

Research Journal of Pharmaceutical, Biological and Chemical Sciences

Factors of Adaptation to Changing Ecological Conditions.

Leonid Petrovich Tel'tsov¹, Ol'ga Sergeevna Shubina^{2*}, Tat'yana Alexeevna Romanova¹,
and Ol'ga Ivanovna Komusova²

¹Federal State Budgetary Educational Institution of Higher Professional Education "Ogarev Mordovia State University", Russia, the Republic of Mordovia, Saransk, Bol'shevistskaya st., 68

²Federal State Budgetary Educational Institution of Higher Education "Evseyev State Pedagogical Institute of Mordovia", Russia, the Republic of Mordovia, Saransk, Studencheskaya st., 11A

ABSTRACT

This article studies the age-related adaptation process of human beings and animals during ontogenesis. The adaptation of the animal organism and the human organism to the ecological conditions happens stepwise. The modern age periodization of a human development is introduced here and periods, stages, steps and critical phases of ontogenesis are defined.

Keywords: adaptation, ecology, stages of development, periodization, critical phases of development.

**Corresponding author*



INTRODUCTION

The modern ecology is considered to be a science about mankind's survival under conditions of crisis. Having absorbed some branches of other science disciplines the modern ecology turned to a science including a significant amount of knowledge: the systematic approach to the study of living organisms; organism and environment; popular ecology, synecology; coenobiology; the study of ecosystems; global ecology; applied ecology. Many sciences study the laws of individual development of human beings and animals: anatomy, histology, embryology, genetics, biological chemistry, general biology and development biology. If you study the ontogenesis of human beings and animals it is necessary for you to have deep knowledge of 1) development biology of an organism, its systems, organs, tissues and cells; 2) social conditions of human life, technologies of animal keeping and feeding; 3) right organization of medical and veterinary measures.

THE LAWS OF INDIVIDUAL DEVELOPMENT OF ORGANISMS

Life of human beings and animals is called ontogenesis. Ontogenesis is individual development of a human organism and an animal organism, the complex of successive morphological, physiological and biochemical transformations that the organisms undergo starting with the moment of germination till natural death.

Life of human beings and animals develops according to the genetic laws and is influenced by nature. An organism adapts differently being at different stages of development. The adaptation to the outside environment determines the health of an organism. That is the result of age-related ecological adaptation of an organism towards the environment. That's why it is necessary to take into consideration the laws of genetic development and ecological influence on an organism.

Having looked through multi-year researches on this topic we in cooperation with the students and the scientific school set 8 laws of individual development [1, 2]. The definitions of these laws that reveal new aspects in the study of ontogenetic evolutionary adaptation are given here.

The first law is the individual development of human beings and animals consists of three periods – the embryonic period, the postnatal period and maturity. Each period includes several life stages.

The second law is heredity of human beings and animals is realized according to the stages of development. A new gene is functioning at each stage. The chemical constitution and the quantitative composition of programmed differentiation in cells, morphological and physiological possibilities of tissues, organs and organism systems are different.

The third law is the interplay of the contiguous stages happens according to the principals of acceleration or retardation. The partial compensation of growth and development is possible only at the next contiguous stage. The compensation is directly-proportional to the impact intensity at the next stage and inversely proportional to age.

The fourth law is critical phases of organism development are revealed at the junction of stages. The activation of operational genes happens within critical phases. Modifying, mutative and complex variability of genes happens under the influence of outer and inner factors of environment during critical phases.

The fifth law is the duration of critical phases of an organism, organs and tissues depends on the thoroughness of the transformational changes at the next stage.

The sixth law is biological rhythms are specific in the time aspect at each stage of development of an organism, its systems, organs and tissues.

The seventh law is the continuity (permanence) and the fluidity (immanence) of individual development in ontogenesis are determined by asynchrony and heterochrony of organism systems, organs and tissues.

The eighth law is the impermanence of development of mature tissues, organs and systems at each stage is compensated by morphofunctional generation of tissues, organs and systems of an organism.

THE STUDY OF GENOTYPIC, PHENOTYPIC AND ONTOGENETIC ADAPTATION

Ontogenesis is evolutionary programmed in the genotype. It is successive, strictly regulated morphofunctional process. Ontogenesis proceeds unevenly and discretely and the qualitative change of the processes expressed in the change of growth and differentiation character happens during it. Without admitting the discontinuity of development, or it's better to say – the unevenness of it, it is impossible to understand the mechanism of adaptive responses of an organism on the impact of different factors of environment, the evolutionary amplifications of ontogenesis and its discrete genetic determination. All living organisms have the possibility to adapt (at the levels of an organism, systems, organs, tissues and also at the level of cells). In the process of adaptation the biochemical processes, functional qualities of cells and their elements are changing. The genotypes that appeared under control of the natural and artificial selection determine the inherent adaptiveness of an organism to the conditions of the outside environment that is usually the place of human or animal ontogenesis. But as the factors of outside environment are diverse and variable within quite broad limits the selection creates special age mechanisms of adaptation of individual development in the process of evolution. These mechanisms are inherently and genetically determined according to the stages of development (See the second law). The possibility of an organism to adapt to changing conditions of outside environment in the process of individual development isn't studied sufficiently nowadays. The final result of organism adaptiveness in early ontogenesis is the preservation of an organism till reproduction of posterity. The organism can adapt to the factors of outside environment functioning constantly and systematically and to the fluctuating factors also. The genotypic and phenotypic, ontogenetic adaptation is different at age stages of development. The genotypic adaptation is inherently determined adaptiveness of an organism to the particular conditions of outside environment and forms age stages of ontogenesis (Table 1).

On one hand the ontogenetic adaptation is relatively subdivided into tissue adaptation, cell adaptation, system adaptation and organism adaptation. On the other hand the ontogenetic adaptation can be subdivided into substantial and functional. In the case of substantial adaptation to the impact of a toxic agent the threshold of the protein denaturation in protoplasm raises. While the functional adaptation the changes in the functions of cells, tissues, organs and of the whole organism happen.

THE MODERN AGE PERIODIZATION OF HUMAN DEVELOPMENT IN ONTOGENESIS

The modern age periodization of human development in ontogenesis, we've worked out on the basis of multi-year researches of ontogenesis and of new methodic foundation, can be taken as an orienting point for application of individual development laws in practical medicine (See Table 1). The first law of individual development, we've introduced, says that there are three periods, in the life of human beings and mammals, not two as the science literature states. Each period includes several life stages (See Table 1). That's why it is necessary to know how adaptation happens in all periods of life, including the embryonic period. While studying the adaptation it is necessary to observe not only the development of an embryo, a fetus and a foetus, but also to observe how mothers are doing. Their adaptation while pregnancy is the main thing for the fetus development. Each stage consists of corresponding steps and steps are presented by phases (See Table 1). Thanks to adaptation the chemical constitution of cells, morphofunctional and physiological possibilities of organism tissues, organs and systems are different at each stage. They can vary according to the set of chemical elements, the set of programed differentiations, the number of functional units, biological rhythms and etc. That's why we recommend to make food rations for humans and feeding rations for animals for each ontogenesis stage and to create specific, appropriate conditions. They are different at each stage.

It was stated for the first time that the inheritance (the second law) of a zygote (in a fertilized ovum) is realized while ontogenesis gradually. The younger an organism is, the higher the realization of genotype in phenotype is [3, 5]. Basing on theoretical background of this law the innovative conception of raising productivity of farm livestock and poultry while ontogenesis at each development stage was introduced [4]. The knowledge of specificity of body metabolism and of adaptation at each age stage allows to manage the process of development purposefully and to enlarge the phenotype. Adaptation changes at each development stage. It is necessary for parents, teachers, biologists, scientists, preschool teachers – all the specialist working with children, to know about it. Doctors need to know that adaptation to illnesses is different at each stage. As

a rule ill children are cured only within one age stage of development. That is what we need to strive to, applying recovery and adaptive methods of treatment. If the illness stays uncured at the definite stage and slips to another stage it becomes inveterate.

The third law says about the interplay of the contiguous stages of development in ontogenesis [5]. It is determined by real life conditions, health of human beings and animals at the next stage. The partial compensation is directly-proportional to the impact intensity of outer and inner factors at the next stage and inversely proportional to age. According to the philosophic law of the negation of the negation each successive stage negates the previous one and that's why only partial compensation happens [6]. The interplay of the contiguous stages according to the law of individual development proceeds in accordance with the principle of acceleration or retardation. This statement also can be fully applied to the evolutionary adaptation. It is stated that indices of metabolism, energy and information can be neutralized while human and animal development at the contiguous stages but at the next but one stage the metabolism is different and all the processes at it happen in a different way.

It is stated that genes work only at one particular age stage. This fact explains why human beings have so great number of genes (there are 31 thousands of them) [7]. Genes working in the beginning of the stage, t. e. at the junction of stages, and at critical phases of development are also included (See Table 1). The setting of the active gene for development during the whole stage happens simultaneously [8, 2]. The theory of critical phases (or critical periods according to P. G. Svetlov) is scientifically proven by P. G. Svetlov [9]. He was honored by a State Prize for his works in this sphere. According to this theory [9] outside environment influences an organism during critical phases by means of different adaptive factors: 1) damaging factors leading to death or pathological changes; 2) modifying adaptive factors causing deviance from a norm but not leading to pathological changes. They lead to morphoses, mutations and anomalies in organism development; 3) typical influence of the environment protecting "the norm" of organism development.

The studies performed by L. H. Garkav, E. B. Kvakina, M. A. Ukolova state that depending on the power (dose) of the impact at least three adaptation reactions can be developed in an organism; the reaction on mild exposure – the reaction of training; 2) reaction on the exposure of average force that is transitional between mild and strong – reaction of activation, can be calm and increased; 3) reaction on strong exposure or overexposure, that causes stress according to Selye. The investigations showed [10] that during critical phases of development the following phenomena take place: 1) the interchange of one phase by another one; 2) the setting of a genetic program for the next stage; 3) the summarizing of the previous stage; 4) the desynchronization of biological rhythms; 5) the sensitization of tissues and organs to medication and factors of outside environment; 6) genetic mutations in programmed differentiations of cells; 7) the interchange of functions in the generation of definitive organs. The study of critical phases of development is the key position for understanding determined, integral and heterochronic development in ontogenesis. In the table the timescales of all the critical phases of human ontogenesis are given for the first time in the scientific literature (See Table 1).

The desynchronization of adaptation mechanisms happens during the critical phases. At the time any manipulations (vaccinations, flights, transportations, trips, taking medicines and etc.) are prohibited and it is necessary to create the best conditions of day regimen. The animal experiment performed by A. Wright [11] and our experiment [10] proved that the disruption of immunoprotection takes place during critical phases of development. Critical phases of development of mammals and human beings proceed in two forms – evolutionary (stepwise) and necrobiotic (via metamorphosis) [13].

The duration of critical phases of organism development depends on adaptation and the thoroughness of the transformational change at the next stage. That is what the fifth law of individual development says. It is known that the functioning of all the organs and systems of animals and human beings when being physically ideal, having sound mind is determined by biological rhythms that depend on adaptive reactions. The disruption of biological rhythms causes the contraction of different diseases. These theoretical conclusions are used in practice while diagnosing the preclinical impression of some diseases and while curing the sick.

Numerous works of researches around the world and our works prove that an organism doesn't realize all its possibilities programmed in the genotype at each stage of development. Only a part of them called the phenotype is realized. That means that there is a reserve at each stage [8, 13].

Table 1 – Modern Age Periodization of Human Ontogenesis

The period of development	The stages of development	The steps of development	The critical phases
1	2	3	4
i. The prenatal period (from impregnation to birth).	1. The early stage. (the embryonic from impregnation to 34 days of embryo)	1. The early embryonic step (from impregnation to 34 days). 1.1. Zygotes (to 1 day). 1.2. Embryonic fission (2-12 days) 1.3. Gastrulation (13-19days). 2. The late embryonic step or setting up of rachial and temporary organs (from 20 to 34 days).	1. The critical phase of zygotes (to 1day) on the 10-14 th day after menstruation. 2. The critical phase of nidations (on the 15-19 th day after impregnation). 3. The critical phase of setting up temporary organs (28-34 day).
	2. The middle stage (fetal, from 35 to 60days)	3. The early fetal step (35-45 days). 4. The late fetal step (46-60days).	4. The critical phase of setting up the definitive organs (55-60 days).
	3. The late stage (foetal, from 2 month to birth).	5. The early foetal step (from 61 days to 5 months). 6. The middle foetal step (from 5 months to 7months). 7. The late foetal step (from 7months to birth).	5. The critical phase of the tunctions of the definitive organs (5-5,5months). 6. The critical phase of birth (within 3-5 days before birth).
ii. Postnatal period (from birth to 21-25 years).	4. New-born stage (from birth to 10-15 days).	8. The step of being new-born (from birth to 10-15 days).	7. The critical phase of newbornness (from birth to 8-10 days).
	5. Breastfeeding stage (from 10-15days to 1 year).	9. The step of milk feeding (from 10-15days to 1 year).	
	6. Childhood stage (from 1 year to 11 years (girls), from 1 year to 12 years (boys)).	10. The step of early childhood (from 1 year to 3 years). 11. The step of middle childhood (from 3 to 6 years). 12. The step of late childhood (from 6 to 11 years (girls), from 6 to 12 years (boys))	8. The critical phase of the childhood (during 6 - 6,5 year).
	7. The pubertal stage (from 11 to 15 years (girls), from 12 to 16 years (boys)).	13. The step of adolescence (from 11 to 15 years (girls), from 12 to 16 years (boys)).	9. The critical phase of adolescence (from 11 to 15 years (girls), from 12 to 16 years (boys)).
	8. The preadult stage (from 15 to 21 years (girls), from 16 to 25 years (boys)).	14. The step of young adults (from 15 to 21 years (girls), from 16 to 25 years (boys)).	10. The critical phase of young adults (during 20-21 year (girls), during 23- 25 year (boys)).
iii. Maturity (from 21-25 years till natural death.	9. The maturity stage (from 21 to 55 years (women), from 25 to 60 years (men)).	15. The step of the first maturity (from 21to 48 years (women), from 25 to 45 years (men)). 16. The step of the second maturity (from 48 to 55 years (women), from 45 to 60 years (men)).	11. The critical phase of the first maturity (from 48 to 50 years (women), from 43 to 46 years (men)). 12. The critical phase of the second maturity (55-57 years (women), 60-64 years (men)).
	10. The young elderly stage (from 55 – 60 to 75 years (women), from 60 to 75 years (men)).	17. The young elderly step (from 55 – 60 to 75 years (women), from 60 to 75 years (men)).	13. The critical phase of young elderly people (75-78 years (women), 73-75 years (men)).
	11.The stage of old age (from 75 to 90 years (Men and women))	18. The step of old people (from 75 to 90 years (Men and women)).	14. the critical phase of old age Старческая фаза (88 - 91 years – men and women).
	12. The stage of long-livers (from 90 years and older (men and women)).	19. The step of long-livers (from 90 years and older).	

This genetic reserve is not only for human development, growth and getting productivity of animals but it is also for adaptation, for development of mental and physical possibilities of human beings and their reserves. A man uses only about 10-12 % of their genotype during ontogenesis. It is evident that the adaptation reserve is also used on the same scale [12, 13].

CONCLUSION

The adaptation of an organism to ecological conditions in human beings and animals is stated to happen according to stages of development. During critical phases of development an organism is more sensitive to ecological conditions. During critical phases genetic mutations happen in cell nuclear of programmed differentiations. Modifying, mutative and complex variability of genes happens under the influence of outer and inner factors of environment during critical phases of development of an organism, organs, tissues.

ACKNOWLEDGEMENT

The study was carried out with the financial support of the Ministry of Education and Science of the Russian Federation within the state programme of FSBEI HE "Evseyev State Pedagogical Institute of Mordovia" (project "The influence of anthropogenic factors on the morphofunctional state of the organism").

REFERENCES

- [1] Teltsov, L. P., Shashanov, I. R., 2005. About the laws of mammal individual development. The bulletin of Ulyanovsk State University. Biology, 1(9): 120-125.
- [2] Teltsov, L. P., Mikhailevskaia, E. O., Muzyka, I. G., 2009. Glossary of terms in developmental biology, embryology, anatomy, histology and cytology. 570 p.
- [3] Severtsov, A. S., 1987. The foundations of evolutionary theory. The printing house of MSU. 320 p.
- [4] Teltsov, L. P., 2001. The stages of development of human organs and inheritance. The proceedings of an international conference "Natural Science at the Turn of the Century", 2: 135-140.
- [5] Teltsov, L. P., Solov'eva, L. P., 2001. Inheritance and the stages of development of animals and human being in ontogenesis. Russian Morphological Journal, 1-2: 153-155.
- [6] Garkavi, L. H., Kvakina, E. B., Ukolova, E. B., 1979. Adaptive reactions and resistance of the organism. 119 p.
- [7] Baranov, V. S., Baranova, E. V., 2004. To live in harmony with one's genes. Nature, 12: 3-9.
- [8] Korochkin, L. I., 2002. Biology of individual development. MSU. 264 p.
- [9] Svetlov, P. G., 1966. The theory of critical periods of development and its meaning for understanding principles of environment impact on ontogenesis: Problems of cytology and general physiology. 263-274.
- [10] Teltsov, L. P., Stolyarov, V. A. and others, 1999. The criteria for identification of critical phases of organ development in ontogenesis. The proceedings of the 5th Russian conference of anatomists, histologists and embryologists. Russian Morphological Journal, 1-2: 147-148.
- [11] Wright, A. 1991. The foundations of immunology. The World. 328 p.
- [12] Teltsov, L. P., Shashanov, I. R. and others, 2006. The laws of individual development of human beings and animals. The bulletin of Kazan Academy of Veterinary Medicine, 185: 310-321.
- [13] Teltsov, L. P., Semchenko V. V. And others. 2015. The laws of individual development of human and animal organisms. The proceedings of an international research-to-practice conference dedicated to the diamond anniversary of the honored worker of science of the Russian Federation, the Doctor of Biology, professor, Teltsov Leonid Petrovich, 1: 8-17.