Alexander Gurwitsch And the Concept Of the Biological Field,

Part 2

by Michael Lipkind

Alexander Gavrilovich Gurwitsch (1874-1954)

A student of the great biologist discusses the importance of Gurwitsch's thought and work.

From archives of L. Beloussov

EDITOR'S NOTE

In part 1, which appears in the Summer 1998 issue of 21st Century, *p. 37, virologist Michael Lipkind presents the history of Gurwitsch's work, and his development of the theory of the biological field, from successive models describing the development of specific tissues during embryogenesis, to the formation of dynamic molecular constellations. Lipkind also describes Gurwitsch's discovery of the emission of coherent photons from cells in mitosis, which could trigger mitosis in other neighboring cells.*

In part 2, Lipkind sets forth Gurwitsch's postulates of the biological field theory, and raises again the question of what organizes the unique properties of living systems. "What accounts for the evident fact that chemical processes in living systems proceed differently than those in vitro (outside living systems)?" The field theory acts as a guide to experimentally answer this question, and Gurwitsch demonstrates that the biological field is vectorial and anisotropic, which creates singularities within living systems.

Lipkind also addresses Gurwitsch's approach to the singularity of the function of the brain cortex, and the failure of the classical neuron theory to explain the "break of continuity" between receipt of stimuli and the generation of thought.

The author is currently a research professor of virology at the Kimron Veterinary Institute in the Volcani Center for Research in Agriculture in Israel. Lipkind also works at the International Institute of Biophysics in Neuss, Germany, whose main research focus is biophotonics, which is a continuation of Gurwitsch's mitogenetic radiation, and is a member of the board of directors of the Institute.

Future 21st Century *articles will report on current research in the field of biophysics. Lipkind's two-part series was edited by Colin M. Lowry and David Cherry.*

Postulates of the Theory and Nature of the Field

The basic postulates of Gurwitsch's theory of the vectorial biological field are these:

1. Each cell is a source of the field.

2. The field is vectorial in nature and the vectors are directed centrifugally from the source.

3. The generation of the field is associated with processes in the nucleus, related to transformations of chromatin (DNA). The choice of chromatin as a source of the field relates to its strict continuity throughout the life cycle, and its transfer by heredity, as well as its incredible stability in vivo as a substance, compared with all other material components of the living system.

4. There are elementary "flashes" of the generated field, which are connected with certain events in the metabolism of the chromatin. It is suggested (without strong obligation) that these events involve interactions of the chromatin with certain kinds of proteins. The total number of flashes per unit time, designated as field intensity, depends immediately on the intensity of chromatin metabolism and on general cell metabolism.

5. The elementary flashes of the generated field associated with chromatin metabolism can occur only within the already existing field. Essentially, this is the expression of the succession of processes in living systems, or the proclamation of the principles declared by William Harvey (*"omne vivum ex ovo"*) and Louis Pasteur's rejection of the spontaneous generation of life.

6. The field vectors originating from the nucleus result from the distribution of elementary field flashes at any given moment. Therefore, the field intensity is a completely dynamic, fluctuating parameter, which reacts subtly to metabolic changes.

7. The field is spatially anisotropic, and this is the main postulate. This means that the isodynamic surface at which all the vectors are equal is not spherical, but ellipsoidal. The anisotropy of the ellipsoid can be expressed as a ratio among its three axes, and such ratio, being species-specific, is considered an invariant species constant. An infinite number of possible axis ratios covers all the potential species.

8. The field vector decreases in strength with increasing distance from the field source. It is reasonable to assume that the value (length) of the vector depends on the square of its distance from the source, but the true function is a matter of empirical examination. In spite of the decrement, the influence of the field is not limited by the cell boundary, but spreads beyond it.

9. Field vectors exert influence upon excited protein molecules, transforming a portion of the excitation energy into directed kinetic energy, and the direction of the movement is determined by the field vector. This is expressed either in the directed movement (flow) of the excited protein molecules along the vector, or in specific deformations of the protein molecule, especially when they are in a state of stable polymerization. This means that in the living state the field works against the chaotic movement of protein molecules.

10. The intensity of the field at a certain point (the length of the vector at this point) determines what share of the whole molecular excitation energy is transformed into the directed kinetic form. This can be represented as the ratio between the directed kinetic energy and the total excitation energy of the molecules. The intensity of the field does not depend on the amount of chromatin: It depends on its metabolic turnover.

11. The vectors from separate field sources can be composed geometrically, and the resulting vector will determine the direction of the kinetic energy at the point of composition. In a multi-celled embryo, there is an integral actual field resulting from the geometric composition of all the vectors issuing from all sources (nuclei). In such a composition, both the field intensity and the field anisotropy make contributions to the value of the resulting vector.

Although the nature of the biological field is not defined in these postulates, two comments concerning this problem are in order.

First, Gurwitsch's biological field cannot be reduced to any known physical field: It is an immanent property of living things. According to postulate 5, the elementary flash of the field is induced only by the existing field, so that it is successive and cannot originate de novo. This is the full expression of the vitalist principle.

Second, Gurwitsch's biological field is not energetic, which means that no special energy is focussed in the field source. The field vector transforms a portion of the metabolic energy accumulated in the excited protein molecules into directed kinetic energy, moving or deforming the molecules. The energy is not supplied by the field to the site of its action, instead the field vector employs the local energy accumulated at the site.

The Analysis of Actual Integral Fields

The above postulates express the logical basis of the conception of the vectorial biological field, which is presented as a universal, fundamental, biological (vitalistic) invariant principle. In this form, the conception is balanced logically, and contains no internal contradictions or tautologies. However, Gurwitsch developed his theory further, having introduced a notion of actual integral field which serves as a working principle. Descriptions and some schematic illustrations of the formation and action of the actual fields at the molecular, cellular, and supracellular levels are presented here.

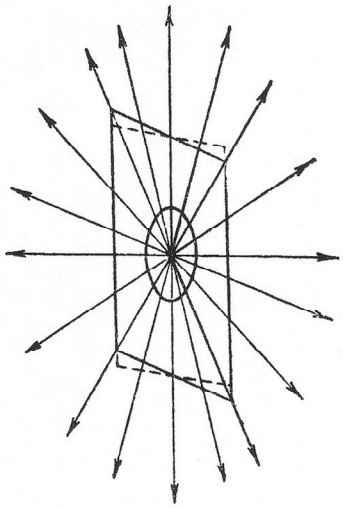

Figure 1
FIELD CONFIGURATION OF A CELL OF OBLIQUE SHAPE

The side walls of the cell are symmetric to the axes of field anisotropy, while the top and bottom walls are asymmetric to the axes. This causes the straightening of the cell (dotted lines).

Source: A.G. Gurwitsch 1944

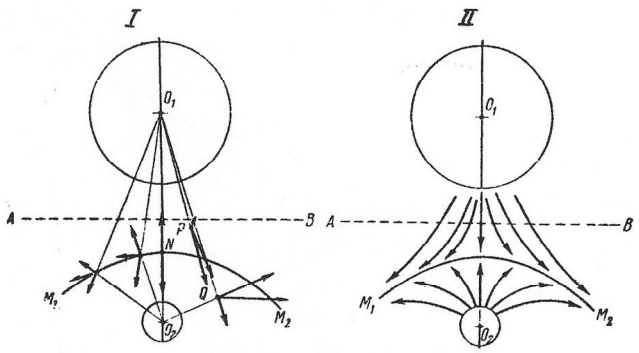

Figure 2
FORMATION OF THE NULL ZONE

The nuclei of adjacent cells, O_1 and O_2, are the sources of isotropic fields whose intensities are proportional to the diameters of the circles. Drawing I shows the vectorial calculation for some particular points. Drawing II provides the general picture. The borderline between the cells is A-B, and M_1-M_2 is the null zone. The resulting vector at point N is zero, and elsewhere along M_1-M_2 the resulting vectors are tangentially directed; at points P and Q, beyond the null zone, the resulting vectors are directed towards the null zone.

Source: A.G. Gurwitsch, *Analytical Biology*, unpublished; the figure is reproduced from Beloussov 1963

Molecular Level

In a single cell, if the nucleus is considered the field source, it will have a repulsive action on the excited protein molecules in the cytoplasm. This results in increasing the concentration of excited molecules towards the cell periphery. Simultaneously, a "counterflow" increases the concentration of non-excited molecules in perinuclear zones. Given such conditions, the most balanced position of the nucleus would be in the geo-

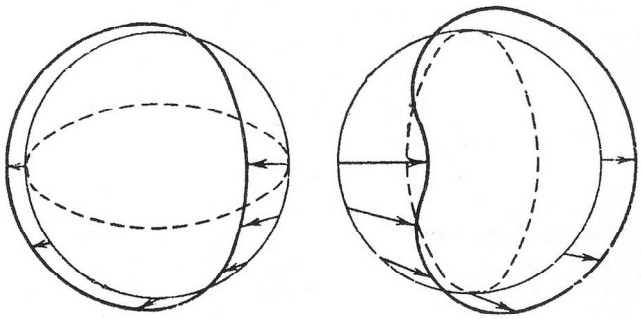

Figure 3
INTERACTION OF THE FIELDS OF TWO CELLS

The cells are initially of spherical form. The anisotropy of their fields is indicated by the inscribed ellipses. Mutually perpendicular orientations of the ellipses' long axes are shown.

Source: A.G. Gurwitsch 1944

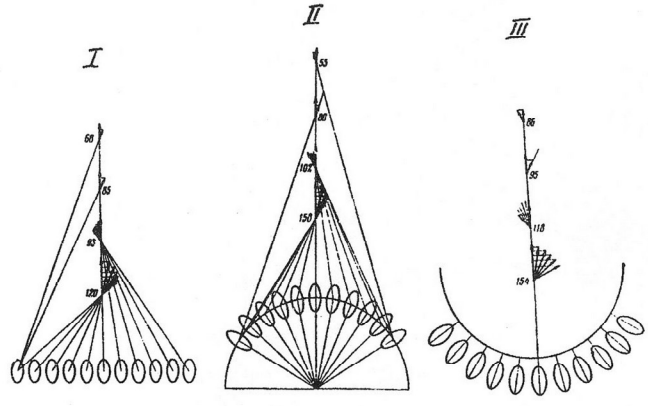

Figure 4
ACTUAL INTEGRAL FIELD FOR CELL LAYERS OF VARYING CONFIGURATION

Flat, convex, and concave configurations of cell layers. Values of the resulting vectors are given in relative units at four equally spaced points.

Source: A.G. Gurwitsch 1944

metric center of the cell. Any oblique shape, being unbalanced, would eventually become a symmetric one (Figure 1).

The interaction between two field sources (not only between the nuclei of adjacent cells, but also between chromatin-containing organelles like mitochondria and chloroplasts, or between the nucleus and centrosome within a cell) will result in the geometric composition of the opposing vectors. This leads to the formation of a "zero zone" where the value of the resulting vector is equal to zero. Since the excited molecules are driven together into these zones by the opposing vectors of the two interacting sources, the concentration of excited molecules will be maximal in these zones (Figure 2). Such "condensation zones," according to Gurwitsch, favor various molecular interactions.

However, the essential result of the field action is the formation of unbalanced molecular constellations. Insofar as the constellations form an unbalanced continuum in a defined space, the actual field within this space can have a complex configuration corresponding to the local geometry of field vectors, which, in turn, depends on the interrelations among the field sources. Therefore, the character of the unbalanced molecular constellations (their steric configuration) depends on the actual fields. On the other hand, the constellations are not only the result of, but also the object of, the actual field action.

The facilitation of the molecular reactions occurring within the "zero condensation zones" can promote the formation of stable submicroscopic structures (called vestigia by Gurwitsch) which may become visible by being constituents of intracellular structural formations. These structural "vestigia" can be considered as traces of increased molecular activity in specific "hot" points of the condensation zones, with the specificity being determined by the particular configuration of the actual field.

The analysis of the formation of the actual integral fields and their actions at the molecular level seem rather speculative, although it is based on the concept of unbalanced molecular constellations, which, in turn, is based on the phenomenon of degradational mitogenetic radiation. However, the analysis of the actual field formation at the cellular level is supported by more experimental evidence, and is more easily demonstrable.

Cellular and Supracellular Level

Transference (movements) and deformations of cells and nuclei under the influence of the actual field vectors, should be considered as a result of the transference of the internal cell molecular content. Gurwitsch performed his analysis of the actual integral fields using the formal rules of the geometrical composition of the field vectors, and found some remarkable regularities.

The simplest case of the formation of the actual field is that presented by the interaction of two single cells (nuclei). It can be seen (Figure 3), that the mutual influence of the opposite vectors results in both the divergence and deformation of the nuclei of the cells. These effects decrease with the increase in distance between the interacting cells.

The formation and action of integral actual fields in epithelial layers and large three-dimensional cell complexes are of particular interest, because these developing parts are realized through morphogenesis. The remarkable peculiarity of the actual field of the epithelial layer is that the synthetic field in each of its cells is much stronger (the resulting vector is longer) than the field vector of the local single cell would be. Accordingly, the actual field outside the layer (external field) depends on both the extent and configuration of the layer (Figure 4). It can be seen (Figure 5), that the larger the extent of the layer, the stronger the external actual field (the longer the field vector at the same distance from the layer). This means that the actual field in this case is practically without decrement, and hence the notion of the long-distance effect of the actual field should be accepted (Gurwitsch's model of the "effective cone").

As to the actual fields of large cell complexes, there is a difference between flat and spherical cell complexes. In the former case, almost all the cells (except the marginal ones) have similar field conditions: The actual field in each cell does not depend on the coordinates within the complex. In contrast, within a spherical complex, the field vectors differ considerably, depending on the changing coordinates (Figure 6).

The models considered above describing some regularities of the actual field formation are static ones. Gurwitsch also considered some dynamic situations. In particular, he analyzed the mechanism of the curving of epithelial layers, one of the main phenomena of morphogenesis. Application of the vectorial composition shows that an apparently insignificant initial displacement of one of the cell nuclei relative to an adjacent one is sufficient to start the formation of a continuously growing concavity (Figure 7). A similar consideration can be applied to the opposite case, the protruding of the epithelial layer (for example, development of the sea urchin gastrula, Figure 8).

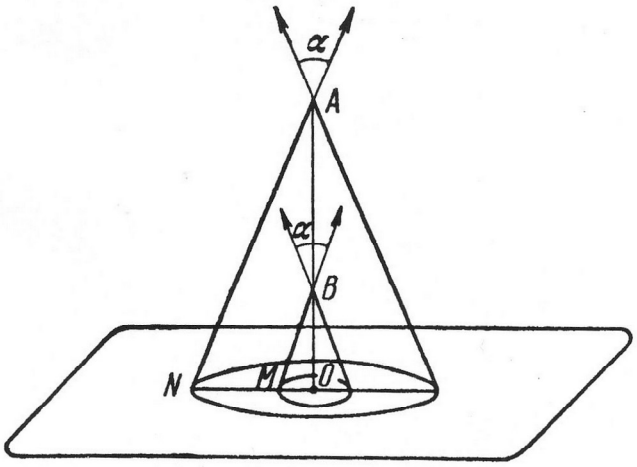

Figure 5
LONGE-RANGE EFFECT OF THE ACTUAL INTEGRAL FIELD

This depicts the long-range effect of the actual integral field from a cell layer of unlimited extent. Within angle α the field vectors do not deviate much from the perpendicular to the cell layer. At increasing distance from the layer in direction B → A, the decline in field strength is compensated for by the contribution of field vectors from cells within a larger area, denoted here as the ring MN.

Source: A.G. Gurwitsch, *Analytical Biology*, unpublished; figure is reproduced from Beloussov 1963

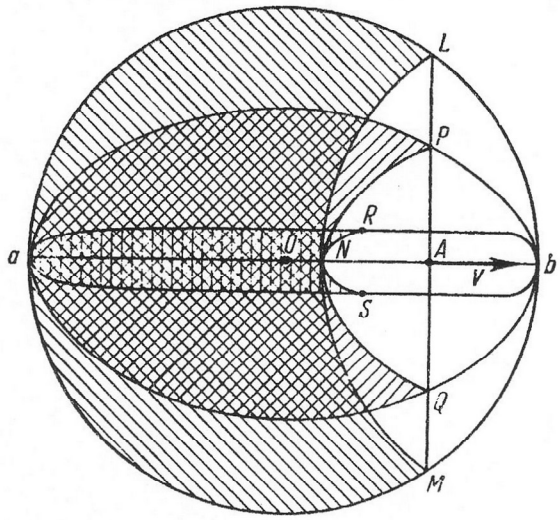

Figure 6
ACTUAL INTEGRAL FIELD OF SPHERICAL AND 'FLAT' THREE-DIMENSIONAL CELL COMPLEXES

In a spherical cell complex with surface LaMb, the resulting vector V at point A, being composed of cell vectors originating from the cells within volume LaMN, is directed toward the right: The field influences on A of cells located within two equal volumes, ALNM and ALbM, which are equidistant from A, cancel each other out. In the ellipsoidal cell complex with surface bPaQ, vector V at point A results from the field influences of cells within volume PaQN. In the completely "flat" cell complex aReS, the field influence on point A comes from the cells within volume RaSN. Since volume RaSN is greater than PaQN, which, in turn, is greater than volume LaMN, and since the center of gravity of the cell complex exerting influence from the left, moves away from point A, along with the "flattening" of the complex, vector V decreases. This means that, along with the "flattening" of the cell complex, a cell maintaining the same location relative to the complex center, "feels" its asymmetry to a lesser degree.

Source: A.G. Gurwitsch, Analytical Biology, unpublished; figure is reproduced from Beloussov 1963

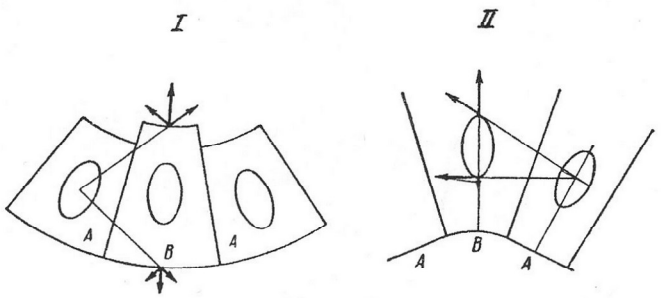

Figure 7
CURVING OF THE EPITHELIAL LAYER AS A RESULT OF FIELD VECTOR COMPOSITION

The influence of field vectors from the cells marked A on the larger cell B, is seen in drawing I: The resulting vector, directed toward the concave side of the layer, prevails over the opposite one. Further progress of the process is seen in drawing II.

Source: A.G. Gurwitsch 1944

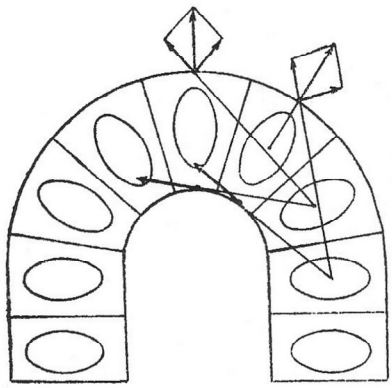

Figure 8
ACTUAL FIELD AT THE EXTERIOR SURFACE OF THE CONVEX LAYER

The vectors show the probability of the cell protruding.

Source: A.G. Gurwitsch 1944

The next model demonstrates the significance of the field anisotropy for the configuration of the actual field. It is evident that even small differences in the ratio of the ellipsoid axes, designated as an anisotropy index, can have a significant influence on the actual field.

Analysis of Living Phenomena With the Vectorial Biological Field Theory

According to Gurwitsch's epistemological principles, the fruitfulness of a theory lies only in its service as the basis for working hypotheses available to experimental examination. Gurwitsch carried out a tremendous attempt to make the theory of the biological field "work" by applying it to an incredibly wide scope of biological phenomena (Gurwitsch 1944). In addition to morphogenesis, the midwife of the field theory, the range embraced such differing biological problems as differentiation and histogenesis, mitosis, metabolism, neuromuscular function, dynamic functional organization of the brain cortex, and some aspects of the psychic sphere (somato-psychic connections) including the philosophical problem of psychic indeterminism.

In the previously described morphogenesis of the triton phalanx (Anikin 1929), the cell coordinate-dependent deformations of cell nuclei were explained by means of an abstract invariant field construction suitable for this case (see Figures 12 and 13 in Part 1). The same morphogenic phenomenology can be analyzed by means of the vectorial field conception, which easily explains both the deformations and the movements of the cells (nuclei), the model of the interaction between the two cells (Figure 3) being an obvious illustration (compare Figure 12, Part 1, p. 47 with Figure 3). Construction of the actual field of the phalanx leads to the same results as Anikin's calculations from an abstract formula.

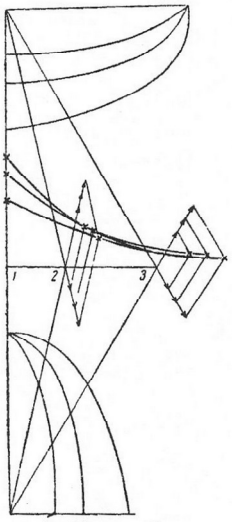

Figure 9
INFLUENCE OF FIELD ANISOTROPY ON THE ACTUAL INTEGRAL FIELD

Here two cells are shown with the long axes of their nuclei at right angles to each other. The influence of the integral field of the cells on points 1, 2, and 3 depends on the ratio between the long and short axes of the respective ellipses.

Source: A.G. Gurwitsch 1944

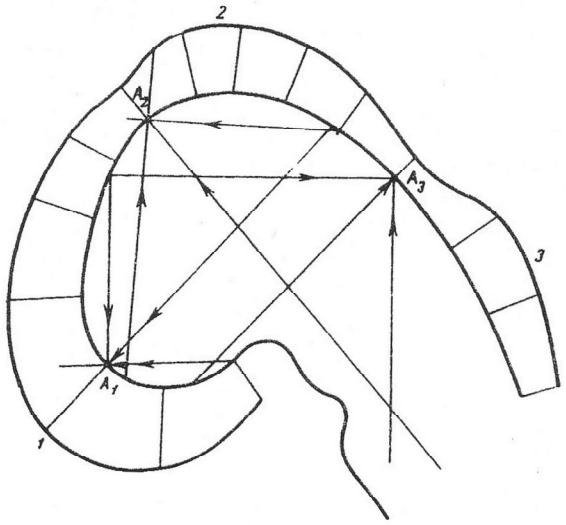

Figure 10
SIMPLIFIED DIAGRAM OF THE SYNTHETIC ACTUAL FIELD OF CEREBRAL VESICLES IN THE CHICK EMBRYO

The inner contour is a medial section through the brain of a chick embryo 40 hours old. The field interaction among areas indicated by points A_1, A_2, and A_3 is designated conditionally by three vectors: one is perpendicular to the point under consideration, and two are at 45° to the perpendicular. The values of the resulting vectors predict the external contour of the following stage, which divides the vesicle into anterior (1), medial (2), and posterior (3) brain.

Source: A.G. Gurwitsch 1944

The most demonstrable example concerns the development of the cerebral vesicles from the initially smooth neural tube of the chick embryo. This model has much in common with Gurwitsch's classic work, "The Mechanism of Form Inheritance" (1914), in which the notion of "dynamically preformed morpha" was first introduced. From the construction of the external actual fields from the opposite epithelial walls of the tube, it was possible to predict the localization of the changes in the curvature of the walls, these points becoming more and more expressed. As a result of this, the division of the neural tube into the anterior, medial, and posterior brain proceeds (Figure 10). From the configuration of the actual field, all the described phenomena, such as the indicative turning of the axes of the nuclei, their reorientations, and cell movements could be very well described (Figures 2-7, Part 1).

Except for these two objects which served earlier for the development of his early field conceptions ("dynamically preformed morpha"), Gurwitsch carried out a vectorial field construction of the more universal early stage of development—gastrulation—using the sea urchin embryo (Gurwitsch 1944). Although the blastula of the echinodermata is ideally symmetric relative to all axes, the cells in the region of the future endoderm are a little larger than those of the future ectoderm, and correspondingly, their nuclei are located a little farther from the blastula surface than those in other regions. These differences are sufficient for the local invagination, which is determined to proceed according to the schemes grounded on the basic field postulates (Figures 7, 8, and 11). It is clear from these schemes that even a low degree of field anisotropy leads in this simple case to significant morphological consequences. After completion of the invagination, the mesenchymal cells migrate out from the endoderm, that is newly formed as a result of invagination. This is explained by the field influences of the neighboring cells (Figure 8). From this follows the further arrangement of the mesenchymal cells in the form of the ring located around the invaginated primary gut. Taking into account the asymmetric (inclined) arrangement of the axes of the invagination, it is possible to explain the further transformation of the spherical gastrula (Figure 11) into the bilaterally symmetric pluteus (a larval form of the echinodermata).

Differentiation and Histogenesis

The appearance of divergence in the development of embryonal cells belonging to the same cell complex (sometimes these are the neighboring cells) is designated as differentiation. The differences among the cells become more distinct, and lead toward specific cell types acquiring special functions. The whole course of the processes occurring in the differentiating cells, leading to acquisition by the cells of a certain tissue specificity and type, is designated as histogenesis.

The differentiation phenomenon presents insuperable obstacles for the preformist conception. Hans Driesch's principle of equipotentiality declares the dependence of the cell's fate on its position in the whole, meaning that any displacement of the cells within the whole will not change the final result, only the fate of an individual cell. This fate is realized especially through differentiation. Therefore, equipotentiality in this case means the "actuality" of the observed divergence between the

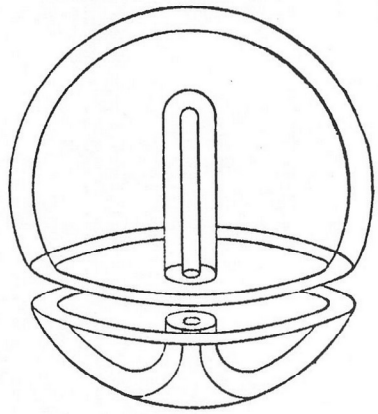

Figure 11
SECTION THROUGH THE SEA URCHIN GASTRULA AT THE LEVEL OF THE MESENCHYMAL RING
Gurwitsch suggests that this section through the sea urchin gastrula corresponds to the "zero level" of the resulting vector of all the cells of the ectoderm and endoderm.

Source: A.G. Gurwitsch 1944

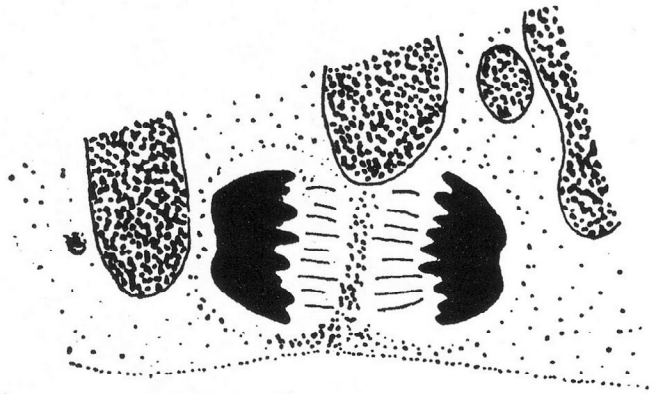

Figure 12
AN ISOLATED MITOSIS IS SYMMETRIC (AXOLOTL)
The mitotic figures are symmetric in this isolated mitosis in the cerebral vesicle of the axolotl.

Source: Puchalskaya 1947

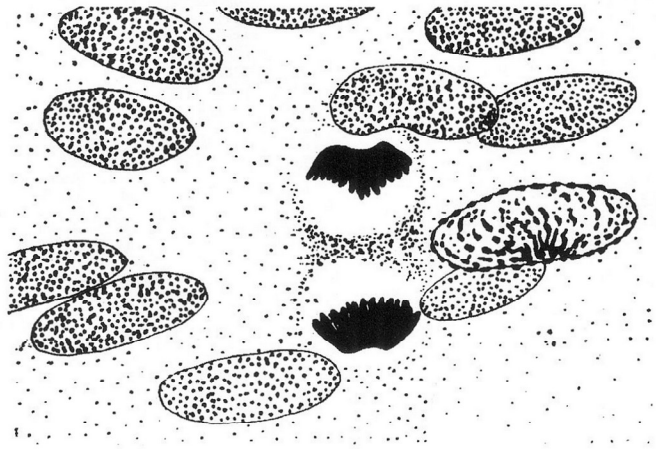

Figure 13
SYMMETRIC TELOPHASE IN THE PRESENCE OF A CELL IN PROPHASE (AXOLOTL)
The long axis (heteropolar vector) of a neighboring cell in prophase, does not intersect the mitotic figure in telophase, which remains symmetric (axolotl cerebral vesicle).

Source: Puchalskaya 1947

differentiating cells (the absence of predetermined entities responsible for the observed differences).

Thus, the epigenetic principle in this case comes forward in the most enigmatic form, even more incomprehensible than that in the case of morphogenesis. The latter case could be realized through the action of some forces (vectors) moving the cells "mechanically" (that is also mysterious, but presents a simpler imagination of the mode of action of any hypothetical "organizing factor," even such an indeterminable one as entelechia). In the case of differentiation, the position within the whole is realized through the involvement of different intracellular processes determining the pathway of histogenesis.

The theory of the vectorial field describes the problem of differentiation by means of relatively simple assumptions (Gurwitsch, *Analytical Biology*). The "actuality" (in contrast to the preformist determination) of the apparent divergence between the cells under differentiation is caused by continual evolution of the actual integral field of both the cell complex and each individual cell. Gurwitsch considers the actual field of each cell as a "microfield" composed of the neighboring cells, on which the "macrofield" of the whole complex is superimposed. Although the results of such interaction can be unlimitedly different, Gurwitsch considers the two main types of the actual field configurations: (a) the sharp prevalence of one vector (anisotropic character of the field), and (b) a relatively homopolar actual field. The former type of the actual field is compatible with the epithelial layers in which the cells are spatially bound, and the anisotropic character of the actual field can persist for a certain period of time. This is realized at the marginal zones of the actual "macrofields" (at the surfaces of the multilayer cell complexes) and, thus, zonal differences in the actual field of the complex can be expected. Accordingly, within the same zone there can be differences among the actual fields of the individual cells ("microfield") which are expressed in the appearance of "condensation (zero) zones" (Figure 2), with the high concentration of the excited molecules facilitating certain chemical reactions and the formation of irreversible "vestigia."

Thus, the actual fields of homogenous complexes consisting of equipotential cells can induce differences both at the level of cell layers and in individual cells, and these differences may become irreversible. Hence, the phenomenon of differentiation is described here from the epigenetic point of view, compatible with the experimentally proven concepts of equipotentiality and equifinality. The above considerations about the origin of the divergence as the cause of differentiation are supported by the evidence that both zonal and individual differentiation are observed in the marginal zones, for example, the differentiation of retinal rods and cones (zonal) and that of neuroblasts (individual).

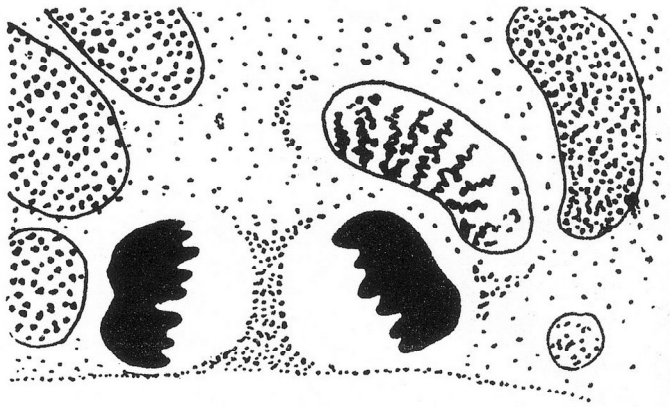

Figure 14
ASYMMETRIC TELOPHASE IN THE PRESENCE OF A PROPHASE CELL (AXOLOTL)
The long axis of the adjacent prophase cell intersects the mitotic figure in telophase, leading to displacement of the closer daughter telophase figure (axolotl cerebral vesicle).

Source: Puchalskaya 1947

The most interesting phenomenon of histogenesis, according to Gurwitsch, is the increasing divergence from the cell principle (meaning that the phenomena are not simply the result of changes in individual cells) which is so evident during the early embryonal period, before differentiation. This divergence can be expressed in either an initial construction of a new type of cell organization, or the formation of extracellular structural elements (for example, collagen fibers).

The basis for the description of the latter case by the theory of the biological field, is demonstrated by one of its main postulates, declaring the spreading of the cell field vectors beyond the cell borders. This postulate is strengthened by the conclusion that there are long-distance field effects from the epithelial layer (Figures 4, 5). The actual fields in the extracellular areas may form not only the "zero points" but "zero lines" and "zero surfaces," which, being condensation zones, promote the synthesis of the peptide chains oriented according to the directions of the condensation surfaces. Gurwitsch emphasizes that all of these considerations seem to be "very simple," but they permit us to understand the strict regularity in the orientation of the fibrils in bone plates, the cornea, and different cuticular and skeletal formations of invertebrates.

As to the construction of the cell organization, Gurwitsch accepts the assumption that there may be more than one field source in certain types of cells. This assumption is supported by evidence for the presence of chromatin-containing structures (field sources) in the cytoplasm, such as mitochondria or chloroplasts, or the centrosome (considered a nucleus-derived structure). The presence of additional field sources within the same cell leads to the formation of the intracellular actual field, which breaks the stability of the settled "macrofield" and becomes a factor of further irreversible evolution within the intracellular range, while the whole complex is completing its morphogenetic development. This helps explain the continuous cellular changes occurring during the process of histogenesis.

Mitosis

The best example of the field analysis applied to the subcellular level was the adequate description of mitosis which presents a highly complicated chain of events realized in an incredibly strict sequence and coordination in space-time. All the stages of the "miraculous phenomenon of karyokinesis" (Gurwitsch 1941) were analyzed by Gurwitsch in every detail by means of the vectorial field postulates, and described in his unpublished work, "The Theory of Mitosis" (1954). However, these model constructions were supported in a brilliantly illustrative way by the studies performed by E. Puchalskaya, under the direct guidance of Gurwitsch.

The studies were carried out on cerebral vesicles of amphibian embryos, meristems of onion roots, and microsporocytes of larch (Larix sp.). It was found that in a high number of the mitoses in the late stages, such as anaphase and telophase, the karyokinetic figures are asymmetric. The asymmetry was expressed in distortion of the mitotic spindle which is "normally" rectilinear, and in displacement or rotation of the mitotic figures in late anaphase and telophase. Further observation of the asymmetry showed that in some of the cases, there were mitoses in the neighboring cells, but at an earlier stage (prophase and metaphase), while in the case of isolated mitoses, these were usually symmetric (Figure 12). The existence of mitoses at an early stage in the neighboring cells was not always a condition for the occurrence of asymmetry. However, the asymmetry was found to depend on a certain specific steric orientation of the prophase or metaphase figures in the neighboring cells (Figures 13 and 14).

An "ordinary" explanation would be that the observed asymmetry is the result of mechanical factors: The cells with earlier mitoses have a higher turgor which would be a cause for mechanical pressure. As to the amphibian brain cells, the asymmetric displacement of the mitotic figure was not usually followed by any changes in the cell boundaries, but the absence of strict cell boundaries, and the small size of the cells, made it impossible to totally exclude the mechanical factor. However, in the plant cells, especially in the meristems of the onion roots, with their thick, rigid cell walls, clear-cut cell contours remained unchanged in the cases of heavy asymmetry, which permits the exclusion of the "mechanical" hypothesis. The important fact was that the existence of neighboring cells with prophase or metaphase mitotic figures was not the only condition for the induction of asymmetry: the mitotic figures of the prophase and metaphase cells were specifically oriented relative to the cells in anaphase and telophase in which the mitotic asymmetry was observed.

The analysis of this puzzling phenomenon by means of the vectorial field postulates, was based on the following working hypothesis. The field anisotropy, expressed as a specific ratio of the ellipsoid axes of the elementary field flashes, relates also to the vectors originating from the nucleus as a field source. Similarly, the same anisotropy principle is applicable to any chromatin-containing derivatives which can be field sources, and the mitotic figure is an example of this case.

Calculations show that if one takes into account the specific horseshoe-like form of the chromosomes in prophase and metaphase, the resulting field vector of the cell will pass through its geometric center, and through the "navel," the place between the arms of the horseshoe-shaped chromo-

somes. Accordingly, this vector is characterized by heteropolarity, which means that, although it is oriented along the axis of the metaphase cell, the vector is considerably stronger (longer) in one preferred direction, coinciding with the "navel" site of the chromosomes. Also, chromatin metabolism substantially increases during mitosis, as the DNA in the chromosomes becomes condensed and tightly packed, reaching its maximum at metaphase, and declining considerably during anaphase and telophase. Therefore, insofar as the value of the field vector depends on the chromatin's metabolic activity, the prophase and metaphase cells produce very strong field sources. Thus, because of both the anisotropy law and the high intensity of the chromatin metabolism, the resulting vector of the metaphase and prophase cell is a strong heteropolar vector "shooting" preferentially in one direction. This working hypothesis was used by Puchalskaya (1947), with the following results.

It was observed that the asymmetry in anaphase and telophase cells was found in those cases in which the prophase or metaphase figures in the neighboring cells were oriented in such a way, that the direction of the resulting heteropolar field vector crossed the anaphase and telophase figures (Figures 14-23). All of these illustrations, obtained in different objects,

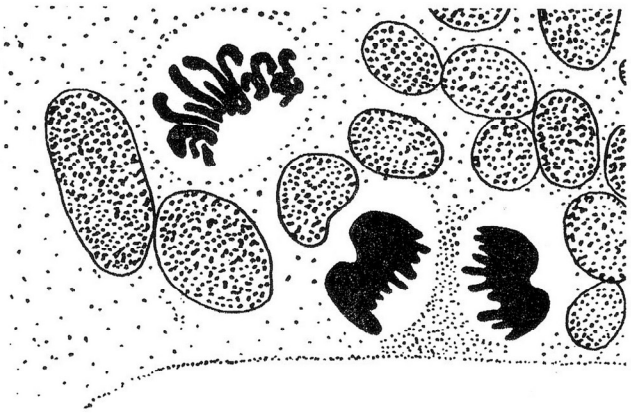

Figure 15
ASYMMETRIC TELOPHASE IN THE PRESENCE OF A CELL IN METAPHASE (AXOLOTL)
The long axis of the adjacent metaphase cell intersects one of the daughter mitotic figures, which corresponds to its displacement (axolotl cerebral vesicle).

Source: Puchalskaya 1947

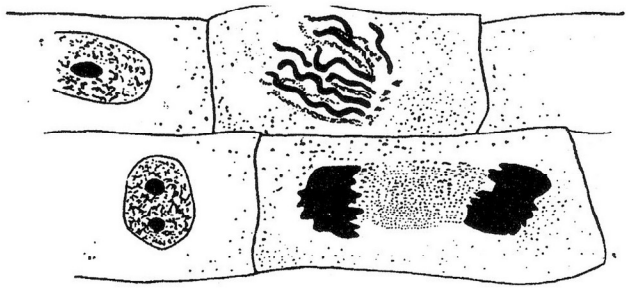

Figure 17
INFLUENCE OF PROPHASE CELL ON A TELOPHASE MITOTIC FIGURE (ONION)
The heteropolar long axis of the cell in prophase intersects the telophase mitotic figure: One of the daughter figures is displaced (onion root).

Source: Puchalskaya 1947

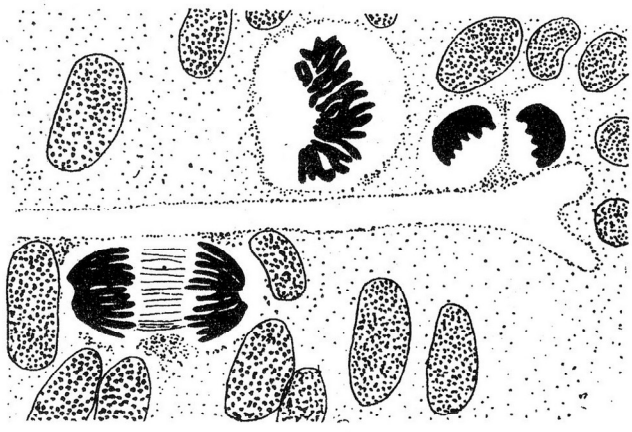

Figure 16
ASYMMETRY AND SYMMETRY IN TELOPHASE AND ANAPHASE (AXOLOTL)
An asymmetric telophase is intersected by the axis of a cell in metaphase (above); a symmetric anaphase (below) is not intersected by the same axis (axolotl cerebral vesicle).

Source: Puchalskaya 1947

Figure 18
INFLUENCE OF PROPHASE CELL ON AN ANAPHASE MITOTIC FIGURE (ONION)
The heteropolar long axis of the prophase cell (left) intersects the anaphase figure: One of the daughter figures is displaced (onion root).

Source: Puchalskaya 1947

demonstrate the same regularity. On the contrary, in all cases where the prophase or metaphase figures in the neighboring cells are oriented such that the resulting vector does not intersect the anaphase and telophase cells, there is no asymmetry, even though these field sources are in close proximity (Figures 12, 13, and 21). Figure 21 points toward the triumph of the working hypothesis: It shows two prophase figures in adjacent cells, whose resulting vectors are "missing the target," with the telophase figure remaining perfectly symmetric.

The statistical treatment of data obtained from onion root meristems produced the following results: (a) from a total of 339 cases of isolated mitoses, 35 were asymmetric (10.3 percent); (b) from the total of 115 cases in which the direction of the resulting vectors of the neighboring prophase and metaphase cells intersected the later mitotic figures, 113 were asymmetric (98.3 percent); (c) from the total of 303 cases in which the direction of the resulting vectors of the neighboring prophase and metaphase cells did not intersect the later mitotic figures, only 2 showed asymmetry (0.7 percent). Similar data were obtained for the other objects studied.

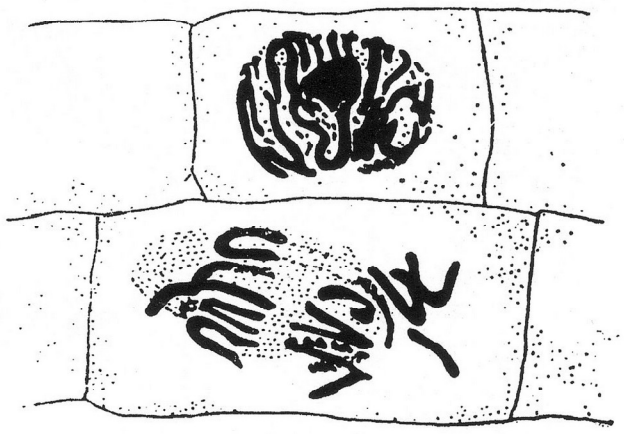

Figure 19
MORE DRASTIC INFLUENCE OF PROPHASE CELL ON AN ANAPHASE MITOTIC FIGURE (ONION)
The heteropolar long axis of the prophase cell (right) intersects the anaphase mitotic figure, which corresponds to its displacement (onion root).

Source: Puchalskaya 1947

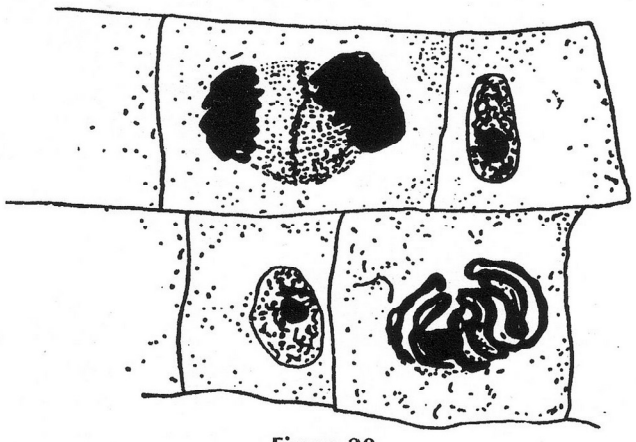

Figure 20
INFLUENCE OF PROPHASE CELL ON A TELOPHASE MITOTIC FIGURE (ONION)
The long heteropolar axis of the prophase cell intersects one of the daughter telophase figures, which corresponds to its displacement (onion root).

Source: Puchalskaya 1947

These results present demonstrative evidence supporting the principal postulates of the vectorial biological field conception concerning the correlation between field intensity and that of chromatin metabolism. Dramatic changes in morphology of the mitotic figures are remarkably explained by the repulsive action of the vectorial field of prophase and metaphase cells, which have a strong resulting vector, resulting from the high intensity of the chromatin metabolism, and the sharply expressed field anisotropy.

These unique data, which were published in Russian in a small collection of articles on mitogenesis and the theory of the biological field (Puchalskaya 1947), have escaped all attention of Western science.[1]

Reversible Physiological Processes

Although Gurwitsch's elaboration of the biological field theory was based on fundamental problems of developmental biology, the reversible processes had to be intently considered, insofar as the theory began involving all of the levels of biological organization, including the molecular level. Gurwitsch's keen interest in the processes of nervous excitation and regularities of brain cortex function had appeared earlier (Gurwitsch 1929): It was part of his general interest in reversible re-

1. Experiments by Herbert A. Pohl, in the early 1980s, measured the dielectric field strength at the exterior of living cells, and found that the field intensity was greatest during mitosis, specifically metaphase. This result clearly supports Gurwitsch's hypothesis (H.A. Pohl, ed. 1987). —Eds.

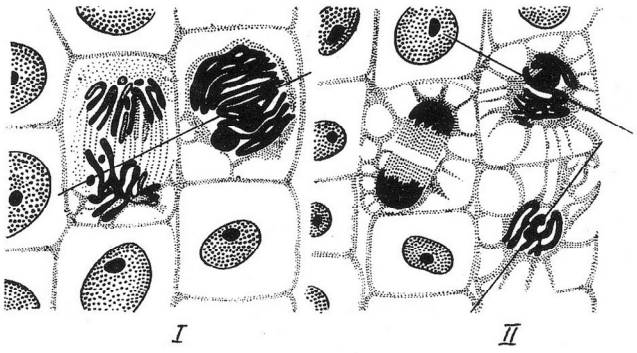

Figure 21
INFLUENCE OF SPATIAL ARRANGEMENT OF MITOTIC FIGURES ON THEIR MORPHOLOGY (ONION)
The long heteropolar axis of the prophase cell intersects one of the daughter anaphase figures, causing distortion (I). The long heteropolar axes of two adjacent prophase cells (II) do not intersect an adjacent telophase figure, which remains perfectly symmetric (onion root).

Source: Puchalskaya 1947; reproduced from Beloussov 1963

actions as physiological processes, which he tried to comprehend on the basis of the same supreme principles of equipotentiality and equifinality. The discovery of degradational mitogenetic radiation (A.G. Gurwitsch 1937b, L.D. Gurwitsch 1937a) gave an experimental basis for the conception of unbalanced molecular constellations, which appeared to be the main "working" principle for the application of the vectorial biological field theory to reversible processes.

The logical thread of Gurwitsch's considerations in this area is as follows.

In the individual life cycle, "unrestrained" embryonic development, resulting from interactions of continuously evolving actual synthetic fields, finally fades away, and gives way to a stabilization of the resulting field of the whole. Thus, progressive, irreversible processes gradually cease and are exchanged for stationary, reversible ones. Parallel to this, the actual synthetic fields cease evolving, and identical and invariant individual cell fields become independent and dominant. This is not a "field background" for the reversible processes proceeding independently, but the field is a species-specific invariant factor that determines the conservative character of the current reversible "acts" or reactions.

Central Metabolic Processes

Because metabolism is one of the central problems of both classical biochemistry and modern molecular biology, it is the very image of the tremendous advances made by the analytical trend dominant in the biological sciences. At first sight it seems to have no deficiency in its theoretical basis, and there is doubt whether all of the above-mentioned "supreme" principles can be applied to the metabolic processes. Accordingly, enzymology, which serves as a basis for metabolic biochemistry, is one of the most elaborated branches in biology. The modern undisputed dogma "gene → enzyme" seems to serve as a magical bridge between the higher sphere of determining (and regulating) factors and the inferior layer of executive agents.

The situation is not, however, so harmonious. Indeed, the whole edifice of metabolic biochemistry rests on the fundamental notion of the enzyme as a highly specific biological catalyst, which is believed to provide at the molecular level all the complicated specificity of the observed living phenomena. However, the enzyme's high specificity, to correspond to the observed living phenomenon, must be projected onto a highly complicated network of the enzyme-directed metabolic pathways. The schemes of these pathways are composed on the basis of the results of studies of each particular enzyme reaction. However, any particular living phenomenon proceeding at a higher level (cellular or supracellular), if resulting from events occurring at a lower (molecular) level, must be determined by a high number of enzymatic reactions highly coordinated in space-time. It becomes evident that precisely this coordination is what determines the observed specificity of the living phenomena.

The conditions of the enzymatic reactions defined in purely chemical terms are absolutely insufficient for explaining the specificity of the living phenomenon observed at the higher level. Thus, any attempt to infer the coordination of enzymatic acts from the conditions of the same molecular level is a failure, and evidently needs the involvement of factors of quite another kind. An attempt to ascribe the coordinating conditions to cell membrane structures or surfaces (Golgi body, endoplasmic reticulum, cytoskeleton, and so on), meets the same logical obstacles. The specific "architectonics" of the membrane structures which are to provide the specific spatial arrangement of the chemical processes in vivo does not preexist in a completed form, but itself is constituted as a result of some specific synthetic reactions.

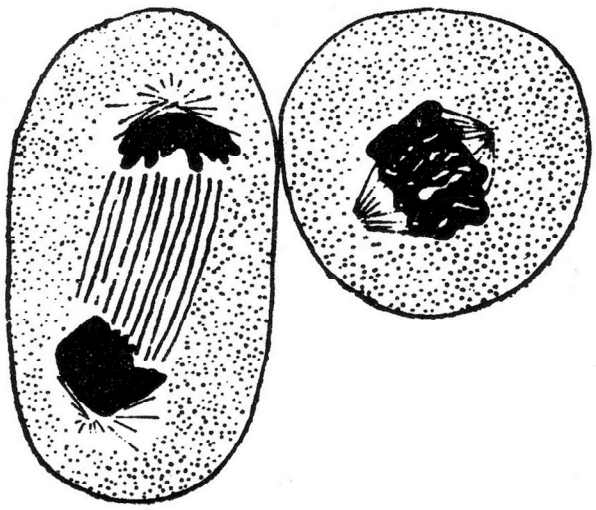

Figure 22
INFLUENCE OF ORIENTATION OF MITOTIC FIGURES ON THEIR MORPHOLOGY (LARCH)
In the case of two maternal microsporocytes, one of the daughter telophase figures is intersected by the long axis of the other cell nucleus in early anaphase, and is displaced.

Source: Puchalskaya 1947

The involvement of the genomic level does not solve the problem either, because the problem of the coordination of the enzymatic reactions is replaced by that of the coordination of on-off switching of the respective genes, with the same logical dead end. Thus the problem is merely transferred to a more and more remote level, so that it begins to look like one of the eternal nature-philosophical questions; that is, beyond scientific analysis: Further inquiry would seem simply indecent (like vain discourses about finite or infinite divisibility of elementary particles), since it would inevitably lead to a tautological answer. However, very often the tautology may be imaginary or temporary, and such a situation was clearly illustrated by Gurwitsch in his *Analytical Biology:*

> To the question: What accounts for the evident fact that chemical processes in living systems proceed differently than those in vitro? The answer will be that: This is because of special conditions existing in the living systems. To the next question: What is the essence of these conditions? The answer will be: The conditions are the result of not yet ascertained, but in principle ascertainable, particular combinations of molecules in living systems. To the next question: What brings about these particular combinations of the molecules? The only possible answer, from the conventional point of

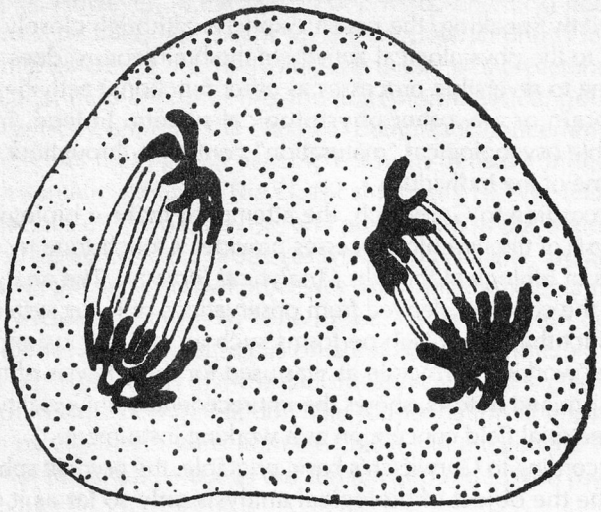

Figure 23
MUTUAL DISTORTION OF TWO MITOSES PROCEEDING IN A SINGLE MATERNAL MICROSPOROCYTE

The asymmetry is seen in the upper parts of the mitotic figures; that is, in the parts closer to each other. This shows the influence of the field anisotropy.

Source: Puchalskaya 1947

view, will be: The special conditions in the living systems.

In such form the tautology is quite evident, but it follows from the immovable conviction that everything which can be observed in living systems results in the final instance from canonic properties of the involved molecules. Any other assumption beyond the limits of this assertion is declared to be tautological, because according to the definition, it cannot be reduced to a molecular scheme. The vicious cycle of such argumentation is evident: Although being non-conventional, the disputed assumption, if defined in a restrictive way, can escape the tautology. It will seem incomprehensible only from the canonic point of view.

The "non-conventional disputed assumption" defined in a restrictive way, and not reduced to the canonic properties of the molecules, is the field factor, which coordinates the (enzymatic) processes within the molecular level and "subordinates" the coordinating conditions of the molecular level to the field conditions at the higher levels (cellular and supracellular). Using the glossary of the theory of the vectorial biological field, the specific conditions for the chemical processes in living systems are realized through the unbalanced molecular constellations (Gurwitsch 1944). The constellations include excited protein molecules whose specific orientation within the complex is determined by the resulting vectors of the actual synthetic field. The specific orientation of chemically non-bound molecules within the constellations provides the following special conditions:

1. Parallel orientation (along the resulting field vectors) of the excited protein molecules within the constellations, initiates common energetic levels. Accordingly, a quantum of energy absorbed by one of the molecules belonging to the constellation circulates within the limits of the whole constellation. This means that all the quanta of energy absorbed by the excited molecules flow into the common energetic pool. (Precisely this energy is needed for the continuous maintenance of the unbalanced state of the constellations, and hence this energy is liberated in the form of degradational mitogenetic radiation after the constellation breaks down.) Obviously, these common energetic levels can substantially favor the realization of certain reactions.

2. The specific orientation of the excited molecules within the constellations can cause specific (and multiform) steric conditions for facilitating or hindering certain chemical reactions, which in vitro are either of low probability, or per contra, proceed without limitation.

3. As a result of the realization of certain enzymatic chemical reactions in vivo, due to the specific spatial orientation of the excited protein molecules within the constellations, certain stable compounds and structures are formed ("vestigia," according to Gurwitsch) which play a role in the regulation and coordination of chemical reactions. For example, they regulate the specific intracellular distribution of various membrane-bound enzymes providing a large number of coordinated chains of enzymatic reactions.

The above-mentioned consequences of the field-driven orientation of the molecules within the unbalanced constellations ("unbalanced molecular orderliness," according to Gurwitsch) are essentially expressions of those notorious specific conditions which determine the particular path of chemical reactions in living systems, which are not due to the canonic properties of the molecules involved. Here the notion of "specific conditions" is devoid of any tautology, because it has a restrictive spatial parameter.

The substantiation of the competence of the vectorial field conception for the analysis of the reversible processes is different from that for the analysis of morphogenesis. In the latter case, the criterion for the applicability of the field conception is based on data of the direct geometric configurations of different parts of the developing embryo which can be modelled using the basic vectorial field postulates. In the case of the reversible processes, the argumentation is based on the applicability to the problem of the concept of the unbalanced molecular constellations, which is inferred from the experimental evidence of degradational mitogenetic radiation. In this case, the postulated field action follows as a necessity, as well as this definition: The existence and renewal of the unbalanced molecular constellations is possible in the presence of a factor which is external to the constellations, and is not their intrinsic property. The character of the actual vectorial field and the dependence of the field intensity in turn on metabolic activity makes the actual field a powerful tool, which not only is a "leading factor" of morphogenesis, but also is a coordinating and regulating factor in the realization of the reversible metabolic processes.

These considerations open a *terra incognita* for experimental studies on the coordination of metabolic processes in connection with the non-equilibrium state of the molecular substrate in living systems.

Neurophysiology and General Regularities Of the Brain Cortex Function

The field concept was applied by Gurwitsch to the neurophysiological sphere for the first time in his paper, "Der Begriff der Äquipotentialität in seiner Anwendung auf Physiologische Probleme" [The Concept of Equipotentiality in its Application to Physiological Problems] (1929). Later on, his interests in neurophysiology were closely connected with the progress and achievements made in the studies of mitogenetic radiation. The methods used to study mitogenetic radiation, especially the mitogenetic spectral analysis, turned out to be powerful tools for the analysis of the molecular substrate of the neuromuscular system, using the vectorial field conception. It was precisely this field which became the favorite of Anna Gurwitsch (A.G. Gurwitsch's daughter), who became a recognized leader in "mitogenetic physiology."

All of the developments in the application of the field conception to the analysis of the neuromuscular system will be considered in detail in a later section. Here, some general considerations concerning the vectorial field conception, as applied to the function of the brain cortex, will be elaborated in brief.

In Gurwitsch's 1929 paper, the notion of "brain continuum" was suggested with incredible profundity. According to this concept, the cortex presents a three-dimensional continuous non-structural constellation, and all the structural histo-elements are immersed in it, and impregnated by it. The functional state of the continuum is determined by its own immanent characteristics (related to it as a whole) on which current afferent excitations are superimposed. However, the final results, such as volitional impulses or reflex actions, are determined by the state of the continuum, which, thus, reacts as a whole.

In the case of the optical functional complex, each state of the cortex continuum in the visual area of the cortex is a correlate of visual perception. Gurwitsch writes:

> However, the continuum state is determined by the excitations of the related neurons only to a certain degree, since the excitation corresponding to the perception of the whole, or the image perception (Gestalt), cannot be considered as an associative connection of the excitations of single neurons. The evidence is that the elementary excitations flow into the continuum as a common reservoir [Gurwitsch 1929].

The above abstract conception of the brain continuum was revived and concretized when the theory of the vectorial biological field was established (Gurwitsch 1944). In light of it, the dynamic cell field spreading beyond the cell borders to extracellular space, continuously constitutes a current connection between the cells, and the resulting integral field is a single, general, indissoluble, continual whole, interspersed with "points of condensation" or maxima, which are intracellular areas of the cell fields. The actual integral field in brain areas is now the expression of the above abstract continuum. It has constant (invariant) characteristics which, it is suggested, determine the general character of the individual organism, including psychological phenomena.

The Psychic Sphere

Strictly speaking, the psychic sphere, although closely related to the physiological activity of the brain cortex, does not belong to reversible processes as other functional activities of the brain or any other physiological system. Indeed, irreversible psychological "maturation" continues throughout the lifetime of the individual.

According to Gurwitsch, the attempt to make a biological analysis of the psychic processes provides a touchstone for the limits of biological thought *(Analytical Biology)*. The analysis used the concepts derived from observations of living systems. The fact that Gurwitsch performs such an attempt, using the same "working" principle as was used for the analysis of metabolism and mitosis, shows the unprecedented universality of his vectorial field conception as a working instrument.

According to Gurwitsch's basic principle, the psychic sphere can be the object of biological analysis only so far as it depends on somatic processes. The goal of the analysis is to establish unequivocal connections between both spheres. Progress along this research path will depend on the lucky choice of the "acts" (phenomena) of the psychic sphere which are to be analyzed. Gurwitsch chooses two such activities. The first is the connection between the external stimuli and the psychic phenomena which can be designated as feelings. The second concerns the incessant stream of chaotic thoughts which is a certain background for all the other psychic activities. These two evidently different phenomena have a common basis, which is as follows.

Analysis of both cases inevitably reveals what is designated by Gurwitsch as "the break in continuity" or "the gap in the entirety"; these are, perhaps, imperfect translations of the notion introduced by Gurwitsch in Russian in the original manuscript of *Analytical Biology*. This "break in continuity" is meant to be found while analyzing the somato-psychic and psycho-somatic chains of processes: Such a chain is considered to be continuous as soon as at least one parameter is common to both its parts. Both the "classical" point of view and Gurwitsch's own viewpoint accept as evident "the break in continuity," but differ in principle in the further analysis.

From the classical point of view, all of the events within the somatic part of the chain—from the excitation of the receptor up to the last event just before the "break in continuity"—do not differ in principle from each other. The same consideration can be applied to the psychic part of the chain in the opposite direction: psychic feeling → effector reaction of the corresponding organ. Accordingly, the task is to establish unequivocal relations between the content (matter) of the last event in the somatic part of the chain and the essence (content) of the corresponding feeling at the psychic end of the chain (and vice versa). In such a case, the somatic part of the chain can be reduced to just the conduction of the stimulus from the receptor to the place of the "break in continuity." The latter is so drastic that, in Gurwitsch's opinion, there is no basis for any hope to establish the unequivocal connections between the two spheres, so that the above-formulated task is a mere declaration.

On the contrary, Gurwitsch considers that, intuitively, we suspect that the processes of the somatic part of the chain get more and more complicated, and the last one before the "break in continuity" must be fundamentally different from the earlier

events. However, in the arsenal of physico-chemical notions, there is no adequate means for the description of this fundamental difference. Precisely here the theory of the vectorial biological field can offer the adequate non-classical notions. Gurwitsch confronts the classical definitions concerning the essence of feeling as a psychic act in its causal connection with somatic stimulus. The classical formula is: "We feel (are conscious of) the origin, rise, and proceeding in our brain cortex of certain somatic processes which, in principle, are analogous to the other known processes occurring in the organism." Gurwitsch's formula is: "The processes in the brain cortex which we feel (are conscious of) are different in principle from any other processes in the organism, and can be designated by a non-tautological definition." The substantiation of this assertion by Gurwitsch starts from the analysis of the general structure of the brain cortex as the somatic ground for the psychic activities.

Characteristics of the Cortex As a Whole

The analysis is based on the attempt to distinguish the basic characteristics of the cortex as a whole, as opposed to the principle of its reduction into elements. Accordingly, Gurwitsch takes into account the following unique characteristics of the brain cortex organization:

1. The number of cells in the cortex area corresponding to a certain receptor considerably exceeds (perhaps by several orders of magnitude) the number of nerve fibers connecting it (through a set of intermediate centers) with all the elements of the receptor.

2. The cortex is characterized by complicated specific architectonics, which includes regular spatial arrangement and orientation of the neurons (elements); this leads to the conclusion that interrelations among the cells are characterized by spatial (geometric) parameters.

3. The different types of cells in the cortex have peculiar specific configurations of the cell body and cell projections (axon, dendrite).

4. The cells of the cortex are rich in chromatin-containing organelles (mitochondria), which can be found in the most distal parts of neuron fibers.

5. The cortex is highly sensitive to toxic agents and to oxygen deficiency, which cause severe disorders at concentrations which do not strongly affect other systems of the organism.

All of these data are employed by Gurwitsch in his theoretical considerations, while the classical conception does not employ such cortex characteristics as specific configurations of different cell types, nor the architectonics of the cortex as a whole. Instead, it pays almost all of its attention to synapses, which became the basic point of the classic neuron theory. Therefore, the classical conception is grounded upon the specific anatomic connections corresponding to functional complexes. The latter, studied by physiological methodology, has led to a situation where many discrete acts are under research, and the problem of conduction became the central one in experimental efforts. Thus, the main content of the intrinsic cortical processes, which obviously does not consist in conduction of impulses to and from the cortex, escapes consideration in classic neuron theory. The idea of cortex function is reduced to interactions and interrelations among neurons (elements) by means of strictly determined connections.

In contrast, Gurwitsch accepts the inseparable, irresolvable something of the cortex considered as a whole, and constructs his conception of the psychic functioning of the cortex, using the postulates of the vectorial biological field, in the following way.

1. Each neural cell is the source of the field, and as a result of their vectorial interactions, the actual integral field is established.

2. Geometric parameters of the field of each individual cell depend on its configuration, including the cell projections, as they contain cytochromatin (mitochondria), which is a potential source of the elementary field flashes. Architectonics (stereometrical configuration) of the actual field of the cortex is the result of three parameters: the number of cells, their spatial arrangement, and the characteristics of their own cellular fields.

3. The field of the cortex is of high intensity. In particular, this is indicated by the extraordinary richness in cytochromatin (mitochondria), which is known to produce a high rate of energetic metabolism.

4. As a result of the wide and dense distribution of the dendrites which are rich in cytochromatin (mitochondria), the actual field in any point of the cortex is of a stabilizing nature, because of the field's high intensity. This means that there is a high degree of vectorization of molecular processes; that is, a high degree of the non-equilibrium state of the molecular constellations.

The whole complex of these conditions constitutes the state of the "field tension." Such a state would correspond to a fictitious situation in which the cortex "is left to its own resources" (very stationary metabolism), as if isolated from any external stimuli. However, in reality, the cortex is under diverse, continuous, excitational influences, coming from extero-, entero-, and proprio-receptors, causing changes in the state of the corresponding cortical neurons. The important thing is that these changes are superimposed on a momentary state of the cortex actual field, which is a quasi-stable (dynamic) independently existing factor.

The vectorial field conception presents a dualistic confrontation between the field sources and the substrate of their influence. In this respect, the interference of the impulses coming from the receptors may have two possible consequences: (a) The impulses interfere only with the state of the substrate, causing a disharmony between the field and the state of the substrate; (b) The impulses also influence some field parameters, so that the changes in state of the substrate causing the disharmony are the result of both the immediate influence of the impulses and the impulse-caused modification of the field.

The final conclusion from these considerations is as follows. In the somato-psychic chain of processes, the last event in the somatic part of the chain before the break in continuity, after which the feeling (psychic part of the chain) becomes evident, may be defined in two ways: either as the origin of the disharmony in the field substrate, or simply as the momentary state of the actual field of the cortex. We "feel" the states of the actual field of the cortex. Similarly, the chaotic stream of incoherent thoughts can be imagined as the feeling of the quasi-stationary state of the actual field (continuous fluctuations of the field tension), not depending on any discrete excitations or volitional acts.

However, the basic thesis that "we feel the state of the cortex actual field," may seem too general and dim (perhaps a bit mystifying), not giving the satisfaction of understanding. Therefore, Gurwitsch gives it a more limited interpretation and confronts it with other conceptions.

Returning to the cortex architectonics, Gurwitsch emphasizes its high regularity (mostly absent in the histological organization of the subcortical centers) expressed by the three parameters: homogeneous structure and configuration of the cells prevailing in a given area (pyramid cells, for example), lamellar character of their spatial arrangement and, especially, strictly parallel orientation of the cell axes. The combination of these three parameters is specific for certain cortical areas (cytoarchitectonic areas) characterized histologically and physiologically (functional connections with certain receptor or effector zones). Therefore, the actual field of such areas is designated a macrofield by Gurwitsch. The macrofields of the various cytoarchitectonic areas constitute the general actual field of the whole cortex.

Although any sharp changes in the momentary states of the macrofields of certain cytoarchitectonic areas affect the macrofields of the neighboring areas, causing changes in the general cortex field, the general field, being conservative, acts counter to ("smoothes out") the changes in the macrofield of the excited area. This conservative character of the general cortex field, influencing its parts (macrofields of cytoarchitectonic areas), can be correlated with a personal disposition, to which the notions of decomposition and "more-less" estimation are not applicable. At the same time, the disposition influences the individual feelings and acts, which agrees with the idea of the general cortical field influencing the macrofields of the cytoarchitectonic areas.

The idea of a common indication in the individual's behavior and the cortical processes related to the cortex as a whole, is not alien to the classical conception. However, Gurwitsch exposes a difference in principle between the two conceptions.

In the classical conception, interactions, connections, and associations—apart from the anatomical connections between single cells and cell complexes—are comprehended as a spreading of the state of excitation from the primarily affected cells to the more remote cells. Certainly, the directed spreading of the excitation, which essentially is a process of conduction, is an established fact, but Gurwitsch emphasizes that only that which has been decomposed can be conducted. Therefore, in order to bind the conducted excitation with the feeling at the other (psychic) end of the somato-psychic chain, the first act of conduction toward "feeling formation" must be followed by the stage of joining up the conducted elements of that something which was decomposed, and to which the final feeling at the psychic end corresponds. However, in the classical conception, there is no adequate apparatus for joining up the elements: This would be possible if one accepted the existence of qualitative differences between the excitations of each cell, but this contradicts the clear equipotentiality of the cells within each cytoarchitectonic area.

Alternatively, the vectorial field conception: The conservative indivisible whole (general cortical field) composed of the macrofields, and the local discrete deviations of microfields caused by afferent impulses, are responded to by the whole architectonics with certain gradients.

The final confrontation of the two conceptions in an abstract mode is as follows: (a) The integral feeling is a result of the composition of discrete elementary excitations into a certain whole (the classical conception); (b) The integral feeling is a modification of the pre-existing whole under the influence of the discrete excitations (Gurwitsch's conception). The important inference from this confrontation is that, according to the classical conception, the brain cortex is an exclusively reacting apparatus which is compatible only with those feelings which are bound to the acts as reactions to the impulses. Thus, there is no apparatus for any other feelings; for example, those associated with mental operations not bound to the observed acts. On the contrary, the general actual field of the cortex, in Gurwitsch's expression, "has its independent life," and its state—regardless of current perturbations brought by the afferent impulses—may be designated as unbalanced labile tension. Fluctuations of this tension caused by the complexity of the cortical field architectonics, are expressed (are felt) as a chaotic stream of incoherent thoughts.

A special problem considered by Gurwitsch concerns vestigia (vestiges), or traces of feelings which are preserved in the cortex and can be reproduced. Thus, the vestigium is a kind of preserved mold from that configuration of the local actual microfield which existed at the moment when the feeling was generated. Evidently, this problem is closely related to the problems of memory and recollection. The analysis is limited to those feelings which are immediately connected with receptor activity (afferent impulses).

All the above schemes concerning somato-psychic chains of events originating in receptors and (through the break in continuity) ending with feelings, were based on the complete reversibility of the processes considered. However, the notion of the vestigium demands that the scheme must include a new parameter, a certain seldom realized value, which results in irreversibility of the last event, which is the vestigium. The arsenal of classical biology offers two possible ways for the realization of this scheme on the molecular level: either chemical chain reaction or conduction of the electric potential. Neither one, however, is compatible with the inference about the qualitative diversity of the excitements in the same neural fiber. Purely chemical and electrical parameters are not sufficient for an adequate description of the enormously variegated types of excitations differing in their content. Therefore, Gurwitsch comes to a conclusion (on the basis of data on the mitogenetic analysis of the nerve impulse) that the chain processes spreading along the neural fiber are not limited to chemical parameters, but are also characterized by steric parameters. These parameters are thought to operate as follows.

Certain molecular "functional units" in the neural fibers are assumed to be peptide molecules of certain sizes. As members of non-equilibrium constellations, the molecules acquire certain specific (mutual) orientations and undergo reversible steric deformations which are transferred along the somato-psychic chain. As opposed to chemical variants, the degree of the deformation and the diversity of the deformations are practically unlimited. Thus, the nature of the impulse moving from the receptors to the cortex is associated with the wave of deformations spreading in the neural fiber along the somato-psychic

Gurwitsch's laboratory in Moscow in June 1948. Gurwitsch is second from right in first row. The third from right is his daughter, Anna.

From archives of L. Beloussov

chain. If this chain passes through an area with a high field intensity (for example, an area with a high density of neurons) the deformations may undergo some changes. On the other hand, the wave of deformations can involve some cellular components including cytochromatin, which would cause changes in some field parameters.

As a result of such conjugated and interdependent processes, in certain rare cases some deformations may become steady and irreversible, and these are vestigia. Activation of the vestigia is thought to be a molecular analogue of the psychic phenomena of recollection and reminiscence. The act of activating the vestigia is assumed by Gurwitsch to be connected with the process of their self-reproduction. The same assumption is employed by Gurwitsch in interpreting the mechanism for conducting various excitations in the same nerve fiber. This is an unprecedented assumption, having no analogies in biology and chemistry, but it does not contradict the fundamentals of the physics of energy, since the deformed protein molecule has a higher energetic potential that can be transferred to a non-deformed molecule with a lower potential. Insofar as such a transfer proceeds within the vectorial biological field, it would transfer not only the energy, but also the deformation.

The intensity of the self-reproduction of the deformations may vary, so that in the case of low intensity, the newly formed vestigium exists for a short period and then vanishes; in the case of a moderate intensity, the vestigium persists in a latent state (memory), and in the case of high intensity, the latent vestigium can be activated by an impulse analogous to the initial one (recollection). In the case of high intensity, the activation leads to changes in the macrofield expressed by a corresponding feeling.

In further analysis, Gurwitsch changes the notion "latent" (vestigium) to the more specific "subliminal." It should then be accepted that the subliminal vestigia, stored and continually accumulated in the cortex, exert influence on certain parameters of the corresponding local microfields. These slight, negligible changes slowly and progressively lead to still slower but inevitable changes in the macrofield. The slow changes do not lead to the feelings which result from the sharp discrete changes of the macrofields, but they may exert influence on feelings by imparting to them additional tints. Therefore, such subliminal vestigia slowly change the architectonics of the general field of the cortex. Insofar as the state of the latter is associated by Gurwitsch with the totality of psychic phenomena, including individual disposition, the above considerations permit us to describe the slow, progressive evolution of the individual disposition (psychic maturation) as the evolution of the cortical field depending, in turn, on the accumulation of the latent subliminal vestigia.

Psychic Indeterminism

The problem of psychic indeterminism seems to go beyond the purely biological prerogative, and grows into the philosophical sphere associated with its basic problem: the spirit-matter relationship. The involvement of "exact sciences" such as physics in this problem (limited to a purely speculative level) can be seen from the utterances of such eminent thinkers as Niels Bohr, Erwin Schrödinger, and in general, the ideas on the connection between psychic indeterminism, on the one hand, and the indeterminism and "free will" of the elementary particles, on the other, are widely discussed in the literature on the philosophy of mind (Rensch 1976). As to the ability of the biological sciences to address this problem,

complete feebleness is all that can be demonstrated, even on the speculative level. Classical neuron theory is not capable of even attempting to explain the visibly indeterministic phenomenology.

As opposed to the purely speculative character of the problem itself, Gurwitsch's analysis is founded on histo-morphological and physiological grounds, to which he applies the theory of the vectorial biological field (Gurwitsch 1944). First, true to his peculiar approach in attacking a scientific problem, he tries to formulate a particular definition of psychic indeterminism which would permit a non-tautological analysis of this immanent, eternal problem. He raises the following question: Can any impulses be transmitted from the cortex to the effector organs if all the receptors of the organism are absolutely blocked? Although such an experiment is not possible, the presumably positive answer to the question does not seem to be absurd or nonsensical.

However, Gurwitsch attempts to formulate the question in another form. If one supposes that an individual is under stimulation by a monotonous afferent impulse, and his reactions to this impulse (acts) are continuously registered, there are two alternative possibilities, corresponding to the existence or absence of indeterminism. In the first case, all the registered reactions (acts) of the individual are statistically equally probable, without any prevalence of either of them (true indeterminism). In the second case, a specific kind of reaction prevails, and deviations from this kind will be arranged according to the Gaussian distribution (the absence of indeterminism). Although the performing of such an experiment in pure conditions is also beyond real possibility, there is hardly any doubt that the second alternative is the case (assuming the sanity of the individual under study). Therefore, true indeterminism in the sense of the definition given above should be rejected. Its resemblance to Gurwitsch's view results from certain probabilities for different variants, meaning the absence of "obligation" for the most probable of them.

However, in biological reality, the hypothetical possibility of psychic indeterminism is understood as the question of whether there is an unequivocal connection between an incoming afferent impulse and the following effector act. Precisely this notion of indeterminism was used by Gurwitsch for the analysis. Certainly, insofar as psychic activity is postulated to be associated with the processes in the brain cortex, this question does not concern a simple stimulus-response cerebro-spinal reflex arch, whose deterministic nature is beyond any question.

From the classical point of view, the absence of the unequivocal connection between afferent and efferent impulses, is explained as a result of the extraordinary complexity of the processes in the cortex, which is essentially an evasion.

The vectorial biological field concept gives the problem a new, non-tautological description. The proclaimed "extraordinary complexity" of the processes in the cortex, which obscure and pervert the postulated unequivocal connection between the afferent and efferent processes, can be considered the result of the total actions of the highly numerous, simultaneous, and immediately preceding impulses, including a great many of those coming from enteroreceptors not reaching the consciousness. These obscuring impulses prevent the dominant impulse from being fully displayed, and hence, prevent the demonstration of the deterministic nature of the psychic phenomena. However, classical neuron theory does not indicate with what morphological apparatus or substrate these obscuring sideline impulses come into contact.

Indeed, taking into account the multiplicity and diversity of the sideline impulses, it is impossible theoretically to relate them to a different effector apparatus (and there is no histo-anatomical evidence for it). The only model somehow manifested by reality is connected with the organization of the central nervous system of many invertebrates, which is constituted of a general non-segmented ganglionar center into which all afferent impulses flow, and from which all effector impulses flow in turn. However, this model is not suitable for the case under discussion, since it leaves no place for the postulated prevailing connections responsible for the typical reactions.

The theory of the vectorial biological field helps to establish a certain hierarchy in the functioning of the afferent and efferent chain processes, in the following way. Although the anatomical neuronal connections are dominant, they are not isolated within the brain cortex. The incoming afferent impulses (the corresponding chain processes) interfere with the chain processes spreading in the unbalanced molecular constellations, whose configurations are determined by the corresponding local microfields and area macrofields, by their intensity and configuration. The influence of the interfering chain processes on the initial receptor-caused afferent impulse can obscure and distort the initial impulse. The resulting field-induced deformations of the substrate, which will finally determine the specificity of the effector act, may appear to be numerous and quite different, so that a number of different acts in response to the same afferent impulse will become manifest, compatible with the indeterministic conception.

Taking into account the purely speculative background of the problem of psychic indeterminism, Gurwitsch's analysis, made from the intrinsically biological point of view on the basis of rational scientific methodology, can be considered an unprecedented, courageous attempt.

Embryogenesis of the Psyche

The statement of this problem is based on the following considerations by Gurwitsch. There is an immanent (continuous) connection between the psychic and somatic spheres, and the former develops in parallel with the embryonal development of the soma. This thesis sounds quite innocent, until it is sharpened by its simple logical extension, which now takes the form of an audacious postulate: Psychic elements are present at any stage of the embryo's development. However, an important reservation is made about what type of elements is meant. It is clear that the psychic elements of the developing embryo are thought to be rather rudimentary, and evolve (or develop by jumps) along with the embryo's development.

If, in general, the psychic sphere is the totality of current transient feelings, continuously changing, mixed in their content and only partly dependent on the environment, all these fleeting feelings originate and proceed on a certain background (also slowly developing) which can be designated as our individuality. Gurwitsch's postulate about somato-psychic immanent connections concerns only this background. Accordingly, Gurwitsch considers as inscrutable the idea that this "background" originates at a certain stage of embryogenesis "out of nothing,"

without a rudimentary source. The path of the analysis is to create a concept of this source by examining the embryonic stages in reverse, and imagining a gradual involution of the psychic sphere up through any conceivable rudimentary state. However, such an idea in itself may seem rather utopian, since the notion of the rudiment means preservation of the main analogies between "feeling" as a fully developed psychic phenomenon of the adult organism, and its embryonic counterpart.

While confronting both (the mature form and its rudiment) one often resorts to comparison by means of estimations such as "more-less" and "simpler-more complex." Are there any kinds of feelings, as psychic phenomena, which permit such estimations? Gurwitsch assumes that a positive answer to this question is possible if such a psychic phenomenon as "knowledge" is concerned. Indeed, knowledge is that basis of the psychic sphere which develops, grows, and becomes complex starting just after birth. However, if such a conceivable analysis of psychic involution can be described by means of comprehensible notions, it would be logical to continue it further by including intrauterine life. Moreover, strictly speaking, it is impossible to stop this mental operation, and to indicate any final point in the retrospective analysis which would be the "point of origin of the psyche."

Gurwitsch uses the concept of knowledge in a limited sense, identifying it, essentially, with the notion of "feeling," and avoiding the usage of the notion of "consciousness" as more equivocal and uncertain. Then, according to such a concept of knowledge, the latter means knowledge about one's momentary state, and its changes, and this notion of knowledge is identical to the state of feeling.

However, as described previously, feeling is the first event after the "break in continuity" that is compatible with the last event before the break, which is the state of the actual field of the corresponding cortex area. This consideration permits one to offer the following preliminary definition of the rudimentary psyche at any stage of embryogenesis: The rudimentary psychic feeling of an embryo is limited to the knowledge of the momentary state of its actual field.

However, together with the feelings, the psychic sphere includes what can be called "actions" or "deeds." Does this notion permit their reduction to the rudiment, as with the notion of feeling? Gurwitsch accepts that the psychic concept of "action" is difficult to define, even in the "normal" case, so that the definition of the rudimentary case might not be possible. Nevertheless, Gurwitsch suggests the following definition of "action": If a certain observed phenomenon appears as the last event from different chains of events, this phenomenon is a result of action. Thus, the essence of the problem is associated with the "act of choice" of one of the possible paths (chains of events) among a number of them, where the other paths are also possible. Gurwitsch applies this to the processes of embryogenesis, emphasizing that it is not evident a priori that the embryogenetic processes can be designated as "actions."

However, Driesch's concept of equipotentiality of the embryonic elements, based on his experiments on harmonic regulation, leads to the conclusion that the behavior of the embryonic elements under experimental conditions suits the above definition of "action." Together with this, as Driesch himself noted, it would be unnatural to think that embryos display actions only when they undergo gross experimental interference: If actions of the embryo are manifested under extraordinary circumstances, it must be concluded that under "normal" conditions, it also acts in reaction to all the inevitable fluctuations of the parameters of development.

Accordingly, the final concept of the embryonic rudimentary psyche is defined as follows: The embryo "knows" the state and changes of its actual field and "acts" in order to smooth the tension arising from the changes.

However, Gurwitsch admits that his idea of embryonic psychic actions essentially coincides with Driesch's general concept of "harmonic regulation," which concerns the same phenomenon of embryonic behavior in response to experimental interference. Perhaps, it may be answered, the designation of the known phenomena of harmonic regulation as psychic acts is simply a battle over terms. Indeed, the problem of the biological basis of the "normal" psyche exists whether we like it or not, and it may only be our attitude toward the problem that is arbitrary, such as that any rational investigation is utterly impossible. Or it may be said that the problem of the embryonal psyche is just a mental construct, aiming to relate the facts of embryonal regulation to the sphere of psychic phenomena.

Gurwitsch convincingly demonstrates that the problem of the embryonic psyche is not just a far-fetched play on words. First of all, Gurwitsch's analysis, based on the principle of "reduction to an absurdity," leads inevitably to recognition of the objective existence of the embryonic psyche. Second, the possibility of applying the same concept of the tension of the actual field to such different phenomena as embryonal regulation and psychic feelings of the mature individual, seems to be fruitful.

Moreover, the consecutive analysis of the processes of embryonal regulation, leads to the same conclusion about the "break in continuity" as in the case of the somato-psychic chain. The only difference is that in the latter case, the first event after the break relates to "feelings," while in the case of embryonal regulation, the first event relates to "acts." Therefore, the assumption that the embryonic "acts" are determined by the immediately preceding "feelings" may seem to be arbitrary. However, insofar as the embryonic "acts," according to the definition given above, originate in the embryo's "choice," it must be a certain "factor of choice" which essentially is designated by Gurwitsch as related to "feelings."

The last objection confronted by Gurwitsch (his stylistic peculiarity was a kind of dialogue with the devil's advocate) was that the identification of embryonal regulation with psychic "feelings" does not introduce any new notion beyond Driesch's classic formulations, and hence, the whole conception of embryonic psyche is futile and vapid. However, this is not true.

The point is, that the essence of embryonal regulation was defined by Driesch as an urge towards return to a "norm." However, in this case, the notion of the "norm" coincides with the whole totality of that which, in fact, is the organism itself, so that the definition of the "norm" is tautological. A non-tautological definition must contain some limiting parameters, and such parameters are formulated by the conception of the actual field.

Indeed, notions like state or tension of the actual field, which are employed for description of the embryonic psyche, do not coincide with the notion of the organism or embryo. Therefore, the association of the notion of psychic feeling

with the state of the actual field escapes tautology. The comparison between two definitions which follow is quite demonstrative: "The embryo 'knows' the momentary state of its actual field" and the paraphrase definition of Driesch, "the embryo 'knows' its momentary state." The latter definition cannot be applied to everyone's individuality, because everyone "feels" only particular partial states, not seizing the psychic sphere in all its totality. Gurwitsch's conception of the actual field, in its application to the embryo psyche, has the same limiting significance.

Concluding Remarks

Gurwitsch always emphasized that living phenomena of any sort, and at any level of organization, belong to systems which, at any moment of observation, are at some stage of the ascending-descending curve of their life cycle. Contemporary biologists have usually missed this, or at least, not used it in their theoretical conceptions. The principal purpose of biology is to elucidate the regularities of the processes which constitute the life cycle. According to "classical" biology (and to the overwhelming majority of biologists), the life cycle is a phenomenon of a quite unequivocal "iron regularity" (Gurwitsch's expression) laid in the egg, but current attendant circumstances continuously distort its realization, and it remains hidden. Such an "iron regularity" is realized through the rigid, unequivocal connections among all essential processes, and the main task of scientific analysis is to cast away all contingencies, in order to reveal these connections in their naked purity.

Hence, the classical point of view is that the "norm" coincides with all the possible minimal and maximal deviations. Indeed, the undoubtedly intrinsic observable property of the life cycle is its conservativeness and, according to the dominant views, it is precisely this conservativeness that is an expression of the postulated unequivocal regularity determining the life cycle. However, the facts related to developmental mechanics (Roux and Spemann), harmonic regulation (Driesch) and the influence of centrifugation on egg cleavage (Gurwitsch) testify against rigid, unequivocal connections. The concept of "normating," introduced by Gurwitsch, presents a factor organizing the specificity of the processes at all levels, leaving a considerable degree of freedom in the behavior of the individual elements included in the realization of these processes.

As an illustration of the action of such normating factors, Gurwitsch uses a metaphor conceived by Virchow who, in his famous theory of cellular pathology, considered the organism (the whole) as a cell republic (Virchow, 1858). The main condition for the optimal functioning of any republic is to elaborate a constitution which combines order and stability of the state as a whole, with the minimum possible limitation of the freedom of all the citizens as individuals. This definition exactly reflects the concept of normating. Continuing with this allegory, one should state that the republic's constitution is based on certain principles of society which are its lawful notions, such as rules, codes, and customs. Similarly, the normating principle in biology should also "work" on certain specific parameters (which are to be normated) common to different biological phenomena, otherwise this notion becomes a mere tautology, and loses any value. Therefore, Gurwitsch clearly determines these lawful parameters upon which the normating principle acts: These are purely spatial (vectorial) parameters of cell behavior, and this is, essentially, the basis of the constitution of the cell republic. However, by definition, any factor acting within the limits of steric parameters and, hence, making the elements' behavior depend on their coordinates within the whole, is a field factor.

In this connection, it should be emphasized that the notion of "field" introduced into biology by Gurwitsch, was used by others in the 1920s and 1930s, without any strict definition of the concept, and often without common sense. In certain cases involving demonstration of equipotentiality of the elements, the presence of a field was just declared in a vague and emasculated form (see review by C.H. Waddington, 1966). Evidently, such groundless declarations of the presence of a field were not a step forward from the original conclusions of Driesch, and hence, the usage of the concept of field in such cases was just a matter of semantic tautology.

The field conception developed by Gurwitsch, was based first on the elaboration of particular models of morphogenesis using specific invariant laws (dynamically preformed morpha) and then on the development of the unitary vectorial field conception, using specific, strictly defined postulates. This marked substantial progress towards the creation of the epigenetic conception of development as a working principle. This, in itself, is a great advantage as compared to the other general conceptions concerning embryonal development, such as the classical genetics of Mendel, and the developmental mechanics of Roux and Spemann.

Driesch's conception (considered logically beyond reproach by Gurwitsch), based on remarkable experiments, was led by its author to a deadlock by introducing the concept of *entelechia,* which was beyond rational scientific analysis. Therefore, the great achievement of Gurwitsch was that he brought his theory from the heavens of an immaculate logical structure to the grounds of a "working" instrument, helping to explain the phenomenology displayed at all the levels of biological organization. It is precisely the concept of actual fields that can serve as such a working tool.

The relationship of Gurwitsch's field to physical laws, and the principles of field action, were comprehensively discussed in Gurwitsch's last work, which was published in Russian 37 years after the author's death, and is still practically unknown in the West (Gurwitsch, *Principles of Analytical Biology and the Theory of the Cellular Field,* 1991). The following quotation from this work is worth noting.

> The dominating conviction is that different chains of events in the analysis of observed living phenomena will, in some distant future, boil down to the level of those data and notions which are used in physics and chemistry. In opposition to this conviction, our suggestion is that the confluence will occur at a higher level, specific to the living phenomena, which means that biology can possess its own specific fundamental notion, not contradicting the fundamental notions of physics and chemistry, but also not reduced to them. The field theory is an attempt to formulate such a fundamental notion. . . . The field conception is not based on physico-chemical notions, but on physico-chemical possibilities. These possibilities are

designated by physical terms, and the theory of the biological field using these terms makes from them an unparalleled combination. Yet it does not contradict the basis of physical thought and experience which underlies all the constructions for sequences of events of various observable, phenomenologically independent processes of embryogenesis, as well as of repeated (periodic or aperiodic) processes continuously proceeding during the whole life cycle.

However, even though we attribute to the field the significance of a basic "fundamental notion," specific to living systems, to which, hence, a property of universality is imparted, the whole conception is alien to an idea that everything occurring in living systems is unequivocally determined or even depends on the field. Such a primitive idea would be equivalent to a mere tautology. On the contrary, the field definition is strictly outlined and limiting. The field . . . has a significance of a normating invariant factor of steric parameters on processes proceeding in living systems at a molecular level.

Thus, the succession of developments of the field conception, reviewed above, from the first abstract models describing single morphogenic phenomena, to the general theory of the vectorial biological field, covering, by its explanatory power, all the levels of organization of the living organism, is one of the superb efforts of the human mind in the attempt to comprehend the fundamental regularities of the development, organization, and function of living systems.

Returning to the question posed in the introduction, whether there is any connection between Gurwitsch's theory of the biological field, and modern trends of contemporary theoretical biology, we come to the conclusion that there is a deep discrepancy between the two. Gurwitsch's theory of the biological field is practically unknown in the West. However, finding a consonance between Gurwitsch's ideas and modern theoretical constructions could be a fascinating task.

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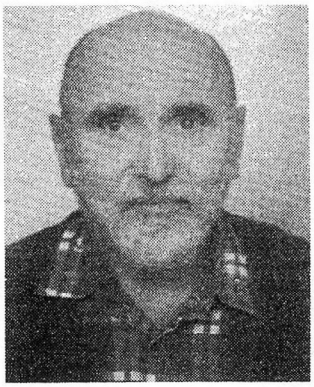

Michael Lipkind was born in Moscow in 1934, and was personally acquainted with Gurwitsch in his youth. Gurwitsch's brilliant intellectual power, original scientific and philosophical vision, humane personality, steadfast honesty and generosity during a cruel period of Russian history, strongly influenced Lipkind, who considers himself as Gurwitsch's disciple.