ORGANOGENESIS: MECHANICS OF DEVELOPMENT

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Introduction. Mechanics of individual development is debated, for its study morphogenesis is used as important object [6]. Motive force of this process is interactions of different systems [1]. Organogenesis, its mechanics and significance for evolution and ontogenesis are described in literature in detail [4,6,8]. It is considered, that it may study mechanics of vital activity, including development of organism, in experiments. Nature makes such experiments constantly by means of natural selection. It is necessary to use knowledge about results of natural selection without fail for knowledge of mechanics of organogenesis – method of comparison of organs in animals of different species and classes. It is studied organ only as part of whole organism in indissoluble connection with its function [8].

Matherials and methods. I present results of some my investigations on comparative anatomy and embryology [3-5], the another results it can find on the site of Russian Acadamy of Natural History (www.famous-scientists.ru/1251/ – Petrenko Valeriy Mikhaylovich – the list of publications).

Results and discussion. There are two main components of development of all organisms: 1) growth – increasing of sizes; 2) differentiation – increasing of complexity of structure by means of separation of parts and appearance of every possible differences. Both sides of development are interconnected indissolubly, but it is quite possible incomplete correlation of growth and differentiation. Minot [2] indicated «law of uneven growth» as main modus of development. According Thompson [7], morphogenesis of body and organs is determined by speed of their growth in different directions. Svetlov introduced term «differentiative growth»: considerable part of differentiation is realized by means of uneven growth [6].

Differentiative growth, leading to division of body on the parts, may mark as the segmenting. Its mechanism consist in unevenness on rates and directions do not only in general, but on extent of body too – intermittent, polyfocal growth: the active centres (of intensive growth of the parts) alternate with intermediate zones (of «slow» growth), which narrow beetwen anlages of organs, increasing in volume. Their proliferating epithelial germs form main (primary) organisers of morphogenesis. Mesenchyme is orientated on epithelial germs of organs and distributed beetwen neighbouring organ's anlages, forming as epithelial-mesenchymal complexes. Mesenchyme and its derivatives form secondary organisers of morphogenesis (nucleus of limb buds, stromal germs of lymph nodes and that similar). They modify growth of primary organisers (ectodermal ridges of limb bud or endothelial walls of primary lymphatic vessels as matrices for anlages of lymph nodes). The main types of epithelial growth: 1) by plate, which can roll in tube (germinal layers, neuroectoderm, surface epitheliums); 2) the tree-form (by branching) – tubes of glandular epithelium and vascular endothelium branch repeatedly, branches introduce into surrounding tissues with division of organ on parts (new organs, their lobes, lobules and others). Thus segmentation of primordium gut on extent is initiated by local diverticulums of its entodermal tube. Small branches of that diverticulums sprout surrounding mesenchyme in different directions, avoiding obstacles on the way of their growth, including «sluggish» tube of surface epithelium of embryonic body and visceral tracts. Vessels grow in a similar manner, forming thick nets about epithelial germs of organs. Diverticulums exert straight morphogenetical pressure upon gut, growing into mesenteries and shortening them in different degree – from formation of short peritoneal ligaments (lesser omentum) to almost complete absorbtion (lungs into mesenteries of esophagus). Large vascular organs (heart, aorta, venae cavae and hepatic portal vein) take part in organogenesis in such a way too. Epithelial tube of

soma is more passive, grows slowly and is devided on the branches (head, limbs) much smaller – equitree-form growth. I studied significance of correlative volume of neighbouring organs as reflection of intensity / rate of their growth (~ gradient of morphogenetic pressure) for embryonic organogenesis, including in aspect of specific features of interactions beetwen organs. Example:
1. Liver is main organizer of embryonic organogenesis in abdominal cavity, where dominates in man from 4^{th} for 9^{th} week (in pig and sheep – 3-5^{th} weeks, in rat – 13-17^{th} days) of embryogenesis, when its relative sizes are the most considerable. Principle scheme of mechanics of organogenesis in abdominal cavity it can present in form of formula : liver ↔ other organs.
1.1. [Liver ↔ umbilical intestinal loop and mesonephroses] → features of turn of umbilical intestinal loop → features of secondary adhesions of peritoneum → general quantity and placing of visceral, in particular mesenteric, and lumbar, in particular paraaortic, lymph nodes → features of morphogenesis of intestinal lymphatic trunks.
1.2. [Liver ↔ mesonephroses → (kidneys ↔ suprarenal glands)] → features of morphogenesis of [inferior (posterior) vena cava → petroperitoneal lymphatic sac, lumbar trunks and chyle cistern of thoracic duct in embryos and then in fetus] → quantity and placing of lumbar lymph nodes → features of morphogenesis of initial part thoracic duct and its roots in fetuses.

Liver of placental mammals is the largest organ of their embryos, because it is centre of embryonic hemopoiesis. Usually yolk sac of this animals is small and reduced early. In birds and more in reptiles yolk sac is reduced more later, that slows down setting of physiologic umbilical hernia into abdominal cavity of embryo. Absence of secondary adhesions of peritoneum in birds and reptiles is connected probably with this. Dorsal secondary adhesions of peritoneum are absent at all in rat, that correlates with slowed-up decreasing of sizes of liver relatively capacity of abdominal cavity in fetus (in comparison with human fetus). Growth of dorsal, retroportal part of liver influences on this process in rat very much – right until «doubling» of liver. It «pushs» stomack and duodenum from dorsal abdominal wall with preservation of mobility of root of dorsal mesentery. Rotation of primary intestinal loop is slowed down in embryogenesis of rat with reduction and fall of some the stages. Embryonic liver of pig grows approximately as in man. But very large, slowly degenerate mesonephroses of pig embryos slow down cranial growth («ascent» in abdominal cavity) of pelvic kidneys and postrenal part of posterior vena cava, aid formation of more large cranial and (particularly) caudal intersubcardinal venous anastomoses. In chicken embryo liver is relatively small, because yolk hemopoiesis is prevailed, but mesonephroses degenerate slowly and kidneys preserve pelvic position, therefore postrenal part of posterioir vena cava is do not formed at all.

Features of organogenesis in abdominal cavity of human embryos and fetuses are determined first of all by features of growth and changing correlation of volumes of liver and intestine. My data of comparative anatomy: 1) «opposite» correlation of sizes of liver and right half of large intestine, particularly caecum; 2) mobile man with mixed type of food is closed to very mobile, vegetarian degus on relative sizes of liver and to mobile, omnivorous rat – on relatively small caecum.

Conclusion. Formation of definitive anatomic and topographic relations of organs passes on base of their uneven growth and interactions, including walls of corporal cavities (limiting factor of capacity). Like this it can explain development of lymph nodes and lymphatic trunks. Hence it is becoming intelligible correlation of types of general individual constitution and own constitution of lymphatic system. Correlation of rates of growth of organs on different directions is changed with change of influence of given organ on development of neighbouring organs. Interactions beetwen tissues such as the epitheliostromal (the epithelio-mesenchymal) are in the base of organogenesis too. Its main mechanism is polyfocal growth of embryo: epithelial or similar germs of organs form multipolar world of embryogenesis.

Functional activity of organism under loading, for example – food and / or motive, determinates corresponding morphogenesis and formatiom of topography of organs in evolution

by changing of their absolute and relative growth. In ontogenesis this is consolidated by natural selection (evolution → ontogenesis): topographic coordinations / ergontic correlations → organizing coordinations / morpho-functional correlations. Natural selection is multifactor process. Volume of caecum, for example, depends do not only from degree, but from duration of its filling, including fermentation of food remains, and this, in one′s turn, depends from «coarseness» of food (rat → guinea-pig ↑). Duration of filling of organ depends yet, but opposite, from its evacuation function, which, in one′s turn, depends from degree of development of musculature, the own and the skeletal (degus → guinea-pig ↓).

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