a common trajectory!

16.3.3 About muscle contraction

All muscles, without any exception, are a transformation of inner tissue cells under circumstances of traction/elongation. Circumstances that we can observe within a dilation field. A dilation field, just like a retention field, is often the result of a distusion field[181]. This dilation field is an expression of an expansion growth. In this case an inflation growth of swelling young cartilage cells (distusion field). It is a growth that the cells of the epimere cannot follow with the same speed. Consequently, these cells become elongated.

This elongation will not only change the form of the cell but also increases the resistance within the cell membrane. The resistance of the cell membrane is defined as the turgor of the cell. In the case of the future muscle cell, this turgor is the basic tonus of that cell. It is the physical expression of its metabolic state in the context of its environmental conditions. Any metabolic response of that cell to a change in the environment leads to a change in the turgor/tonus of that cell. Whenever this tonus is increasing, the muscle will contract. Please notice that the direction of the contraction is an inversion of the initial elongation!

[181] This is not always the case. Smooth muscles such as muscles of blood vessels and organs have another motor behind the dilation field (for instance growth of organs – see part 3 and 4).