

FOR OFFICIAL USE ONLY

JPRS L/9501

23 January 1981

USSR Report

LIFE SCIENCES

BIOMEDICAL AND BEHAVIORAL SCIENCES

(FOUO 1/81)



FOREIGN BROADCAST INFORMATION SERVICE

FOR OFFICIAL USE ONLY

NOTE

JPRS publications contain information primarily from foreign newspapers, periodicals and books, but also from news agency transmissions and broadcasts. Materials from foreign-language sources are translated; those from English-language sources are transcribed or reprinted, with the original phrasing and other characteristics retained.

Headlines, editorial reports, and material enclosed in brackets [] are supplied by JPRS. Processing indicators such as [Text] or [Excerpt] in the first line of each item, or following the last line of a brief, indicate how the original information was processed. Where no processing indicator is given, the information was summarized or extracted.

Unfamiliar names rendered phonetically or transliterated are enclosed in parentheses. Words or names preceded by a question mark and enclosed in parentheses were not clear in the original but have been supplied as appropriate in context. Other unattributed parenthetical notes within the body of an item originate with the source. Times within items are as given by source.

The contents of this publication in no way represent the policies, views or attitudes of the U.S. Government.

COPYRIGHT LAWS AND REGULATIONS GOVERNING OWNERSHIP OF MATERIALS REPRODUCED HEREIN REQUIRE THAT DISSEMINATION OF THIS PUBLICATION BE RESTRICTED FOR OFFICIAL USE ONLY.

FOR OFFICIAL USE ONLY

JPRS L/9501

23 January 1981

USSR REPORT
LIFE SCIENCES
BIOMEDICAL AND BEHAVIORAL SCIENCES
(FOUO 1/81)

CONTENTS

ADVANCED BIOTECHNOLOGY

The Development of Molecular-Biological Research and Multilateral Cooperation	1
Some Questions of the Theory of Swimming of Fishes and Dolphins	8
Book on Biological Bases of Behavior Control of Fish in Flowing Water	13
Applied Mathematics in Biology	24

ADVANCED MEDICAL TECHNOLOGY

Mathematical Descriptions of Cardiac Bioelectrical Activity	27
Applications of Focused Ultrasound	30
Monograph Analyzes Cryogenic Preservatives	35
Lasers in Traumatology and Orthopedics	38

ENVIRONMENTAL HAZARDS

Radiation Exposure, Reduction of and Methods for Chemical Protection	41
Radiation Injury Diagnosis Based on Analysis of Blood Nucleic Acids	50
Biophysics of Complex Systems and Radiation Injuries	55

- a -

[III - USSR - 21a S&T FOUO]

FOR OFFICIAL USE ONLY

Radioactive Agents and Wounds	78
Prediction of Ionizing Radiation Transfer by Photometric Methods	82
Radiation Safety and Shielding of Nuclear Power Plants	85
Biological Aspects of Radioactive Contamination of the Seas	90

-b-

FOR OFFICIAL USE ONLY

FOR OFFICIAL USE ONLY

ADVANCED BIOTECHNOLOGY

UDC 577.23

THE DEVELOPMENT OF MOLECULAR-BIOLOGICAL RESEARCH AND MULTILATERAL COOPERATION

Moscow VESTNIK AKADEMII NAUK SSSR in Russian No 6, 1980 pp 82-88

[Paper presented by Academician J. Říman of the Czechoslovak Academy of Sciences at the XI Meeting of Representatives of the Academies of Sciences of the Socialist Countries in Tallinn]

[Text] The topic of this presentation is closely related to one of the most important tasks of bilateral and multilateral cooperation among socialist countries in the field of natural sciences, which is to ensure the foremost development of the most promising scientific investigations. Specifically, the discussion will focus on the necessary, in our opinion, measures that must be taken to ensure the development of molecular-biological research currently being coordinated by the New Program of Multilateral Cooperation.

As part of the topic which interests us, we would first like to briefly characterize the goals and methods of those studies which are basically molecular-genetic in nature. In general the goal of this research is to explain the molecular basis of the various functions of biological systems--from the simplest forms, i.e., functionally active biological macromolecules (nucleic acids and proteins) and molecular complexes (nucleoproteides and phages, viruses, procaryotic and eucaryotic cells to multicellular plant and animal organisms.

Biological phenomena, which serve as the subject of molecular biology, are simultaneously studied as phenomena by other biological disciplines. This involves the fundamental behavior of living systems, such as nourishment, growth, reproduction, mobility, irritability, secretability and specific characteristics such as infectability, resistance, differentiation, abnormal cell transformations, immunity and tissue histocompatibility as well.

The spectrum of experimental methods used in molecular-biological research is very wide and attests to the complexity of the problems being investigated.

Molecular-biological analysis, based on the biochemistry of nucleic acids and proteins, requires, in addition to complex physical-chemical and physical methods, x-ray diffraction techniques, neutron scattering and nuclear magnetic resonance, and now, mathematical models, not only the necessary equipment but also a wide assortment of special reactants, enzymes and radioactive isotopes. The application of this arsenal of techniques can be effective only if there is a well characterized experimental biological model, whose value increases the more its genetic structure is defined.

FOR OFFICIAL USE ONLY

FOR OFFICIAL USE ONLY

It is necessary to emphasize the qualitative specifics of the experimental model in molecular-biological research in comparison to that used in other areas of biological research. If the model is biologically and genetically simple enough, then it becomes not only the subject of the research, but its instrument as well, since it becomes necessary at all stages of research - from the statement of the problem to the interpretation of the results. This approach allowed us to postulate the existence of a nucleotide triplet as the basic unit of the genetic code some 20 years ago, while direct biochemical proof of this was obtained only in 1961.

In the last decade, the application of this relatively simple experimental biological model was partially responsible for the transformation of oncogenic viruses and their host cells into valuable tools in the study of not only malignant cell changes but of several normal cell functions and the structure of cell genome as well. Therefore we now have numerous data on the molecular basis of virus and microbe functions.

Today this approach, together with the wide application of recombinant DNA techniques as well as the whole complex of immunological, immunogenetic, cytological, physico-chemical analysis and mathematical models, offers wide possibilities for the study of the molecular basis of fundamental and specialized functions of eucaryotic cells, among these human cells. This is supported by the wealth of new data obtained in the past few years which have substantially changed our ideas.

This in part includes the data on the dual role of biological molecularly functioning elements, i.e., those transmitted in replication and those replicating in transmission, and data on nucleases in replication (after the discovery of functioning macromolecule complexes).

These are also data obtained by virtue of the discovery of reversible transcriptase (1970) and the restriction enzymes, and later by the development of techniques for determining DNA and RNA sequences, by obtaining recombinant DNA, in other words, data obtained by virtue of the application of the technology of genetic engineering (after 1972).

In addition, these are new data on the "maturity" of the information transcript and primarily on the previously unknown technique of genetic recombination by combining information carrying RNA fragments after a preliminary breakdown of the molecular predecessors (splicing). This relatively simple technique of genetic recombination in eucaryotic cells, which was also probably the earliest evolutionary phenomenon, allows us to postulate that specifically RNA and not DNA serves as the primary information material. It is probable that a simple ribonucleotide (for example, nicotinamidadenine-dinucleotide) could have become in the process of evolution the primary information unit, the genetic monomer which served as the basis of cell metabolism as the precursor of reactions which are catalyzed by enzymes which evolved later. This new idea about the primary information function of RNA is not even contradicted by data on protein which recognize nucleotides. To these proteins, in addition to the already known lac-repressor, belong the enzymes of RNA-RNase II maturation which is a nucleotide and probably also the proteins of membranes which are responsible for the transport of specific nucleic acids within the cell.

FOR OFFICIAL USE ONLY

FOR OFFICIAL USE ONLY

This, in the final analysis, is a very striking result obtained in the process of studying the structure of eucaryotic genes; the discovery of their mosaic structure in which coding and non-coding sequences alternate, the so-called exones and intrones. The recently obtained proofs of the fact that individual exones within the gene determine individual functional regions in the structure of specialized proteins (on the example of the heavy chain in immunoglobulin) are directly related to this discovery.

In general, it can be said that the application of new recombinant DNA techniques is approaching the possibility of molecular analysis of eucaryotic cells on a level which is now reached only by studies of viruses and microbe cells. This is supported in part by the preliminary results of experiments on determining the functional properties of catalytic regions in the information molecules of eucariotic cells.

The detailed analysis of the structure of some animal genes, including human genes, became possible thanks to the newly discovered capability of producing significantly greater (several milligrams) quantities of individual genes in microbe cells which received these genes through genetic engineering. This is the method used in the production of, for example, globin, immunoglobulin, ovalbumin, histone genes and the genes of some viruses. The recently discovered principle about the increased selective transcription of weak quantities of information RNA will enable us in the near future to obtain larger quantities of genes such as the gastrin gene, which was recently isolated in precisely this way, and it will facilitate detailed study of these previously inaccessible genes.

Comparative studies of defective and non-defective oncogenic viruses led to the discovery and retransmission of the gene sarc. Finally, by means of direct biological evidence, the region in the molecule of plasmidic DNA (one of the plasmids of the bacteria Escherichia coli) which is responsible for its virulence was recently identified.

The use of the genetically determined biological model as an experimental tool, together with current techniques of isolation, cleaning, amplification, immunological and molecular analysis of specific components of living systems, allows us to study in detail the mechanisms of various functional phenomena of the eucaryotic cell on all of its structural levels even to the level of cell organelles.

This approach has led to important results in the area of cell nucleus research and in studies of chromatin and cytoplasmatic cell organelles.

Studies of cell membranes - their morphogenesis and various functions: transport, signal, recognition, receptor, and among these the function of the nerve cell membrane during the transmission of a nerve impulse proceed in similar ways.

This method is likewise used in the study of cell mobility carried out by its actomyosin apparatus which directly participates in the formation of the cell cytoskeleton, and especially by the geodome which reacts to external signals.

FOR OFFICIAL USE ONLY

FOR OFFICIAL USE ONLY

In addition, enzyme mechanisms of the so-called biological clock which determines the daily biorhythm of some birds and mammals were discovered. These are usually conditioned by the level of synthesis of the hormone epiphase-melatonin. A hypothesis was also set forth about the molecular mechanism of genetic clocks, where the primary role is assigned to the activity of the restriction-modification enzymes.

Finally, there have been successful results in the field of bioenergetics, especially photosynthesis in plants as well as photosynthetic bacteria.

In this far from complete survey of the successes of contemporary molecular biology we have not yet touched on its applied aspect. The practical application of genetic engineering is well known, for example, the production of important physiologically active natural substances in significant quantities, primarily the various substances produced in the human organism such as insulin, the growth hormone, interferon and others, and the production of a series of bacterial enzymes important for industry. Moreover, data have recently been published on the successful identification of the infectious nature of the DNA as well as in the DNA of the lambdoidic phage and reproducing in the bacteria *Escherichia coli*.

Of extremely practical significance is the perfecting of substitute enzyme therapy of genetic diseases of man, in which the chemical recognition signals of the enzymes are used to heighten the selectivity of cell activity. Another accomplishment is the recent synthesis of the first pigment-protein complex (α -pyrochlorophyll-pheophytin), which imitates the function of the photosynthetic reaction center of green bacteria (*Rhodospseudomonas sphaeroides*), and which represents the first level of transforming solar energy into electrical energy.

This brief characterization of goals, methods and some of the most recent results in the field of molecular biology represents not so much a survey of the state of current molecular-biological research or an example of its great scientific and practical significance but serves as a basis for the recommendations made below for ensuring the development of this type of research within the context of multilateral scientific cooperation among the socialist countries.

The development of molecular-biological research depends on two interrelated factors.

The first factor is scientific personnel who, in the course of the experiment and depending on the specific problem, are able to effectively use ideas and methods from a variety of related biological and non-biological areas and disciplines.

The second factor is the material base of molecular biology, including the following: special equipment, that is, preparatory, analytical and cultivation technology and among these, special laboratory equipment for microwork as well as for the purpose of increasing the effectiveness and safety of experimental work; ultrapure reactants, special compounds and biologically active material including a growing assortment of specific antibodies, serums and serum components for tissue cultures, and biologically active materials and radioisotopes with great specificity;

FOR OFFICIAL USE ONLY

FOR OFFICIAL USE ONLY

a sufficient quantity and the necessary assortment of genetic biomodels, e.g., mutant strains of plasmids, phages, viruses, microbe cells, plant and animal cells as well as pure strains of laboratory animals.

Both of these factors should correspond to the level of experiments being conducted.

We should take into account the fact that in the past twenty years in the countries of the West the development of molecular biology, in spite of the deepening economic crisis, is ensured by large investments of capital, by a rapid development of special industries and by an increase in the production of products which are required by all types of research. At the present time this tendency can be noted not only in the United States, Great Britain, France, Italy, but in average and smaller countries as well, for example, Sweden, The Netherlands, Switzerland and even Luxembourg and Liechtenstein.

Until 1970 the material support for molecular biology in the West consisted of, in general, the production of unique instruments, equipment and the required assortment of reactants and special biologically active substances. The commercial production of biomodels was practically limited to pure strains of experimental animals. The discovery of reverse transcriptase in 1970 led to a mass commercial production of the AMV virus in the U.S. as a source of reverse transcriptase, and soon after, to the mass production of a whole series of various oncoviral strains which literally resulted in an explosion of information in that area of molecular biology.

In 1971, that is, a year before the official announcement about work in genetic engineering, the commercial production of basic technological elements for these experiments was already organized in the U.S. In the U.S. and Western Europe specialized centers for the mass production of not only compounds such as insulin, the growth hormone, interferon, industrial enzymes but also of separate genes for basic research were set up.

During the last two years, for example, there has been a sharp increase in the production of biomodels, among them cell hybrids used in the production of certain antibodies. The method of cultivating the B-lymphocyte antibody producer by joining it to a tumor cell enables scientists to select a specific cell clone for the mass production of any given antibody. This method allows the production of a practically unlimited range of experimental antibodies for immunology, endocrinology and toxicology. According to several Western companies, the capital investment required for the production of certain biomodel types pays for itself five times faster than in the area of electronics. In the mass production of biomodels like viruses, cell hybrids and individual genes, small specialized companies are more effective and profitable since larger ones do not adjust readily to the constantly changing requirements.

Molecular-biological research is supported in all remaining areas, including the production of equipment designed to make research more effective.

FOR OFFICIAL USE ONLY

FOR OFFICIAL USE ONLY

Our primary goal is to increase the effectiveness of molecular-biological research and we should explore and realize all of our potential in reaching this goal.

Let us now examine the current state and developmental potential of molecular biology in the socialist countries.

Today we can with all assurance say that in the past decade molecular-biological research developed at a fast rate both quantitatively and qualitatively. Molecular biology has reached a high level in the USSR based on its own traditions as well as on the most promising international accomplishments and enjoys the support of the CPSU Central Committee and the USSR Council of Ministers. Molecular-biological research in other brother countries, Bulgaria, Hungary, German Democratic Republic, Poland and Czechoslovakia, has also had great successes and progress.

The results obtained in the fields of microbiology and genetics of microorganisms, virology and oncovirology, immunology and immunogenetics, in membranology, in the field of protein and nucleic acid biosynthesis and recently in recombinant DNA techniques indicate a good preparation on the part of our scientific personnel, an ability to resolve any problems which the development of molecular biology poses in successful competition with scientific developments in capitalist countries.

But in addition to personnel, the successful development of molecular-biological research requires a material base of its own production. Therefore we must, to the extent that we are able and by mutual cooperation, find and develop everything that can contribute to the independent development of our molecular biology and ensure our experimental and technological competitiveness in this area which will facilitate a mutually agreeable exchange of technology and data with the capitalist countries.

Molecular-biological experiments are of a very fundamental nature. Therefore there is no doubt that in time we will have our own well organized and growing material base in whose creation would have participated all of our countries. We should immediately begin building this base, quickly and with initiative, everyone to the best of his ability. Certain measures can be taken immediately, and some already have been, for example, the mobilization of the internal resources of our Academies. With relatively small capital expenditures it is possible to make a decision about a bank for registering and safe-keeping special biological materials.

We have already acquired some experience in creating a common material base for molecular-biological research in our mutual support of the project on "Reverse transcription" (within the program of cooperation among the Academies of Sciences) by the AMV virus, by the enzyme revertase, by desoxyribonucleotide triphosphates, by oligo-inoculation (dT) and by special information molecules and in our mutual support of the topic "Oncovirology and its molecular-biological aspects" (within the framework of the CEMA program "Harmful new formations) by providing fetal calf serum, several pieces of equipment and cell and virus models.

It is also possible now to take some measures to develop a common supply of special enzymes to cooperating countries. Many of our institutes independently and often with no exchange of information are isolating, for example, restrictase

FOR OFFICIAL USE ONLY

FOR OFFICIAL USE ONLY

of various types and even of identical types. In particular, our institute has isolated nine restrictases, seven of these independently and two in cooperation with the Hungarian Academy of Sciences. An inventory of all restrictases isolated in the course of our work will probably show that we already have most of the 80 currently known different types of restrictases. This holds true for the isolation of other enzymes of DNA recombination and in general for special enzymes, the production of which could be increased.

Analogous measures can also be taken in the area of cell models, including the already existing original models of lymphocyte hybrids.

In our opinion, the most purposeful and realistic way to ensure a reliable material base for cooperative molecular-biological studies is to gradually proceed from the level of separate themes which appear to be most promising to the development of a common project on their basis. Such themes, as part of our program of multi-lateral cooperation, should be identified and analyzed with a view to establishing concrete tasks for the participating countries in the development of these themes.

Some effective coordination of the research on these themes should also be found. The coordinating programs will have to change their function from simply registering work to a level of actual coordination. The commission "Molecular Biology" should know the technological requirements of individual themes as well as the potential of the participating countries, in other words, the reserves in the area which can be mobilized for the mutual supplying of project requirements. A supply service could be organized at each base laboratory. This commission should also have a general idea of all molecular-biological research and in particular a rating system as to its relative importance.

Molecular biological research is by its nature already suited to integration. On the other hand, integration in this area is for us the most effective way of ensuring the successful continued development of molecular-biology. The guarantee of its continued progress is a real task of the Academy of Sciences of the socialist countries.

COPYRIGHT: Izdatel'stvo "Nauka", "Vestnik Akademii nauk SSSR", 1980
[23-9233]

9233
CSO: 1840

FOR OFFICIAL USE ONLY

FOR OFFICIAL USE ONLY

UDC 591.524.1:591.177

SOME QUESTIONS OF THE THEORY OF SWIMMING OF FISHES AND DOLPHINS

Moscow DOKLADY AKADEMII NAUK SSSR in Russian Vol 253, No 5, 1980 pp 1082-1085

[Article by Ye. V. Romanenko, Institute of Evolutionary Morphology and Ecology of Animals imeni A. K. Severtsov, USSR Academy of Sciences]

[Text] In recent years there have been several attempts to create a mathematical model of the swimming of fishes and dolphins. However, mainly two dimensional problems have been examined [1,2], and this has permitted only qualitatively examining the mechanisms of swimming and effects connected with that process.

One of the most successful solutions of the spatial problem of the mechanism of swimming of fishes was given by Academician of the Ukrainian Academy of Sciences G. V. Logvinovich [3]. He examined the motion of a slender body in the inertial coordinate system x, y, z , which moves in an unlimited liquid medium in the direction of the Ox axis. Figure 1 presents a diagram which clarifies the formulation of the problem. The diagram has been taken from the work of G. V. Logvinovich, as have all the symbols: the abscissas of the ends of the body x_1 and x_2 and, consequently, the length of the body $L_p = x_1 - x_2$, $R(x)$ is the semi-major axis of an elliptical cross section of the body, the value of dR/dx is small along the entire length of the body, and S -- the longitudinal curvilinear axis of the body -- deviates little from the axis of abscissas. Put as the basis of the theory is the concept of the "permeable layer," according to which the body, in passing through a certain "permeable layer," which is immobile in relation to a quiescent liquid, generates in it an almost plane cross current, similar to the flow of an ideal liquid. A flux of pulses $m_1^* v_n$ flows in that case from the tail fin of the slender body under consideration along the tangent to it. Here m_1^* is the virtual mass, equal to $\pi \rho R^2(x_1)$, ρ is the density of the liquid, V is the velocity of the body, and v_n is the layer velocity normal to the curvilinear axis of the body, determined with the expression

$$v_n = \frac{\partial \eta}{\partial t} - V \frac{\partial \eta}{\partial x}$$

FOR OFFICIAL USE ONLY

FOR OFFICIAL USE ONLY

In such a formulation of the problem for the case of periodic change of swimming movements of a body G. V. Logvinovich obtained the following general expressions for the thrust caused by encounters of pulses, suction and kinetic energy remaining in the wake per unit of path of the tail fin:

$$(1) \quad I = m^*(x) V \left(\frac{\partial \eta}{\partial t} - V \frac{\partial \eta}{\partial x} \right) \frac{\partial \eta}{\partial x} \text{ at } x = x_1,$$

$$(2) \quad P = -\frac{1}{2} \int_{x_1}^{x_2} \frac{dm^*(x)}{dx} \left(\frac{\partial \eta}{\partial t} - V \frac{\partial \eta}{\partial x} \right)^2 dx,$$

$$(3) \quad E = \frac{m^*(x)}{2} \left(\frac{\partial \eta}{\partial t} - V \frac{\partial \eta}{\partial x} \right)^2 \text{ at } x = x_1.$$

Expression (1) is valid only for fishes swimming by the "eel" method, when the amplitude of the wavy oscillations of the body is constant at all its points. A very general expression for the thrust, one without the indicated limitations, also was obtained by Academician G. V. Logvinovich [4] and has the form:

$$(4) \quad I = \int_{x_1}^{x_2} \left(\frac{\partial \eta}{\partial x} \right) \frac{d}{dt} \left[m^*(x) \left(\frac{\partial \eta}{\partial t} - V \frac{\partial \eta}{\partial x} \right) \right] dx.$$

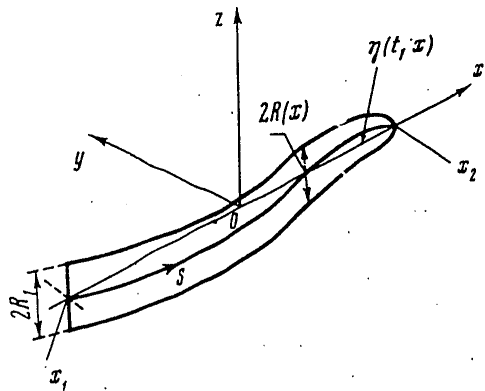


Figure 1. Diagram explaining the formulation of the problem.

The formulas obtained by G. V. Logvinovich permit estimating the hydrodynamic characteristics of fishes on the basis of experimentally measured kinematic characteristics. Academician G. V. Logvinovich applied that theory to describe only one particular case of the swimming of fishes by the "eel" method. In reality not one fish species swims in that way, although in some species, eels in particular, the amplitude of oscillations of the head in the process of swimming amounts to about 30-40 percent of the amplitude of tail oscillations. In other fish species, however, and also in dolphins, it is even less than that.

FOR OFFICIAL USE ONLY

There was an attempt to apply G. V. Logvinovich's theory to describe the swimming of fishes by the "scombroid" method on the assumption of a linear law of increase of amplitude of a locomotor wave during its propagation from head to tail along the fish body [5]

$$(5) \quad \eta = \eta_0 \frac{x_2 - x}{L_p} \sin\left(\frac{Ct}{L} - \frac{x_2 - x}{L}\right), \text{ where } C = \text{constant.}$$

It can readily be shown, however, that representation of the shape of oscillations in such a form is incorrect, as it leads to a negative value of the thrust under that condition $V = C$. Here C is the phase wave velocity. To prove that statement, let us represent the shape of oscillations of a fish body in the form

$$(6) \quad \eta = \eta_0(x) \sin[\omega t - k(x_2 - x)], \text{ where } k = \text{constant.}$$

If we use expressions (2), (4) and (6) we obtain the sum of oscillations of the thrust and suction averaged during the oscillation period for $V = C$

$$(7) \quad \{I\} + \{P\} = -\frac{V^2}{4} m^*(x_1) \left(\frac{\partial \eta_0}{\partial x}\right)_{x=x_1}^2$$

We will consider in such case that at $x = x_2$, $m^* = 0$.

From the noted fact follows the inevitable conclusion that in formula (6) the value of k must be a function of the coordinate, and since $k = \omega/C$, then the locomotor wave phase velocity C must be a function of the coordinate. Then the law of fish body deformation in the process of swimming must have the following form

$$(8) \quad \eta = \eta_0(x) \sin\left[\omega t - \frac{\omega(x_2 - x)}{C(x)}\right].$$

The form of the wave phase velocity-coordinate relation is difficult to predict, and so we will assume that it is approximately linear. As for the shape of the function $\eta_0(x)$, if one starts from obvious experimental data which are reduced to the fact that the locomotor wave amplitude of a fish or dolphin increases monotonically from head to tail, it can be approximated by an exponent with a minimum number of undetermined parameters. Then the law of fish or dolphin body deformation in the process of swimming can be represented definitively in the form

$$(9) \quad \eta = \eta_1 [K_r - 1 + \exp\{\alpha((x_2 - x)/L_p)^\gamma\}] \sin\omega\left\{t - \frac{x_2 - x}{C_r[1 + b(x_2 - x)]}\right\}.$$

Here η_1 is the amplitude of tail oscillations, K_r is the ratio of the amplitudes of head and tail oscillations, ω is the circular frequency, τ is the time, C_r is the value of the locomotor wave phase velocity in the region of the head. The values of η_1 , K_r , γ , b , ω and C_r are unknown and must be determined experimentally. The coefficient α can readily be expressed through K_r from the boundary condition. Actually, the amplitude of tail oscillations at $x = x_1$ must be equal to η_1 , that is, $K_r - 1 + e^{\alpha} = 1$, whence we have $\alpha = \ln(2 - K_r)$.

FOR OFFICIAL USE ONLY

By using expression (9) and the evident condition

$$(10) \{I\} + \{P\} = 0 \text{ at } V = C,$$

it would be possible to estimate the values of the most interesting parameters γ and b . However, the expression for the sum of the thrust and suction proves to be exceptionally unwieldy and little suitable for numerical calculations in that case. Still, such an estimate can be made if it is recalled that the thrust is determined in accordance with expression (4) by projecting on the Ox axis the pulse flowing from the tail fin in a unit of time, and the pulse projection is determined in turn by projection on the same axis of the liquid layer velocity normal to the same axis

$$(11) v_{nx} = \left(\frac{\partial \eta}{\partial t} - V \frac{\partial \eta}{\partial x} \right) \frac{\partial \eta}{\partial x}.$$

The equality to zero of the thrust at $V = C$ is equivalent to equality to zero of expression (11). Therefore to estimate the values of γ and b we will make use of expression (11), equating it to zero under the conditions $V = C$ and $x = x_1$. Here we will make two additional assumptions: firstly, we will make the estimate at a point corresponding to the edge of the tail ($x = x_1$). That assumption evidently is valid, since the thrust is accomplished with the tail. Secondly, we will neglect suction, which according to the data of [3,5] constitutes a very small portion of the total thrust. To sum up, if we use expressions (9) and (11), we obtain

$$(12) \frac{V \alpha^2 e^{2\alpha}}{L_p^2} \gamma^2 = \frac{\omega^2}{V} \left[\frac{1}{1 + L_p b} \right] \left[1 - \frac{1}{1 + L_p b} \right].$$

In the case of the swimming of dolphins, there is a clear connection between the values of ω and V/L_p

$$(13) \omega = 2\pi (1,1 V/L_p + 0,15).$$

In addition, observations of dolphins show that the value of K_r is about 0.25. If we take this and expression (13) into consideration, we obtain a correlating connecting the values of γ and b with respect to bottlenose dolphins

$$(14) \gamma = \frac{6,41}{1 + L_p b} \left(1,1 + \frac{0,15}{V/L_p} \right) \sqrt{L_p b}.$$

The results of calculations according to formula (14) for the most typical values of the relative velocity of a dolphin are given in Table 1.

What sort of correlation between γ and b exists in the case of real swimming of fishes and dolphins can be shown only by careful experiments on animals.

I sincerely thank Academician G. V. Logvinovich, Doctor of Physical and Mathematical Sciences K. A. Naugol'nykh and S. G. Pushkin for their interest in the work and valuable comments.

FOR OFFICIAL USE ONLY

Table 1

b, m^{-1}	γ at $V/L_p=1$	γ at $V/L_p=2$	b, m^{-1}	γ at $V/L_p=1$	γ at $V/L_p=2$
0,05	2,30	2,17	0,3	3,88	3,65
0,1	2,99	2,81	0,4	3,98	3,74
0,2	3,62	3,40	1,0	5,64	5,31

BIBLIOGRAPHY

1. Steckmann, J. ENG. ARCH, No 31, p 214 (1962).
2. Wu, T. Y.-T. FLUID MECHANICS, Vol 45, Part 2, p 337 (1971).
3. Logvinovich, G. V. BIONIKA, Vol 4, p 5 (1970).
4. Logvinovich, G. V. Gidrodinamika techeniy so svobodnymi granitsami (Hydrodynamics of Flows With Free Boundaries). Kiev, 1969.
5. Kozlov, L. F., and Oleynik, R. A. BIONIKA, Vol 12, p 3 (1978).
6. Kinn, V. P., and Pyatetskiy, V. Ye. BIONIKA, Vol 11, p 36 (1977).

COPYRIGHT: Izdatel'stvo "Nauka", "Doklady Akademii nauk SSSR", 1980
[439-2174]

2174
CSO: 1840

FOR OFFICIAL USE ONLY

BOOK ON BIOLOGICAL BASES OF BEHAVIOR CONTROL OF FISH IN FLOWING WATER

Moscow BIOLOGICHESKIYE OSNOVY UPRAVLENIYA POVEDENIYEM RYB V POTOKE VODY
(Biological Bases of Behavioral Control of Fish in Flowing Water) in
Russian 1980 signed to press 23 Apr 79 pp 2, 3-10, 317-319

[Annotation, Introduction and Table of Contents from book by Dmitriy
Sergeyevich Pavlov, 1,250 copies, 318 pages]

[Text] Patterns of fish behavior are examined on the basis of original material: orientation, swimming speed, behavior in a rheogradient, downriver and spawning migrations, behavior in some hydroengineering structures. Much attention is devoted to the ecological study of rheoreaction. Basic stereotypes are revealed of behavior of pelagic and bottom fish in flowing water.

The book is of interest for zoologists, ichthyologists, specialists engaged in research on animal behavior and also for hydraulic engineers and personnel engaged in fishery.

Introduction

The development of the theory and methods of control of biological processes constitutes one of the chief directions of biological research. The problem of behavior control of animals is an important part of it. It concerns one of the most ancient problems of concern to mankind. Nonetheless the scientific bases of behavioral control are beginning to be established only now. Their further development is of major importance to the rational utilization, reconstruction and conservation of the animal world.

Behavior is one of the most complex forms of manifestation of animals' vital activity. As A.N. Severtsov has pointed out (1922), it is of extreme biological importance, ensuring plasticity of animals in regard to rapid environmental changes. For this reason it is quite logical for research on animal behavior to be included on an increasingly large scale at the present time in the general complex of ecological-evolutionary problems.

FOR OFFICIAL USE ONLY

FOR OFFICIAL USE ONLY

Mobility of the physical medium of habitation (air and water, to a lesser degree ground) is a factor acting on the duration of all evolution of animal and vegetable organisms. In the animal world, this factor is of especially great importance for aqueous inhabitants, many of them spend their entire life in flowing water. In regard to the water environment, animals have developed an adaptation pertaining to different aspects of their vital activity. These adaptations are manifested both in animals' structure and in their functions, including behavior. The special features of fish in flowing water constitute an important side of their biology.

The purpose of the given work lies in the development of the biological bases of behavioral control of fish in flowing water. Such a formulation of the questions provides first of all for the study of the basic laws of this behavior and then determination of the possibilities and methods of control.

The pertinence of the subject of research is connected principally with one of the most important problems of contemporaneity--the problem of "man and the biosphere." Water bodies as one of the elements of the biosphere are increasingly becoming subject to the influence of man's activity. As a result of the construction of dams and withdrawal of water for irrigation and other purposes, conditions of currents have sharply changed in many internal water bodies. Conditions have correspondingly changed for the manifestation of behavioral adaptations of fish connected with life in flowing water, particularly spawning and downriver migrations. Preservation of natural reproduction of many species of fish in these water bodies would be impossible without the development of scientific bases of behavioral control of fish in flowing water and the practical implementation of the proper measures.

At the same time, the importance of investigation of the basic laws of behavior of fish in flowing water is determined by the necessity of understanding the role of behavior in the system of their adaptation first of all to dwelling in a mobile environment. This promotes a deeper examination of the different aspects of the ecology of fish, especially their migrations.

The complexity and many-sidedness of the phenomenon of behavior is responsible for the fact that work connected with its study is conducted by representatives of different specialties (physiologists, zoologists, psychologists, mathematicians, bionicists [bioniki] and others) and along different lines. The basic theses of the theory of behavior of animals were analyzed and described by a number of authors (Promptov, 1940, 1956; Anokhin, 1945; I. Pavlov, 1951; Voronin, 1957; Biryukov, 1958; Krushinskiy, 1960, 1972; Slonim, 1965, 1967; Tinbergen, 1969; Shoven, 1972; Fabri, 1975; Khaynd, 1975; Lorenz, 1939; Tinbergen, 1955; and others). The objectives of our work, connected with behavioral study at the level of organisms and populations of a number of species, bring it close to the work of zoologists conducted in regard to the ecological aspect. A comparable direction of research appeared in the second half of the 19th century, undergoing

FOR OFFICIAL USE ONLY

FOR OFFICIAL USE ONLY

significant development in the first half of the 20th century in the works of zoologists and ecologists (Panov, 1975; Novikov, 1975). At the present time, it is becoming practically impossible to examine such traditional problems of ecology as feeding, reproduction, defense and ecology of populations without an analysis of the behavior of animals (Nikol'skiy, 1961; Naumov, 1963; Makfed'yen, 1965; Odum, 1975; and others). A number of researchers consider the study of the behavior of animals in the ecological aspect as one task of ethology (Fabri, 1975; Novikov, 1975; Panov, 1975; and others). B.P. Manteyfel' (1970a, 1974) takes this division of science of behavior and proposes to call it "the ecology of animal behavior" (p 13).

Researches on behavior in its ecological aspect are being developed increasingly in contemporary ichthyology. These works are conducted inseparably from the study of reception of fish. A general characterization of works on this plane has been given by B.P. Manteyfel' (1967, 1970b). Detailed information on individual reactions and receptor systems of fish (school reactions, light reaction, hydrostatic reactions, optomotor reaction, swimming speeds, learning, migrations, vision, hearing, organs of the lateral line [bokovaya liniya], chemical reception, electrical reception and others) can be found in summarizing works of Russian and foreign authors (Baburina, 1972; Barannikova, 1975; Girsa, 1970; Disler, 1960; Disler, Smirnov, 1974; Zusser, 1971; Leshcheva, 1974; Malyukina, 1955; Malyukina et al., 1969, 1974; Pavlov, 1970a; Pavlov, Saburenkov, 1974; Podlubnyy, 1971; Prazdnikova, 1970; Protasov, 1965, 1968a, b, 1972; Pushkov, 1954; Radakov, 1972; Flerov, 1962; Tsvetkov, 1969, 1974; Blaxter, 1969, Brown, 1967; Dijkgraaf, 1933, 1962; Harden Jones, 1968; Hasler, 1966; Hoar, 1951, 1953; Fage, Fontaine, 1958; Teichmann, 1962; and others). It may be said with confidence that behavioral research occupies an increasingly important place in fish ecology. But, despite the long history of such research, the behavior of fish in flowing water up to the present time has hardly been subjected to special study. At the same time, it is impossible to understand many of the features of fish ecology in flowing water bodies: migrations, distribution, feeding, reproduction, defense against enemies, daily and seasonal rhythms, dynamics of populations and so on. We therefore hope that the study of the basic laws of fish behavior in flowing water, representing a new direction in the study of fish ecology, will contribute to a deeper understanding of different aspects of their life.

As shown schematically (Figure 1), the problem of fish behavior in flowing water is connected not only with ecology but also with other scientific disciplines: physiology, especially with the study of orientation and locomotion in flowing water; morphology (for example, with the study of the role of the bodily form of fish in maintenance in flowing water); zoogeography in connection with the dispersion of fish and varying composition of ichthyocenoses depending on the speed of the current in the water body; with hydraulics and hydroengineering. This problem finds a broad outlet in fishery practice.

Turning to the concrete content of the work, it should be emphasized that a basic behavioral reaction of fish connected with dwelling in flowing

FOR OFFICIAL USE ONLY

FOR OFFICIAL USE ONLY

water, as in the case of many other aquatic animals, is rheoreactions. It is of an inborn character and consists of the fact that animals in flowing water move as a rule against the current. Such movement keeps them from being swept down by the current. All other features of behavior in flowing water develop against the background of this specific reactions. For this reason rheoreaction does not just have a specific meaning but actually is the chief reaction of the organism in flowing water, reflecting the essence of behavioral adaptations to flowing water. It should be noted in this connection that the basic theoretical thesis of this work are principally based on actual material characterizing this reaction. We examine the rheoreaction systematically beginning with composite elements and elementary forms of the manifestation of its significance in such complex forms of behavior as migrations.

The rheoreaction is displayed in representatives of different classes of aquatic animals, beginning with the infusoria and ending with amphibians (Stahl, 1884; Dewitz, 1899; Verworm, 1899; Lyon, 1904; Prosser, Braum, 1967; Pavlov, 1972; Arnold, 1974; and others). The innate character of the rheoreaction in fish, as in other aquatic animals, was emphasized by E. Lyon (1904), who called it rheotropism. Subsequently, a number of authors have more frequently designated this reaction as rheotaxis (Fraenkel, Gunn, 1940, 1961; Puchkov, 1954; Harden Jones, 1968; Shoven, 1972; and others). But the occurrence of this reaction of fish to a current as pointed out by Arnold (1974) exceeds the meaning of such narrow terms as tropism and taxis constitutes a significantly broader biological phenomenon. The theory of tropisms and taxes on the whole possesses a mechanical character and does not disclose the biological significance of the behavioral reactions of an organism, putting taxes into the rank of causes of the phenomenon. Criticism of use of the theory of constrained movements was given in a monograph by R. Shoven (1972) and, with respect to fish, in the works of S.G. Zusser (1953, 1971) and B.P. Manteyfel' (1959, 1960, 1961). In the belief that the behavior of fish in flowing water should be considered as a complex behavioral reaction, we proposed (Pavlov, 1966a, 1970a) to designate it as a reaction to a current--a rheoreaction.

The number of special works dealing with the rheoreaction and behavior of fish in flowing water is not great (Lyon, 1904; Schiemenz, 1927; Dijkgraaf, 1933; Gray, 1937; Martinsen, 1937, 1940; Aslanova, 1952; Harden Jones, 1963a-c, 1968; Pavlov, 1965, 1966a-c; 1970a, b; Arnold, 1969-1974). Many authors did not adhere to any sort of plan providing for the systematic study of the problem of fish behavior in flowing water in general but studied only its individual features. A part of the information is scattered in different works bearing no direct relation to this theme of research. Only three works are of a survey character; in them, a number of aspects of fish behavior are examined rather fully (Harden Jones, 1968; Pavlov, 1970a; Arnold, 1974).

In the manifestation of the rheoreaction, two aspects of the phenomenon should be differentiated: orientation and movement (locomotion in flowing water. These two components correspond to the participation of two systems

FOR OFFICIAL USE ONLY

FOR OFFICIAL USE ONLY

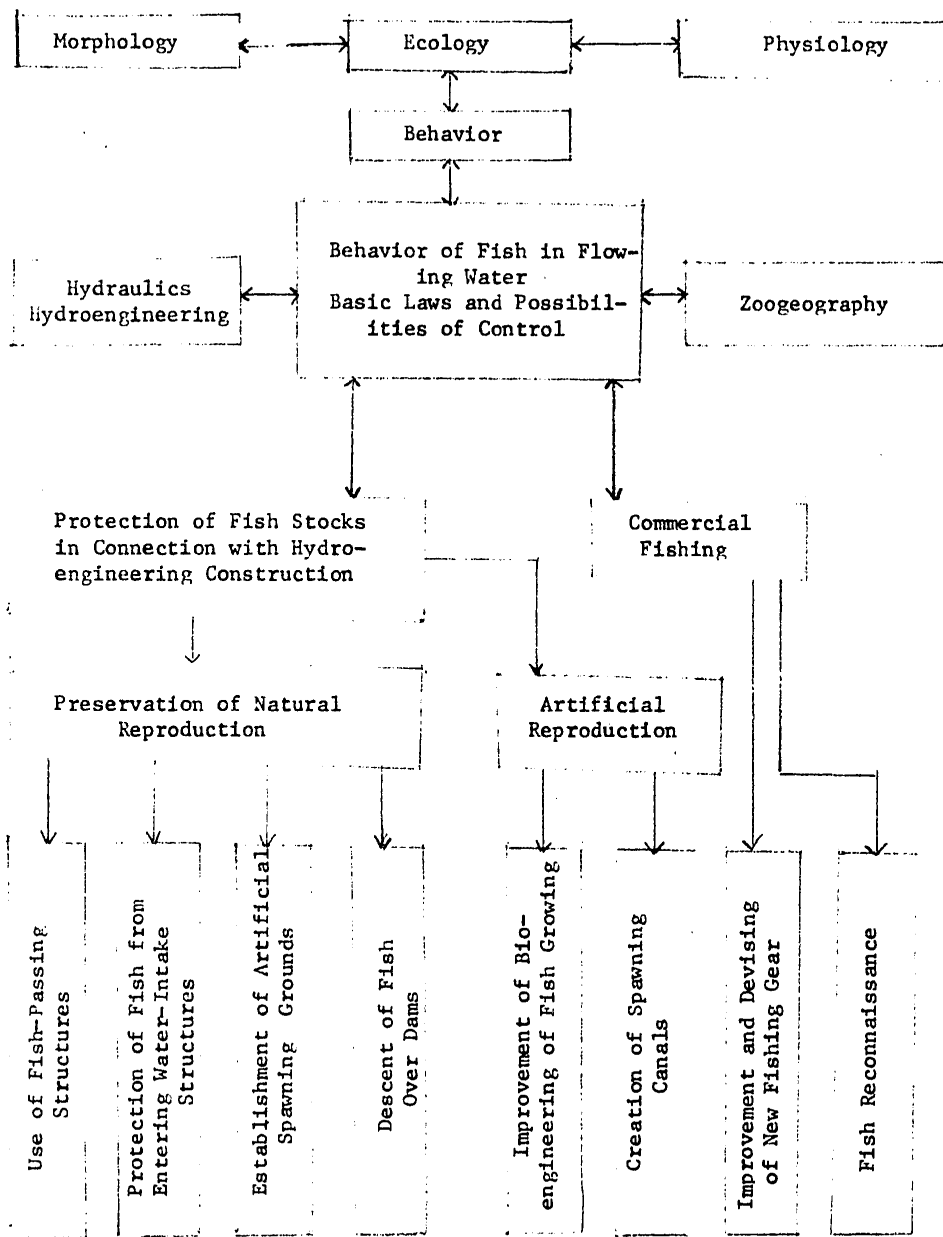


Figure 1. Principal Connections of the Problem of Fish Behavior in Flowing Water to Different Branches of Science and Practice.

FOR OFFICIAL USE ONLY

FOR OFFICIAL USE ONLY

of the organisms--receptor and effector--in its realization as in many other behavioral reactions. The researchers when examining the rheoreaction paid the most attention to the investigation of mechanisms of orientation. At the same time, it is necessary to emphasize the basic importance of E. Lyon's work (1904); he showed that the orientation of fish in flowing water occurs on the bases of stationary reference points, basically with the aid of vision and touch. Ecological analysis of the movement of fish in flowing water was carried out to a significantly lesser extent; the same was true of analysis of the dynamics of behavior in connection with the influence of various abiotic and biotic factors. The question of fish behavior under rheogradient conditions remained practically unstudied. All these features of behavior in flowing water were experimentally investigated by us and are reflected in pertinent chapters of the work.

The rheoreaction, compensating for drifting of the animals caused by the current, contributes to preservation of the region of their habitation. At the same time, it is known that the lives of many fish are connected not only to the retention of a specific region of habitation but also to the use of favorable conditions throughout the entire area of the species. This occurs because of fish migrations in a water body with the current and against it (denatant and contranatant migrations). Harden Jones (1968), summarizing a tremendous body of material on fish migrations, showed that, as a rule, migration routes are determined by the character of currents in a water body. Therefore, when speaking of the fundamental laws of fish behavior in flowing water, it is necessary to pay due attention to such a complex phenomenon in their life as migration. It would be no exaggeration to say that the creation of the theory of animal migrations is one of the most important tasks of modern biology. This work examines first and foremost the special features of the migrational behavior of fish connected with motility of water, particularly the role of the rheoreaction as a reaction determining the specific character of behavior in flowing water. Special attention has been given to downriver [pokatnyye] migrations of young fish whose existence it would appear at first glance is in seeming contradiction to the existence of the rheoreaction. On the whole research on the behavior of fish in flowing water during the period of their migrations makes it possible to understand what takes place to the adaptation of fish to their habitat under the concrete conditions of the water body.

We thus consider that the fundamental laws of fish behavior in flowing water are first of all the laws of rheoreaction and migrational behavior. These features of fish ecology in our view constitute the basis of this phenomenon, the study of which makes it possible to understand the role of behavior in the system of adaptations of a species to the mobility of the water environment and creates a biological basis for prediction and control of fish behavior in flowing water.

Until recently hydraulic engineers were more interested than biologists in the problem of fish behavior in flowing water. This was connected with the need of creating devices for allowing fish to pass over dams (fish-passing structures [rybopropusknyye sooruzheniya]--RPS) and for protecting fish

FOR OFFICIAL USE ONLY

FOR OFFICIAL USE ONLY

against being caught in structures withdrawing water from a water body¹ (fish-protecting devices [rybozashchitnyye ustroystva]--RZU). The employment of these devices has a long history (the RPS--300 years, the RZU--almost 60 years). But their development proceeded mostly empirically, by the method of trial and error (Clay, 1961; Burns, 1966; Bol'shov, 1967; Malevanchik, 1973a). A large number of structures was created, but for the great majority of them no biological bases exist for the possibilities of their use and conditions of work. As a result, for example, of 18 RPS built in our country, only six are operating; at the same time, it has been planned to erect something like 20 different structures (Malevanchik 1973b). The problem of the RZU also demands solution. More young are destroyed in water-gathering structures than are grown by all of the country's fish-breeding enterprises. Such a situation attests to the pressing need of developing biological bases for the use of these structures; first of all an elucidation is required of the basic laws of fish behavior in flowing water.

Since this work has an ecological character, our task in the study of fish behavior in flowing water consisted not so much of the study of the mechanisms of this behavior as in its comparative study in fish of different ecologies or in individual species of fish in ontogenesis and depending on different abiotic and biotic factors. Such an approach made it possible to disclose the concrete adaptive meaning of fish behavior in flowing water. The object of our study were first of all fresh-water fishes and fishes semi-passing and passing through, the significance of currents in whose lives is particularly great. In connection with hydroengineering construction, the anthropogenic effect on the condition of the habitation of these fishes was most strong. For this reason the development of the biological bases of behavioral control of particularly these fishes is of primary importance. Comparative data were obtained for sea-dwelling fishes and fishes of slow-flowing (stationary) water bodies.

The work contains an introduction, nine chapters, a conclusion and deductions. Chapter I presents research procedures, including a description of experimental conditions and points out a volume of factual material. Chapters II-VIII describe the results of our own researches. The logic of the organization of the work is such that this exposition is found to consist of three parts. First, experimental material is given on the special features of manifestation of the rheoreaction (Chapters II-V), then the material of field researches on fish behavior in flowing water at the time of spawning and especially downriver migrations (Chapters VI-VII); next (Chapter VIII) there is material on fish behavior in flowing water and the possibilities of their control under conditions of hydroengineering construction. Chapter IX does not contain factual material and is based on the conclusions of the preceding chapters. Conclusions are made in it on the

1. These structures in the practice of hydroengineering construction are called water-intake: pumping stations, natural-flow irrigation canals and others.

FOR OFFICIAL USE ONLY

FOR OFFICIAL USE ONLY

significance of the special features of fish behavior in the general complex of adaptaticns providing for the existence of a species in a mobile water environment. In conclusion, the main principles of behavioral control of fish in flowing water are indicated.

The foundation of our work consists of material collected by us from 1962 to 1976 at the Institute of Evolutionary Morphology and Ecology of Animals imeni A.N. Severtsov of the USSR Academy of Sciences in the ichthyology (1962-1967) headed by Corresponding Member of the USSR Academy of Sciences G.V. Nikol'skiy and in the laboratory of behavior of lower vertebrates (1967-1976) headed by Professor B.P. Manteyfel'. I express my deep gratitude to the heads and collectives of colleagues of these laboratories, who have been very helpful in the work, especially Professor B.P. Manteyfel", who has been since 1957 my constant scientific supervisor and consultant. I express deep gratitude to D.V. Radakov, I.I. Girsa and T.S. Leshcheva whose advice I have made use of throughout the entire work. I sincerely thank all the colleagues of the group headed by me with whome I conducted researches over the course of the past five years: A.M. Pakhorukov, N.P. Nekrasov, L.G. Shtaf, G.N. Kuragina and others. I take this occasion to express my deep gratitude to all the participants of the researches conducted by me: Yu.N. Sbukina, Ye.N. Saburenkova, A.Ye. Vashchinnikova and others mentioned in the work and also all the organizations (Astrakhan' State Preserve--AGZ; Glavrybvod [expansion not given]; Institute of the Biology of Inland Waters --IBV of the USSR Academy of Sciences; All-Union Association of Soyuzproyekt; Gidroyekt and others) that have provided me with assistance and support in its accomplishment.

Table of Contents

Introduction	3
Chapter One	
Material and Procedure	11
1. General Description of Material	11
2. Description of Experimental Equipment	14
Optomotor Equipment	14
Hydrodynamic Equipment	15
3. Research Procedures	21
Chapter Two	
Movement of Fish in Flowing Water	31
1. Threshold Velocities of Current	31
2. Swimming Capability of Fish	33
External Kinematics, Hydrodynamics and Power of Swimming of Fish	34
Velocity and Duration of Movement	36
Correlation of Certain Functional Indicators of the Rheo-	
reaction with Swimming Capability of Fish	41
3. Critical Velocities of Current for Fishes of Different Egological	
Groups and Their Change in Ontogenesis	44

FOR OFFICIAL USE ONLY

FOR OFFICIAL USE ONLY

Chapter Three

Orientation of Fish in Flowing Water 51

1. On the Role of Different Sensory Organs in Orientation in Flowing Water 51
2. Special Features of the Rise and Manifestation of the Optomotor Reaction--of the Visual Mechanism of Orientation of Fish in Flowing Water 54
 - Movement of Visual Reference Points as the Fundamental Condition of the Rise and Manifestation of the Optomotor Reaction in Fishes of Different Ecological Groups and Fishes of Different Size 55
3. Place of Optomotor Reaction Among Other Orientation Mechanisms in Flowing Water 57
4. Formation of the Special Features of Orientation in Ontogenesis 59
5. Influence of the Characteristics of Visual and Tactile Reference Points on Functional Indicators of Movement in Flowing Water 68

Chapter Four

Special Features of Manifestation of the Rheoreaction in Connection with Velocity Structure of Flowing Water 74

1. Influence of Velocity Conditions of Water Bodies on Functional Indicators of Movement of Fish in Flowing Water 75
2. Influence of Velocity of Flowing Water on Velocity of Movement of Fish 78
3. Special Features of Behavior of Fishes of Different Ecological Groups on Rheogradient Conditions 80
 - Pelagic Fishes 84
 - Bottom Fishes 87
4. Influence of Velocity of Flowing Water on Behavior of Fish Under Rheogradient Conditions

Chapter Five

Influence of Abiotic, Biotic Factors and Physiological State of Fish on Manifestation of Their Rheoreaction 96

1. Illumination, Spectral Composition of Light, Transparency of Water 96
2. Water Temperature 101
3. Refuges and Stationary Reference Points 105
4. Individual Differences and Training of Fish 108
5. Number of Fish in a Group 110
6. Stage of Maturity of Sex Products [polovyye produkty] 112
7. The Trophic Factor 113
8. Presence of Predator and Other Factors 118

Chapter Six

Behavior of Young of Fish in Flowing Water During Downriver Migrations 120

1. Contemporary State of Theory of Fish Migration 121
2. Adaptive Significance of Downriver Migrations and Status of Works on Study of Migrational Behavior of Young of Fish 124

FOR OFFICIAL USE ONLY

FOR OFFICIAL USE ONLY

3. Migrations of Young of Fish in Volga Delta from System of Flooded Areas into the River and Back Again	129
4. Special Features of Downstream Fish Migration in a River (Volga delta, Kuban' River)	133
Daily Rhythm	135
Vertical and Horizontal Distribution	140
5. Behavioral Mechanisms of Downriver Migrations	152
Passive Migrations	152
Active and Active-Passive Migrations	158
6. The Trophic Factor and Causative Conditionality of Downriver Migrations	161
7. Correlation of Various Behavioral Mechanisms and Adaptive Plasticity of Downriver Migrations	165

Chapter Seven

Special Features of the Movement and Distribution of Semimigratory [poluprokhodnyye] and Migratory [prokhodnyye] Fishes in a River in the Period of Their Spawning Migration	175
1. Role of Currents in Spawning Migrations of Fishes in Fresh Water	175
2. Daily Rhythm of Migrations	177
3. Vertical Distribution of Fishes	183
4. Horizontal Distribution of Fishes	188
5. Rate of Fish Migrations	194
6. Special Features of Fish Movements During Period of Migrations	196

Chapter Eight

Fish Behavior in Flowing Water and the Possibility of Controlling Them Under Conditions of Hydroengineering Construction	207
Protection of Fish from Entering Water Intake Structures	208
1. Laws of Young of Fish Entering Water Intake Structures	209
2. Causes and Mechanisms of Fish Entering. Principles of Fish Protection	212
3. Ecological Means of Protection	215
4. Behavioral Means of Protection	220
Filtration RZU	221
Visual-Luminous Means of Protection	228
Air-Bubble Screens	230
Use of Fish-Passing Structures	233
1. Laws of Fish Distribution in Tailwaters of Dams	234
2. Characteristics of Attracting Fish into Fish-Passing Structures	243
3. Fish Behavior in Fish-Passing Structures and During Their Exit from Them	250

FOR OFFICIAL USE ONLY

FOR OFFICIAL USE ONLY

Chapter Nine

Behavior in Flowing Water as Adaptation to Mobility of Aquatic Medium
of Habitation 257

1. The Place of Rheoreaction Among Other Adaptations to Dwelling
in Flowing Water 257
2. Rheoreaction as an Ecological Phenomenon 259
3. Migratory Behavior of Fish in Flowing Water as Adaptation to
Mastery of the Species' Habitat 261

Conclusion 265

Bibliography 269

COPYRIGHT: Izdatel'stvo "Nauka", 1979
[615-7697]

7697
CSO: 1840

FOR OFFICIAL USE ONLY

FOR OFFICIAL USE ONLY

UDC: 578.087.1

APPLIED MATHEMATICS IN BIOLOGY

Moscow PRIKLADNAYA MATEMATIKA V BIOLOGII (Applied Mathematics in Biology) in Russian 1979 signed to press 30 Oct 79 pp 5-6, 152

[Foreword and table of contents from book edited by Prof N. A. Plokhinskiy, Izdatel'stvo Moskovskogo Universiteta, 2730 copies, 152 pages]

[Text] The commission for application of mathematics to biology of the Moscow Society of Naturalists (MOIP) is publishing its fifth collection, which is dedicated to Aleksandr Aleksandrovich Lyubishchev. The collection begins with a brief article about A. A. Lyubishchev and a list of his works. It also contains an article by A. A. Lyubishchev, "Application of Mathematical Statistics to Practical Systematics," the shorthand notes of which were read at the First Conference on Use of Mathematics in Biology at Leningrad State University, in 1958, but it was never published in its entirety. The article is of great methodological interest with regard to comparative analysis of mathematical methods that could be used in problems of numerical taxonomy. It is timely, even 20 years after it was written, for systematician-biologists.

The collection continues with the cycle of four articles by N. A. Plokhinskiy and a group of his colleagues, which deals with pressing problems of mathematical modeling of short-range homing models: estimation of error of bird orientation in short-range homing, consideration of the effect of distance on speed of return of four bird species, effect of wind velocity on return of homing pigeons and a number of other parameters in the construction of homing models.

Two articles on botany, "Comparison of Flora According to Species Composition" by G. N. Zaytsev and "Use of Diallele Crosses in Pea Breeding" by S. I. Agarkova et al., deal with the pressing problem of finding diagnostic rules for evaluating the species diversity of flora and identification of diagnostically reliable breedings characters of the pea. In these studies, various digital procedures and statistical methods were used to assess the reliability of the selected characters and algorithms of such selection.

The results of a search for a proper model of software suitable for the description of both local (intracellular) and global (intercellular)

FOR OFFICIAL USE ONLY

FOR OFFICIAL USE ONLY

recovery of cells after exposure to radiation are submitted in the extensive article of G. Yu. Dankov, "Mathematical Model of Postradiation Recovery in Radiobiology."

The collection ends with three articles on methodological aspects of constructing diagnostic problems: "Use of Partial Set of Symptoms in Discriminant Diagnostics" by V. Yu. Urbakh and two articles by B. S. Shornikov, "Systemic-Classification Diagnostic Problem in Biomedical Research" and "Discriminant-Classification Analysis of Species Diversity of Diatoms." The author of these two articles expounds the conception of the systems-classification diagnostic problem and its main logical-probabilistic and statistical parameters of construction, analysis and generalization of such problems. Digital examples of solving such problems in medicine and biology are given.

The commission for application of mathematics in biology is hopeful that there will be a positive response among physicians, biologists and specialists in biometrics to this collection, and it will be grateful for critical comments and wishes, to be addressed to 103009, Moscow, K-9, Gertsen Street 6.

Contents

Foreword	5
Aleksandr Aleksandrovich Lyubishchev	7
Lyubishchev, A. A. "Application of Mathematical Statistics to Practical Systematics"	12
Plokhinskiy, N. A.; Markelova, I. O.; Levikov, A. B.; and Sakayan, A. R. "Mathematical Model of Pigeon Homing"	29
Plokhinskiy, N. A., and Suprun, L. V. "Mistakes in Bird Orientation in Short-Range Homing"	34
Suprun, L. V. "Effect of Distance on Speed of Return of Four Bird Species in Short-Range Homing Experiments"	47
Levikov, A. B. "Effect of Wind on Flight of Homing Pigeons"	57
Zaytsev, G. N. "Comparison of Flora According to Species Composition"	66
Agarkova, S. N.; Makagonov, Ye. I.; and Varlakhov, M. D. "Use of Diallele Crosses in Pea Breeding"	70
Dankov, G. Yu. "Mathematical Model of Postradiation Recovery Processes in Radiobiology"	79
Urbakh, V. Yu. "Use of Incomplete Set of Symptoms in Discriminant Analysis"	108

FOR OFFICIAL USE ONLY

Shornikov, B. S. "Systemic-Classification Diagnostic Problem in
Biomedical Research" .117

Shornikov, B. S., and Larina, T. V. "Discriminant-Classification
Analysis of Species Diversity of Diatoms in the Floristic
Description of the Floodplan Portion of the Oka River" 142

COPYRIGHT: Izdatel'stvo Moskovskogo universiteta, 1979
[459-10,657]

10,657
CSO: 1840

FOR OFFICIAL USE ONLY

FOR OFFICIAL USE ONLY

ADVANCED MEDICAL TECHNOLOGY

UDC 62-50

MATHEMATICAL DESCRIPTIONS OF CARDIAC BIOELECTRICAL ACTIVITY

Moscow ELEKTRICHESKIY GENERATOR SERDTSA in Russian 1980 signed to press 11 Jan 80
pp 2, 3-4, 371

[Annotation, author's preface and table of contents from the book "The Heart as an Electrical Generator" by Leonid Ivanovich Titomir, Izdatel'stvo "Nauka." Moscow, 1980, 1450 copies, 372 pp]

[Text] The book deals with the biophysical substantiation of electrocardiographic measurements. Present-day concepts about the electrical processes in the heart and the electrical field generated by them in the bodies of man and animals are considered. An examination is made of mathematical modeling of the heart as an electrical generator, from the cellular level to the level of the heart as a complete unit, and a comparative analysis is made of various models from the viewpoint of the information they contain about the electrophysiological status of the heart.

The book is intended for specialists in theoretical and experimental electrocardiography, the biophysics of the heart, the modeling of biological systems and the automation of electrocardiographic diagnosis.

This book was conceived as a biophysical introduction to present-day electrocardiology. Its aims are a systematized exposition of present-day data on the origin of the heart's electrical field, whose potential is measured during electrocardiographic investigations, and an examination of methods used for a quantitative description of the heart as the generator of its electrical field. The equations of classical electrodynamics for steady-state currents in a volume conductor are used as adequate mathematical relationships for this description, and they are presented in a form enabling them to be used directly for solving electrocardiological problems.

In the discussion of the origin of the heart's electrical field, three key aspects are considered in sequence: the properties of individual cells, fibers, and small sections of cardiac tissue as elementary bioelectrical generators; the formation of the combined cardiac generator from the elementary generators; and the effect of the body's inhomogeneity as a conductor of the heart's electrical field. Much attention is given to the results of mathematical, physical, and biological modeling of electrocardiological phenomena, from the cellular level to the level of the entire organ.

FOR OFFICIAL USE ONLY

FOR OFFICIAL USE ONLY

It should be emphasized that the main subject of the study is precisely the extracellular electrical field, that is, the field existing in the space on the outer surface of the membrane of excited cells. Accordingly, intramembrane electrical processes at the molecular level serving in fact as the primary source for this field are not dealt with here in detail; they are presented only as generally recognized phenomenological models which, however, make it possible to explain satisfactorily the electrical manifestations of very many anatomic and physiologic changes in the heart.

Undoubtedly the most important practical problem in electrocardiology is diagnosis of the cardiac status and cardiac disease. In actual conditions, not only electrical potentials but other physical manifestations of excited heart muscle are used for diagnosis, along with a multiplicity of different objective data about the status of the body and various observations of a "qualitative" nature. Analysis of this information and the diagnostic conclusion usually depend on both objective and subjective factors. In the book, however, the diagnostic problem is considered in a narrow sense: it is discussed rather only at one stage of its resolution, based directly on electrical measurements and lending itself to formalization with the aid of the relationships of electrodynamics. It consists of determining the quantitative characteristics of the heart as a generator of electricity from changes in the electrical field on the surface of the body. At the same time, stress is laid on an important trend that is raising electrocardiological diagnosis to a higher level, namely the desire to make maximum possible use of information about the heart as a generator of electricity accessible to measurement by noninvasive methods on the surface of the body. This trend is finding expression in the development of methods for measuring potential distribution across the entire body surface and mathematical analysis of this distribution using computers.

The author hopes that the book will help in a more profound biophysical interpretation of electrocardiological data and in the development of new approaches to diagnosis of the status of the heart and cardiac disease on the basis of analysis of the heart's electrical field.

(Signed) L. I. Titomir.

CONTENTS

Author's Preface3

Chapter 1
Main relationships in electrodynamics for describing the cardiac electrical field

1. Differential equations for the electrical field of steady-state currents5

2. Multipole splitting of potential12

3. Integral equations for the electrical field of steady-state currents33

4. The principle of reciprocity and the mathematical description of leads45

Chapter 2
The elementary cardiac electric generators

1. The microscopic structure of the heart and the electrophysiological properties of myocardial cells55

FOR OFFICIAL USE ONLY

FOR OFFICIAL USE ONLY

- 2. The propagating potential of action in the individual fibers of the myocardium85
- 3. The electrical field of the individual myocardial fiber in a volume conductor106
- 4. Formation of extracellular field generators at the macroscopic level in the myocardium135

Chapter 3

The combined cardiac electrical generator

- 1. Chronotopography of excitation distribution in the heart167
- 2. Distribution of potential in the cardiac electrical field in the surrounding volume conductor183
- 3. Notes on methodology and terminology in the mathematical description of the cardiac generator199
- 4. Equivalent cardiac generators of the nonpropagating type214
- 5. A single-dipole equivalent generator229
- 6. A multiple-dipole equivalent generator247
- 7. A multipolar equivalent generator258

Chapter 4

The effect of the properties of the body as a volume conductor on the electrical field of the heart.

- 1. Main characteristics of the body as a volume conductor and their significance in solving electrocardiological problems299
- 2. The effect of body inhomogeneity on the potential of the cardiac electrical field308
- 3. The effect of body inhomogeneity on accuracy in determining the characteristics of the cardiac generator332

Conclusion346

Bibliography347

COPYRIGHT: Izdatel'stvo "Nauka", 1980
[392-9642]

9642
CSO: 1840

FOR OFFICIAL USE ONLY

FOR OFFICIAL USE ONLY

APPLICATIONS OF FOCUSED ULTRASOUND

Leningrad FOKUSIROVANNYY UL'TRAZVUK V FIZIOLOGII I MEDITSINE in Russian 1980
p 2, 3-5, 197-198

[Annotation, introduction, and table of contents from book "Focused Ultrasound in Physiology and Medicine," by L. R. Gavrilov and Ye. M. Tsirul'nikov, Institute of Evolutionary Physiology and Biochemistry, imeni I. M. Sechenov, "Nauka," Leningrad, 179 pages]

[Text] This book summarizes the data that have been amassed on the use of focused ultrasound for local action on the surface and deep structures of the body and examines the physical principles of the use of focused ultrasound in physiology and clinical practice, together with the factors responsible for its biological action. Various aspects of the ultrasonic destruction of deep cerebral structures and other biological tissues are discussed and it is shown that surface and deep peripheral receptor structures can be stimulated. The results of exposure of tumors, ocular structures, and the auditory labyrinth to ultrasound are described. New data obtained with the aid of focused ultrasound on the physiology of the tactile, temperature, pain, and acoustic sensory systems are presented. There is a discussion of the feasibility of using this technique in neurology, surgery, oncology, and ophthalmology, for diagnosis of auditory disorders, and for development of auditory prostheses.

Introduction

Ultrasonic methods have come into wide use in the most diverse areas of physiology and medicine over the past few decades. A number of surveys have been published that give detailed consideration to the use of ultrasound for inducing various effects in biological systems (Beier and Doerner, 1954; Bergmann, 1954; Matauschek, 1957; Kelly, 1957, 1965; Wells, 1970; Filipczynsky, 1972; White, 1972, 1976; Kikuchi, 1973; Erikson et al., 1974). Ultrasound is extensively employed in the treatment of various diseases and therapeutic ultrasound equipment has long been a fixture both in major institutions and in the polyclinic network (Bogdanovich, 1967; Speranskiy and Rokityanskiy, 1970; Marmur, 1974; Tsyganov et al., 1978). Ultrasonic diagnosis of damage to organs and tissues is conjoined with x-ray and other diagnostic methods and has in some cases surpassed and replaced them. For example, ultrasonic methods permit measurement of the blood flow rate in the cardiac cavities and blood vessels, determination of the localization of tumors and other pathological foci in the body, and visualization of various deep-seated parts of the body (Grossman et al., 1966; Wells, 1969, 1972, 1977; Fridman, 1973; Vlieger et al., 1974; King, 1974; Hussey, 1975; McDicken, 1976.)

FOR OFFICIAL USE ONLY

FOR OFFICIAL USE ONLY

Ultrasonic methods have proved useful in biochemical and biophysical research, where they are used to study the properties of organic substances and the functions of different structures in the living cell and the intact organism (Ackerman, 1962; El'piner, 1963, 1973; Reid and Sikov, 1972; Chirkin et al., 1977). One innovative new field is the ultrasonic dissection and union of biological tissues (Petrovskiy et al., 1972; Polyakov et al., 1973, and others).

These publications examined the applications in biology and medicine of unfocused, i.e., plane and divergent, ultrasonic waves. Very little mention is made of focused ultrasound in the extensive literature. This is probably because reliable, convenient focusing radiators have only appeared comparatively recently and, most importantly, it is only lately that the similarities and differences in the biological effects produced by the use of plane and focused ultrasonic waves have become clearer.

Focusing of ultrasound, like that of light, is achieved by use of devices such as lenses or radiators with curved surfaces. Since the ultrasound intensity at the focus is far greater than that at the radiator surface and the degree of attenuation in tissue is comparatively small, it is possible to exert a localized action on selected deep parts of the body without significantly affecting surrounding tissues. Investigations initiated in the 1950s and 1960s indicate that lesions of definite size and shape can be produced with high precision and good reproducibility by means of focused ultrasound (Fry et al., 1954, 1958a; Astroem et al., 1961; Lele, 1967). The results of animal studies have found clinical application (Meyers et al., 1959, 1960; Hickey et al., 1961; Fry, 1965a).

Since the 1960s, attempts have been made to use ultrasound to stimulate receptor and neural structures without inflicting damage on adjoining tissues (Makarov et al., 1964; Sagalovich, 1965). The impetus to further research in this area was provided by V. A. Tsukerman's notion (1969) that it would be expedient to attempt to destroy deep cerebral structures with convergent ultrasonic waves, which would eliminate the need for use of electrodes and for preliminary surgery to provide access to these structures.

As a result of the cooperation brought about by Tsukerman between specialists in the physiology of the nervous system and sense organs (G. V. Gershuni, O. B. Il'inskiy, Ye. M. Tsirul'nikov, and others) and acoustic physicists specializing in ultrasonics (M. G. Sirotyuk, L. R. Gavrilov, and others), a systematic search was undertaken for structures sensitive to the stimulatory action of focused ultrasound.

Attempts to stimulate the conductive and central neural structures of vertebrates and man failed to give positive results but nevertheless were successful with respect to the peripheral receptor apparatus. The receptors of different sensory systems (tactile, temperature, pain, and auditory) were found to be stimulated by ultrasound. An electrodeless and nonsurgical method for stimulation of surface and (of particular importance) deep receptor structures thus made its appearance. Some of the results of this research collected in the joint monograph "Reception and Focused Ultrasound," which was published in 1976.

FOR OFFICIAL USE ONLY

FOR OFFICIAL USE ONLY

One of the purposes of the present book is to describe subsequent investigations in this area and to examine the results of the application of focused ultrasound to other fields, particularly the destruction of deep-seated tissues, echo location of ultrasonic lesions, study of functional neural connections, and so forth. There have been few publications on these topics and they are often difficult to find. Moreover, the authors are interested in bringing new efforts to bear on work with focused ultrasound and in facilitating the practical utilization of research results in physiological investigations and clinical practice.

The present volume discusses the physical and theoretical principles of the use of focused ultrasound for acting upon biological systems, examines the causes of its physiological action, generalizes the results of investigations directed at establishing the feasibility of ultrasonic destruction of deep structures without concomitant effects in the tissues surrounding the destruction focus, and discusses the possibility of using ultrasound to stimulate the neural structures of the somatosensory system and to provide auditory information, as well as a number of other topics. The need for properly grounded selection of irradiation regimes is emphasized.

The research in which the present authors participated was conducted at the Institute of Evolutionary Physiology and Biochemistry imeni I. M. Sechenov (USSR Academy of Sciences), the Institute of Physiology imeni I. P. Pavlov (USSR Academy of Sciences), the Institute of the Brain (USSR Academy of Medical Sciences), the Central Design Bureau of the USSR Academy of Medical Sciences, the Moscow Scientific-Research Institute of Ophthalmic Diseases imeni Helmholtz, the Leningrad Scientific-Research Institute for Diseases of the Ear, Throat, and Nose and Speech Disorders, the 1st Leningrad Medical Institute imeni I. P. Pavlov, and a number of other institutions. Physical and theoretical support for most of these investigations was provided by the Acoustics Institute imeni Academician N. N. Andreyev (USSR Academy of Sciences).

The authors have dealt at greater length with the investigations in which they participated; the reader will find references to the specialized literature, where other topics are explored in greater detail. Certain inferences and conclusions drawn from the results of comparatively recent studies are given for the first time here.

The authors wish to thank G. V. Gershuni and B. Ye. Mikhaleva for their helpful advice and comments during preparation of the manuscript for publication and to express their deep gratitude to all with whom they have worked, whose advice, assistance, and direct participation are reflected in this book.

A pioneering publication of this sort may contain errors that are the authors' fault or that have arisen as a consequence of the fact that there are a number of unresolved and disputed questions in the research areas considered. All comments and suggestions will be gratefully received.

Contents	Page
Introduction	3

FOR OFFICIAL USE ONLY

FOR OFFICIAL USE ONLY

Chapter 1.	Physical and Technical Principles of the Use of Focused Ultrasound in Physiology and Medicine	6
1.1.	Acoustic parameters and units for measuring them	6
1.2.	Acoustic properties of biological tissues	9
1.3.	Focusing of ultrasound	15
1.4.	Focusing radiators	19
1.5.	Ultrasonic generators	28
1.6.	Evaluation of ultrasound exposure parameters	34
Chapter 2.	Biological Action of Focused Ultrasound	36
2.1.	Thermal action	36
2.2.	Mechanical action	44
2.3.	Physicochemical action	48
2.4.	Irradiation regimes, cumulative effect, and safety	51
Chapter 3.	Use of Focused Ultrasound for Destruction of Deep Cerebral Structures and Other Biological Tissues	55
3.1.	Methodological characteristics	57
3.2.	Destructive ultrasound doses	61
3.3.	Precision of localization and reproducibility of results	72
3.4.	Mechanism of the destruction of biological tissues	74
3.5.	Histology of ultrasonic lesions in the brain	82
3.6.	Study of structural-functional neural linkages	86
3.7.	Destruction of pathologically altered areas of the brain	87
3.8.	Feasibility of local destruction of cerebral structures by irradiation through the intact skull	88
3.9.	Destruction of tumors	96
Chapter 4.	Focused Ultrasound and Stimulation of Neural Structures	100
4.1.	History	100
4.2.	General methodological features	102
4.3.	Stimulation of cutaneous sensory neural structures	104
4.4.	Stimulation of deep sensory neural structures	109
4.5.	Stimulatory action on animal receptor structures	114
4.6.	Action on the human acoustic labyrinth	117
4.7.	Operative factors in focused-ultrasound stimuli	121
4.8.	Site of stimulus application	129
Chapter 5.	Clinical Use of the Stimulatory Action of Focused Ultrasound	136
5.1.	Investigation of sensitivity in neurological patients	137
5.2.	Use in audiology and for auditory prostheses	139
5.3.	Possibilities for use in other areas	148
Chapter 6.	Other Possibilities for Use of Focused Ultrasound in Medicine	150
6.1.	Action on ocular structures	150
6.2.	Ultrasound as a means for enhancing the antitumor activity of radiation therapy	160
6.3.	Focused ultrasound and reversible changes in the nervous system ..	167
6.4.	Echo location of ultrasonic lesions	171

FOR OFFICIAL USE ONLY

FOR OFFICIAL USE ONLY

Conclusion 179
Bibliography 181

COPYRIGHT: Izdatel'stvo "Nauka", 1980
[331-2478]

2478
CSO: 1840

FOR OFFICIAL USE ONLY

FOR OFFICIAL USE ONLY

MONOGRAPH ANALYZES CRYOGENIC PRESERVATIVES

Kiev KRIOKONSERVANTY in Russian 1979 pp 2, 3-4, 198

[Annotation, Introduction, and Table of Contents from book "Cryogenic Preservatives," by A. M. Belous, M. I. Shrago, and N. S. Pushchkar', Izdatel'stvo "Naukova dumka", 1,000 copies, 200 pages]

[Text] Annotation

This monograph examines the physicochemical, biological, and toxicopharmacological properties of polyvinylpyrrolidone, dextran, oxyethyl derivatives of multiatomic alcohols, starch, and other cryoprotective substances. The unique features of interaction of cryoprotectors with water molecules, some inorganic components of the medium, biomacromolecules, cells, and tissues are demonstrated. Use of cryogenic preservatives for low-temperature preservation of biological objects is described.

This book is intended for biologists, physicians, and other specialists in cryobiology and cryogenic medicine.

Fifty-seven figures, 62 tables, bibliography pages 167-197.

Introduction

The problem of temporary, reversible cessation of life processes enjoyed real resolution in the era of the scientific-technical revolution in the second half of the 20th century: Artificial conditions were discovered in which cells, human tissues, and other objects could be stored in frozen, viable state for periods of time significantly exceeding their physiological life. The mechanisms of cryogenic protection were analyzed, and cryoprotectors preventing damage to biological structures exposed to extreme cold were discovered. A vast literature describing the properties of individual cryoprotectors-- dimethyl sulfoxide, and polyethylene oxide--is devoted to cryoprotectors.

The previous book written by this author collective representing the Ukrainian SSR Academy of Sciences Institute of Problems in Cryogenic Biology and Medicine--"Krioprotektory" [Cryoprotectors]--described the cryoprotectors

FOR OFFICIAL USE ONLY

FOR OFFICIAL USE ONLY

indicated above, their chemical, physicochemical, biological, and toxicopharmacological properties, and their effectiveness as cryogenic protectors. This monograph continues the presentation of similar information on other cryoprotectors--polyvinylpyrrolidone, dextran, and hexethyl starch representing a group of substances that do not penetrate into the cell. Interest in extracellular cryoprotectors is not waning, since they may be used as a basis for creating cryoprotective media that need not be removed from thawed cellular suspension. All of these problems deserve further study.

A large section of the book is devoted to a description of new cryoprotectors created by oxyethylation of polyols--glycerin and pentaerythritol. It is demonstrated that similarly as with polyethylene oxide, oligomers of this series also have cryoprotective activity in relation to blood cells, brain cells, and the cells of other organs. A dependence between the nature of cryoprotective action and the molecular mass of the polymer, which determines its physicochemical properties, is also revealed. Thus one of the ways of directed creation of cryoprotectors with prescribed physicochemical and biological characteristics is shown.

Improvements in the methods of low-temperature preservation of biological objects have proceeded along the lines of creating multicomponent media containing--in addition to cryoprotectors--salts, carbohydrates, plasma proteins, biologically active compounds, and so on. Such "cocktails" are created to intensify the action of the cryoprotectors, to prevent their possible side-effects upon living structures, and to facilitate repair processes following stressful effects and restoration of function.

The book presents some basic recipes for cryoprotective media recommended by domestic and foreign researchers for different cells and tissues stored in frozen state; certain principles behind preparation of perfusion media for hypothermic organ storage are illuminated. Inasmuch as hypothermic perfusion of organs precedes their cryogenic preservation, these problems are examined as being preparatory to low-temperature cooling. The monograph demonstrates the broadness of the problem of cryoprotectors and cryoprotective media, its significance to further development of cryogenic biology, and the need for attracting a broad range of different specialists to its resolution.

The authors make no claim that this is an exhaustive presentation of the problems touched upon, and they hope that their description of these problems in this form will be of interest to cryobiologists, transfusion specialists, transplantation specialists, and other specialists involved with low-temperature preservation of biological objects.

Contents	Page
Introduction	3
Chapter I. Polyvinylpyrrolidone	
Synthesis, Production, and Physicochemical Properties	5
Therapeutic and Biological Use	19
Cryoprotective Properties	25

FOR OFFICIAL USE ONLY

FOR OFFICIAL USE ONLY

Chapter II. Hydroxyethyl Starch
 Synthesis, Physicochemical Properties 47
 Biological and Cryoprotective Properties 50

Chapter III. Dextrans
 Acquisition, Physicochemical Properties 64
 Biological and Cryoprotective Properties 73

Chapter IV. Cryoprotectors Made From Alcohol Oxyethylation Products
 Oxyethylated Glycerins 78
 Oxyethylated Pentaerythritols 92

Chapter V. Combined Preservatives
 Preservatives for Blood and Brain Cells 107
 Preservatives for Freezing Animal Reproductive Cells 125
 Preservatives for Freezing Corneal Tissue 134
 Preservatives for Freezing Microorganisms 138
 Preservatives and Media for Cooling the Heart 144
 Preservative Solutions for Freezing Kidneys 149
 Preservatives for Freezing Various Tissues and Organs 160

Conclusion 163

Bibliography 167

COPYRIGHT: Izdatel'stvo "Naukova dumka", 1979
[435-11004]

11004
CSO: 1840

FOR OFFICIAL USE ONLY

FOR OFFICIAL USE ONLY

LASERS IN TRAUMATOLOGY AND ORTHOPEDICS

Kazan' LAZERY V TRAVMATOLOGII I ORTOPEДИИ in Russian 1978 signed to press 13 Jan 78 pp 3-4, 104

[Introduction and table of contents from book by U. Ya. Bogdanovich, M. G. Karimov, and E. E. Krasnoshchekova, Izdatel'stvo Kazanskogo universiteta, 3630 copies, 104 pages]

[Text] The prospects for further progress in medicine in many ways are related with the use of the latest achievements in science and technology.

A dramatic example of this is, in particular, the successful application of lasers, developed on the basis of the vigorously developing quantum electronics, in medicine.

Gas lasers, and in particular, helium-neon lasers, are of special interest for traumatology and orthopedics.

Low-power helium-neon lasers with a wavelength 6328 A are capable of operating in the continuous mode and their radiation in the red part of the visible spectrum is essentially monochromatic and coherent.

Monochromatic red light has a strong effect on an organism, since the quanta of red light are absorbed by the structural elements of tissue. Their energy potential and metabolism increase. Monochromatic red light alters the tone of vessels and significantly effects penetration processes, cell division and differentiation, which lead to the biotic action of helium-neon laser radiation.

For practical medicine, studies concerning the application of laser light energy for regulating biological processes in a living organism are especially important.

A great deal of data, suggesting that monochromatic red helium-neon laser light acts as a biological stimulator, increasing the regenerative capability of tissues, has accumulated.

However, there is as yet little data concerning the therapeutic effect of laser radiation and the possibility of using such radiation in practical medicine. The existing evidence is not completely convincing. The mechanism for the possible general and local action of laser radiation on an organism is unclear and the possible complications and contraindications to laser therapy have not been studied.

FOR OFFICIAL USE ONLY

FOR OFFICIAL USE ONLY

This monograph presents the results of experimental and clinical studies of the action of low-power continuous laser radiation on a living organism carried out by the authors in the laboratories and clinics of the Kazan' Scientific-Research Institute of Traumatology and Orthopedics.

The action of laser radiation on regeneration processes in skin-facial wounds, healing of fractures of long tubular bones and on the tissues in joints were studied with the help of the most modern research methods, in particular, such methods as the determination of the ionization of the side groups of proteins in the regenerating wound and the method of nuclear magnetic resonance, which permits studying the fine structure and molecular motion in matter and provides information concerning the processes on an atomic level.

The morphofunctional and histochemical characteristics of the changes that occur in skin and the underlying tissues under the action of a helium-neon laser are described by the director of the pathomorphological laboratory, E. M. Sokolova.

The clinical experience in using a low-power continuous laser for treating more than 600 patients with injuries to and diseases of the skeletal-muscular system is generalized with the help of the director of the center for laser therapy Candidate in Medical Sciences A. I. Gordeyeva, senior scientific staff members T. P. Rozovskaya and R. A. Rabkova.

The results of our own studies are prefaced by information concerning the use of lasers, in particular, low-energy helium-neon lasers, in other areas of biology and medicine.

We hope that our modest efforts will be useful to many biologists, doctors (both experimentalists and clinicians), as well as for many specialists working with lasers.

Contents	Page
Introduction	3
Chapter I. Some information concerning the use of lasers in medicine (U. Ya. Bogdanovich)	5
Chapter II. Morphofunctional characteristics of skin, muscle, and the bone regenerator under the action of laser radiation (E. M. Sokolova) ..	17
Chapter III. A study of the action of laser radiation on the microflora of wounds and their healing in experiments on animals (E. E. Krasnoshchekova)	30
Chapter IV. A study of the state of peripheral blood under the action of laser radiation (U. Ya. Bogdanovich)	41
Chapter V. A study of the effect of laser radiation on the healing of fractures (U. Ya. Bogdanovich, M. G. Karimov)	53
Chapter VI. A study of laser action on the healing of diaphysis fractures and intra-articular injuries according to nuclear magnetic resonance data (spin echo) (U. Ya. Bogdanovich, V. I. Rokityanskiy, M. G. Karimov)	61

FOR OFFICIAL USE ONLY

FOR OFFICIAL USE ONLY

Chapter VII. Results of laser treatment of patients with tropic ulcers,
infected and persistent wounds, and orthopedic illnesses
(U. Ya. Bogdanovich, A. I. Gordeyeva, E. E. Krasnoshchekova) 61

Conclusions 90

References 94

COPYRIGHT: Izdatel'stvo Kazanskogo universiteta, 1978
[357-9638]

9638
CSO: 1840

FOR OFFICIAL USE ONLY

FOR OFFICIAL USE ONLY

ENVIRONMENTAL HAZARDS

UDC 577.3:539.12.04+616=001.28:615.7 (082.2)

RADIATION EXPOSURE, REDUCTION OF AND METHODS FOR CHEMICAL PROTECTION

Sverdlovsk LUCHEVOYE VOZDEYSTVIYE, VOSSTANOVLENIYE I KHMICHESKAYA ZASHCHITA in Russian 1978 pp 2, 86-92

[Annotation and abstracts from book "Radiation Exposure, Reduction of and Methods for Chemical Protection," by T. N. Tuzhilkova and B. V. Popov, Academy of Sciences, Ukrainian Scientific Center]

[Text] Indices for radiation protective preparations belonging to different categories of chemical compounds are examined, focusing on quantitation of degree of damage to radiation sensitized tissues and their acute and long term effects. A series of studies on the mechanism of action of radiation protectors are presented. Results of studies on the combined effect of external and internal irradiation and the influence of experimental factors on radiation damage are given. Determination of maximum dosage of the preparations, given administration of radioactive isotopes, is outlined.

The collection is intended for radiobiologists, biophysicists, biochemists, pharmacologists, physiologists, toxicologists and radiologists.

UDC 636:539.11

CHANGES IN BIOCHEMICAL INDICES OF SERUM FROM FARM ANIMALS EXPOSED TO THE PRODUCTS OF NUCLEAR FISSION

[Abstract of article by Yakovleva, V.P. and Shilov, V.P.]

[Text] Five groups of cattle (five animals in each group) were given food mixtures containing products of uranium-235 at 9.5-10 hours of age. In animals to whom an average dose of beta-irradiation of 500-1,000 rads was delivered to the intestinal tract, subacute radiation sickness developed and in those given average doses of 2,500, 3,200, and 5,400 rads acute radiation sickness developed. Cryoglobulins appeared in the blood from

FOR OFFICIAL USE ONLY

all animals. The amount of serum iron and the activity of alkaline phosphatase diminished. Given acute radiation sickness during the period prior to death of the animal (14-20 days), the concentration of potassium and sodium decreased; the content of protein-binding carbohydrates (sialic acids, hexoses, fucoses) was increased sharply; and the activity of serum transaminase increased. The changes in the serum of animals with a subacute course of radiation sickness were reversible. 8 references.

UDC 636:539.12.04:546.79

THE EFFECT OF PRODUCTS OF NUCLEAR FISSION ON THE FUNCTIONAL FERTILITY OF CATTLE AND THE DEVELOPMENT OF THEIR OFF-SPRING

[Abstract of article by Burov, N.I., Dobryakova, G.V. and Shilov, V.P.]

[Text] In cattle, after administration of products of nuclear fission in quantities of 3.3 and 6 Ci, subacute and then chronic radiation sickness developed. The animals with subacute radiation sickness developed a total shut down of thyroid function but retained the ability for impregnation. Their off-spring did not differ from those of control animals. 1 table; 2 illustrations; 5 references.

UDC 636:539.16.04

THE INFLUENCE OF EARLY PRODUCTS OF URANIUM FISSION ON IMMUNITY OF LARGE FARM ANIMALS

[Abstract of article by Kosenko, M.M., Zelenina, M.I. and Goloshchapov, P.V.]

[Text] In order to study methods of organization for animal husbandry in conditions of territorial pollution by radioactive isotopes, five groups of lactating cows were fed early products of uranium fission in quantities of from 3.3 to 33 Ci. The state of immunoreactivity in the animals who eventually died from radiation sickness, was characterized by serious disturbances in phagocytosis, decreased production of the humoral protective factor lysozyme, and by the development of auto-infection.

In the surviving animals, impairment of the mechanism of natural immunity led to a breakdown in antimicrobial barriers resulting in bacterial seeding of the internal organs, muscle and milk. This finding should be considered in decisions of economic use of cattle exposed to products of nuclear fission. 4 illustrations; 5 references.

42

FOR OFFICIAL USE ONLY

FOR OFFICIAL USE ONLY

UDC 577.3:539.122.04

TESTS FOR USE OF EXPERIMENTAL RADIOBIOLOGICAL GAMMA EQUIPMENT

[Abstract of article by Korytnyy, V.S.]

[Text] Tests on the use of experimental radiobiological gamma equipment are presented. Based on results from these studies on the function of dose-effect for various indices of disease and data from basic dosimetry, the need for exactness in determining the level of radiation doses is stressed. Use of similar equipment in research laboratories should be based on adherence to the proposed recommendations on methods of irradiation. 2 illustrations.

UDC 576.3:539.122.04

HISTOLOGICAL CHARACTERISTICS OF CELL COLONIES OF SPLEEN FROM MICE EXPOSED TO THE EFFECTS OF GAMMA IRRADIATION

[Abstract of article by Tuzhilkova, T.N.]

[Text] Histological and hematological investigations on the reactive changes in separate components of the blood in irradiated (doses of 700 and 900 rads) unprotected and protected (900 rads + mercamine) mice are presented. Reticular cells of lymphoid tissue play a central role in the development of endogenic cell colonies of spleen tissue taken from irradiated animals and then combined with "ecdemic" core cells. 1 illustration; 7 references.

UDC (539.12.04+546.79):576.72

THE PROTEIN CONTENTS OF SKELETAL MUSCLE FROM AN ORGANISM EXPOSED TO EXTERNAL IRRADIATION AND GIVEN RADIONUCLIDES OF VARIOUS ATOMIC WEIGHTS

[Abstract of article by Vatulina, G.G.]

[Text] The protein content of skeletal muscle in rats exposed to various external radiational effects and separate and combined multiple administrations of radionuclides of varying atomic weights was examined. Following high levels of exposure to radiation, protein content of muscle tissue changed within a certain period of time. The author concludes that there is a high level of stability in the content of muscle protein despite the effects of radiation factors on an organism. 1 table; 2 illustrations; 7 references.

FOR OFFICIAL USE ONLY

FOR OFFICIAL USE ONLY

UDC (539.12.04+546.79):547

THE ACTIVITY OF MYOSIN ATP GIVEN THE EXPOSURE OF AN ANIMAL TO RADIONUCLIDES OF VARYING ATOMIC WEIGHTS AND EXTERNAL IRRADIATION

[Abstract of article by Vatulina, G.G.]

[Text] The activity of myosin ATP in skeletal muscle of rats exposed to external irradiation and multiple separate and combined administrations of radionuclides of varying atomic weights was examined. The specific reactivity of certain enzymatic systems to radiational factors is described. 1 illustration; 9 references.

UDC 616-006:539.16.04:546.42+616-001:591.471

THE INFLUENCE OF MECHANICAL TRAUMA TO BONE AND THE INCIDENCE OF OSTEOSARCOMA INDUCED BY STRONTIUM-90

[Abstract of article by Semenova, V.P.]

[Text] The blastomogenic effect produced in white rats exposed chronically to strontium-90 (daily exposure of 1 μ C per animal) and to mechanical injury of bone was examined. The results indicated that the longevity of the animals is not a determining factor in the development of osteosarcoma. The incidence of skeletal malignancy depends on the level of destructive and proliferative processes in the skeletal system, caused by the amount of energy absorbed in the critical organ of the animal at the moment of trauma. Thus, in rats in which trauma was produced by administration of doses of 250 and 1,500 rads, the incidence of osteosarcoma was decreased by two in comparison with non-traumatized animals. Mechanical injury to bone produced by a dose of 5,000 rads somewhat increased the incidence of bone tumors in the experimental rats. In half of the cases, osteosarcoma developed instead of traumatic injury. 1 table; 7 references.

UDC 612.33:576.72:539.12.04+615.7

REACTION OF SCYPHIFORM CELLS TO THE EFFECTS OF IONIZING RADIATION AND RADIATION PROTECTIVE AGENTS

[Abstract of article by Tarakhtiy, E.A. and Semenov, D.I.]

[Text] The number and dimensions of scyphiform cells of the small intestines in mice, irradiated with a dose of colbalt-60 gamma rays were examined. An 80 percent fatality rate was ob-

FOR OFFICIAL USE ONLY

FOR OFFICIAL USE ONLY

served in those animals previously given radiation protective agents (cysteine and 15-M). In all the tests, an acute drop in the number of scyphiiform cells (up to 6-22 percent) by the second day was noted. At the end of the observation period (day 32) more complete normalization was observed in the protected animals. Decrease in the number of cells of varying dimensions was observed. By day 32 of the experiment, the dimensions of scyphiiform cells were normalized even in those animals protected with the 15-M agent. 1 table; 3 illustrations; 4 references.

UDC 591.85:539.12.04

THE RELATIONSHIP OF DOSE TO CELLULARITY OF THE BLOOD FORMING TISSUES OF MICE

[Abstract of article by Tarakhtiy, E.A., Semenov, D.I. and Tregubenko, I.P.]

[Text] The cellularity of blood forming tissues (bone marrow, spleen, inguinal and mesenteric lymph nodes and peripheral blood) in BALB mice, irradiated with colbalt-60 gamma rays and previously given radiation protective agents was studied. In different tests, the survival rate was 0, 20, 70, 90 and 100 percent. A direct relationship between the survival rate of the animals and volume of cellular elements in the blood forming tissues was found. 2 tables; 2 illustrations; 7 references.

UDC 577.391:591.463

THE RADIATION REACTION OF THE SPERMATOGENIC EPITHELIA IN MICE GIVEN DIMETHYLSULPHOXIDE

[Abstract of article by Mamina, V.P. and Tregubenko, I.P.]

[Text] Male mice of the BALB line were exposed to gamma irradiation at a dose of 610 rads. Dimethylsulphoxide was used as a radiation protective agent (4.5 g/kg), administered at 20 minutes, 2 hours and 1 hour and 45 minutes prior to irradiation. The mice were sacrificed at 4, 8, 16, 24 and 32 days. Changes in the cellular content of the sperm were studied. Analysis of separate types of spermatogenic cells was conducted on a suspension of homogenized sperm. Despite the high concentration of dimethylsulphoxide in the germinative tissue, an effective functional protective effect was not found. 1 illustration; 4 references.

UDC 577.391:591.875:547.875

QUANTITATIVE CHARACTERISTICS OF CHANGES IN THE EPITHELIA OF THE

45

FOR OFFICIAL USE ONLY

FOR OFFICIAL USE ONLY

SMALL INTESTINES FROM IRRADIATED MICE AND ANIMALS PROTECTED WITH MERCAMINE

[Abstract of article by Rasina, L.N., Semenov, D.I. and Tregubenko, I.P]

[Text] After gamma irradiation in a dose of 610 rads (LD_{65/30}) the number of epithelial cells in the crypts proximal to the villi of the small intestines of mice was decreased. The perimeter of the crypts and villi was altered. Mercamine given before irradiation did not prevent a reduction in the cellular population of the epithelial tissue. However, the range of variation in cellularity was controlled and a sharp increase in the dimensions of cells, especially in the crypts, was prevented. In contrast to unprotected animals, the duration of giant cell presence both in the crypts and villi was shortened. 3 illustrations; 6 references.

UDC 577.391:616-006:546.21

THE PRACTICAL USE OF THE "CRAB-TREE" EFFECT IN RADIATION THERAPY OF RADIORESISTANT TUMORS

[Abstract of article by Mezentsev, A.I., Maslov, E. Yu. and Budlyanskiy, A.V.]

[Text] The possibility of strengthening the effect of radiation of tumors in man by creating artificial hyperglycemia in the area of the malignancy was considered. The authors conducted 52 clinical observations utilizing this method in patients with cancer of the breast (stages II-III). The methodology for administration of the preparation and for irradiation of the tumor is described. The increased effectiveness of radiation of the tumors is caused by the phenomenon of the "crab-tree" effect. 7 references.

UDC 577.391:616-006.546.21

DIFFERENT MEANS OF ADMINISTRATION OF GLUCOSE-C₁₄ FOR INTERWOVEN TUMORS OF WHITE MICE

[Abstract of article by Mezentsev, A.I., Maslov, E.Yu. and Osipova, V.I.]

[Text] Experiments were conducted on mice with interwoven tumors to characterize how glucose-C₁₄ is stored when administered intraperitoneally and by intra-tissue injection. Intra-tissue administration of the preparation caused a significant increase in the retention of glucose in the tumor. However,

FOR OFFICIAL USE ONLY

FOR OFFICIAL USE ONLY

despite intraperitoneal administration of the preparation, the content of glucose was 5-10 times lower. 4 references.

UDC 615.015:547.979.733

ACCUMULATION AND KINETICS OF FIXATION OF MEZO-DIMETHYLAMINO-METHYLETHYLOPORPHYRIN-I IN RADIATION SENSITIVE ORGANS

[Abstract of article by Puchkova, S.M. and Korytnyy, V.S.]

[Text] Mezo-dimethylaminomethylethyloporphyrin-I, administered to mice, accumulates primarily in the liver, spleen and bone marrow. The preparation remains in the organs in two distinct physico-chemical forms. 3 references.

UDC 577.391:615.7:547.789

THE OPTIMAL CONDITION FOR APPLICATION OF RADIATION PROTECTIVE AGENTS FROM THE THIAZOLINE GROUP

[Abstract of article by Puchkova, S.M. and Yakovlev, V.G.]

[Text] Using 450 male mice of the C57B1/6 line, weighing 20-22 g, the radiation protective properties of 2, 2.5-trimethylthiazoline (TK-9) and 2.2-dimethyl thiazoline-4-carboxylic chloride (TK-10) were studied. The preparations were administered in various amounts (from 1/8 to 1/2 LD₁₆) in the course of 2-180 minutes. The optimal radiation protective dose was found to be 1/2 LD₁₆. The UE₅₀ for TK-9 and TK-10 was 415 and 610 mg/kg respectively. The therapeutic index for the compounds examined was approximately 3.0. The preparation of TK-9 had a radiation protective effect when administered in a course of 60 minutes up to the time of irradiation; TK-10 was effective only when given for 15-30 minutes prior to irradiation. 2 tables; 3 references.

UDC (615.9+615.7:591:539.12.04):547.789

THE TOXIC AND RADIATION PROTECTIVE PROPERTIES OF SEVERAL DERIVATIVES OF THIAZOLINE

[Abstract of article by Puchkova, S.M., Yakovlev, V.G., Orlov, A.M. and Smolin, M.D.]

[Text] Experiments were conducted on 50 mice of the C57B1/6 line weighing 19-22 g. An aqueous solution of the preparation was administered intraperitoneally in a dose of 1/2 LD₁₆ for 15 minutes up to irradiation, delivered in a dose range of 650-1,000 rads. The capacity of the dose was 100 rads/minute. The

FOR OFFICIAL USE ONLY

FOR OFFICIAL USE ONLY

compounds studied were relatively nontoxic; LD₅₀ equalled 845-1,700 mg/kg. The exception was the preparation of TK-14 for which LD₅₀ was 520 mg/kg. TK-9 and TK-10 had a high radiation protective effect; given diminished doses LD₅₀/30 equalled respectively 1.2 and 1.3. 2 tables; 4 references.

UDC (615.9+615.7:591:539.12.04):547.582.4

THE TOXIC AND RADIATION PROTECTIVE PROPERTIES OF CERTAIN DERIVATIVES OF THIOBENZIMIDAZOLE.

[Abstract of article by Malkina, R.M., Yakovlev, V.I., Orlov, A.M. and Smolin, M.D.]

[Text] Data are presented on the toxic and radiation protective properties of eight derivatives of thiobenzimidazole and one derivative of isothiuronium. Among them are substances which provide moderate radiation protection. The maximum radiation protective effect based on survival rate did not exceed 50 percent. The index for decreased dosage of aminoethylthiobenzimidazole dibromide is approximately 1.2. All the substances examined increased the average life expectancy of the sacrificed animals by 2-5 days in comparison with non-protected ones. An hypothesis is presented on the mechanism of their action. 2 tables; 2 illustrations; 5 references.

UDC (615.9+615.7:591:539.12.04):547

THE TOXIC AND RADIATION PROTECTIVE PROPERTIES OF CERTAIN PHOSPHORUS CONTAINING DERIVATIVES OF ISOTHIURONIUM

[Abstract of article by Goloshchapova, Zh.A.]

[Text] In experiments on mice, the toxic and radiation protective properties of 27 new phosphorus-containing derivatives of isothiuronium were studied. Four compounds (metaphosphate S-ethylisothiuronium, metaphosphate S-isopropylisothiuronium, diethylphosphate S-ethylisothiuronium and diethylphosphate S-benzylisothiuronium) were found to have a radiation protective effect when administered intraperitoneally after exposure to lethal doses of irradiation. 1 table; 2 illustrations; 6 references.

UDC (615.9+615.7:591:539:12.04):547.979.733

TOXIC AND RADIATION PROTECTIVE PROPERTIES OF CERTAIN PORPHYRINS

[Abstract of article by Tyzhilkova, T.N., Kirillova, G.V., Ponomarev, G.V. and Yashunskiy, V.G.]

FOR OFFICIAL USE ONLY

[Text] Porphyrins are biologically active compounds which exist in many forms in nature. Information pertaining to the radiation protective properties of 15 derivatives of porphyrins are presented. Eight compounds increased the survival rates of animals, irradiated at a dose of 900 rads ($LD_{95/30}$), by 20-40 percent in comparison with the control group. The radiation protective activity of porphyrins depends on their structure, composition, and position of all substituents as well as the presence of a central atom of metal. The most active of the compounds examined is dipotassium salt of the Fe^{+++} complex of mezoporphyrin-IX. 1 table.

UDC 591:539.12.04+615.7:547.262

CERTAIN CHARACTERISTICS OF THE BIOLOGICAL ACTIVITY OF ETHYL ALCOHOL IN RELATION TO ITS ANTI-RADIATION PROPERTIES

[Abstract of article by Vatulina, G.G. and Bol'shakova, S.A.]

[Text] The anti-radiation properties of alcohol in relationship to dose, method and time of administration, rate of intake, dose of irradiation and type of animal were studied. An evaluation of the use of alcohol as a radiation protective substance and as a biological solvent is presented. 1 table; 2 illustrations; 9 references.

COPYRIGHT: UNTs AN SSSR, 1978
[360-9139]

9139
CSO: 1840

FOR OFFICIAL USE ONLY

FOR OFFICIAL USE ONLY

RADIATION INJURY DIAGNOSIS BASED ON ANALYSIS OF BLOOD NUCLEIC ACIDS

Moscow BIOKHMICHESKIYE METODY in Russian 1980 signed to press 16 Jan 80
pp 118-121

[Article by G. A. Kritskiy and S. V. Aleksandrov from the book "Biokhimi-cheskiye Metody" (Biochemical Methods) edited by V. L. Kretovich and K. F. Shol'ts, USSR Academy of Sciences, Order of Lenin Institute of Biochemistry imeni A. N. Bakh, Izdatel'stvo "Nauka", 5,600 copies, 224 pages]

[Text] A very large number of studies are known to be devoted to radiation injury diagnosis. The following basic principles were utilized to reveal radiation injury: determination of compounds eliminated with urine--desoxycytidine, taurine, creatine, pseudouridine, and some other urine components; determination of the blood serum protein concentration and blood enzymatic activity (1-7). These methods, as well as the blood leukocyte count method, reveal changes in the body in response to exposure to doses of 25 r and higher. At the same time it is known from genetic studies that hereditary injury may also be revealed at doses on the order of 5 r. This necessitated a new solution to a pressing problem--that of developing a method for biochemical diagnosis of radiation injury usable with small radiation doses (about 5 r). Inasmuch as it is well known that disturbance of nucleic acid metabolism in tissues accompanied by intensive cell division arises at extremely small radiation doses, we felt that analysis of blood nucleic acids would be highly promising as the basis for revealing the effect of small radiation doses. A number of techniques for determining nucleic acids in various objects have been published (8-11). For various reasons, however, these techniques were unable to provide a solution to this problem. Not all techniques that are satisfactory in relation to the intact organism are equally successful in pathology.

After the body is subjected to radiation, the concentration of nucleic acids in radiosensitive organs (12) and their primary structure (13) change. In addition nucleic acids isolated from radiosensitive tissues of the body at the time of radiation injury contain an enlarged quantity of protein residues bonded to them (14, 15). All of these radiation-caused changes have their reflection in the height and shape of the ultraviolet spectrum of nucleic acids extracted from tissues. In this connection we base ourselves on the hypothesis that consideration of absorption exhibited in the ultraviolet

FOR OFFICIAL USE ONLY

FOR OFFICIAL USE ONLY

range at different wavelengths by extracts containing blood nucleic acids might be a good basis for the radiation injury diagnosis method we were seeking. The method we developed can reveal regularly occurring radiation-caused changes in the irradiated body beginning at a dose of 5 r. The magnitudes of the determined indicators depend on the time after irradiation, and the dose.

The proposed method is based on determining changes in the concentration and spectrum of nucleic acids extracted from blood leukocytic tissue following irradiation of the body.

Instruments and Reagents

An ultrathermostat, for example the U-8; a centrifuge, Yanetskiy's for example, 6,000 rpm; an SF-4A spectrophotometer; heparin; saponin; perchloric acid.

Determination Technique

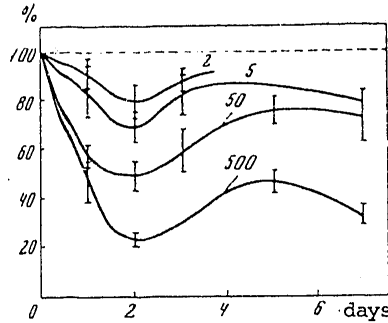
Food is taken away from rats 2-3 hours prior to the experiment, leaving only water. The animals are decapitated. As blood draining out following decapitation is collected separately from each rat in porcelain cups, it is mixed with a drop of heparin solution placed at the bottom of each cup beforehand. Immediately prior to the experiment a hemolyzing saponin solution is prepared in water: 1 part saponin by weight for 8,000 volumes of distilled water. The saponin solution is poured (in 3 ml batches) into centrifuge tubes, to which the blood is also added (0.5-1.5 ml), and mixed. Two samples of blood are taken from each rat. Then the hemolyzates are centrifuged for 10 minutes at 6,000 rpm. The supernatant solution is decanted. Four milliliters of perchloric acid (0.5N) are added to each leukocyte precipitate sample, the precipitates are mixed with glass rods, and then the tubes are placed in a water thermostat for 15 minutes at 70° without removing the rods. Then the tubes are cooled in ice water. The precipitates are once again pulverized with the glass rod. Then the precipitates are separated by centrifugation, the acid extracts are decanted into clean dry test tubes, and the latter are subjected to spectrophotometry at 230, 265, and 290 nm wavelengths. Perchloric acid solution (0.5N) heated in the same fashion as were the experimental samples is used as the control for spectrophotometry.

Computations

The indicators of parallel samples are averaged. Indicators C and K are computed using the following equations:

$$C = \frac{(A - B) \cdot V_1 \cdot 1.03}{V_1}; \quad K = \frac{(A - B) \cdot 1.03}{E_{230}}$$

FOR OFFICIAL USE ONLY



Change in Relative Concentration of Nucleic Acids (Percent of Normal) in Blood Different Times After Exposure of Rats to Radiation: The curves show radiation doses in roentgens.

Change in Rat Blood Indicators Two Days After Exposure of Animals to Different Doses of Roentgen Radiation

Indicators	Animal's State	Radiation Dose, r			
		5	50	200	500
C	Normal	6.45 ± 0.36	5.82 ± 0.27	6.65 ± 0.72	4.45 ± 0.12
	Irradiated	4.48 ± 0.40 p < 0.05	2.85 ± 0.35 p < 0.001	2.81 ± 0.28 p < 0.01	1.51 ± 0.14 p < 0.001
K	Normal	6.85 ± 0.31	7.11 ± 0.19	6.52 ± 0.25	6.07 ± 0.21
	Irradiated	4.99 ± 0.67 p > 0.05	5.96 ± 0.33 p < 0.01	4.87 ± 0.19 p < 0.01	3.66 ± 0.24 p < 0.001

where *C*--nucleic acid concentration (mg per 100 ml blood), *K*--factor reflecting change in nucleic acid spectrum, $A = 3.571 \cdot E_{265}$, $B = 0.802 \cdot E_{230}$; E_{265} , E_{230} , and E_{290} --absorption at 265, 230, and 290 nm, V_1 --blood volume sampled for analysis (ml), V_2 --volume of perchloric acid added to sample for nucleic acid extraction (ml).

We used this method to study the action of roentgen radiation upon rats (16). Some of the results are shown in the table and figure. The experiment was performed on four control and four irradiated Wistar rats. Radiation doses were from 2 to 500 r, and irradiation time was not greater than 25 minutes.

FOR OFFICIAL USE ONLY

FOR OFFICIAL USE ONLY

We can see from the table that the size of indicators *C* and *K* decreases at doses as low as 5 r and higher. Parallelism in the changes occurring in *C* and *K* insures greater reliability of the method as a whole.

The figure reveals insignificant reduction of the concentration of blood nucleic acids following irradiation of the organism at doses as low as 2 r.

Thus this example illustrates the high sensitivity of the proposed technique.

BIBLIOGRAPHY

1. Altman, K. I., Gerber, J. B., and Okada, S., "Radiation Biochemistry," Vol 1, 2, New York-London, 1970.
2. Fedorova, T. A., Tarakanova, M. P., Mazurik, V. K., and Rubachev, P. G., BYULL. EKSPERIM. BIOL. I MED., Vol 1, 1971, p 34.
3. Skurikhina, M. M., and Tereshchenko, O. Ya., RADIOBIOLOGIYA, Vol 3, 1963, pp 829-832.
4. Tereshchenko, O. Ya., and Tarakanova, M. P., RADIOBIOLOGIYA, Vol 8, 1968, pp 863-866.
5. Fedorova, T. A., Tereshchenko, O. Ya., and Mazurik, V. K., "Nukleinovyye Kisloty i belki v organizme pri lucheovom porazhenii" [Nucleic Acids and Proteins in an Organism Subjected to Radiation Injury]. Moscow, Izd-vo Meditsina, 1972.
6. "Proc. Sci. Meeting of Biochemical Indicators of Radiation Injury in Man," Vienna, 1971.
7. Fedorov, N. A., Bogomazov, M. Ya., and Kosenko, A. S., BYULL. EKSPERIM. BIOL. I MED., Vol 10, 1966, p 91.
8. Moretty, G., Staeffen, J., Ferrer, J., Ballan, P., Moulinier, J., Roques, J. C., Bronstet, A., and Crockett, R., GRENE-PATL. BIOL., Vol 19, 1971, pp 679-688.
9. Simakov, P. V., VOPROSY PITANIYA, Vol 6, 1960, pp 69-71.
10. Tsanev, R., and Markov, G. G., BIOCHIM. ET BIOPHYS. ACTA, Vol 42, 1960, pp 442-452.
11. Fridlyand, I. B., Ginzburg, M. B., Kornev, I. I., Zverev, M. P., and Preobrazhenskiy, Yu. V., MED. RADIOL., Vol 16, 1971, pp 22-28.
12. Kritskiy, G. A., Safronova, R. N., Chil Akopyan, L. A., and Kovtun, Yu. T., BIOKHIMIYA, Vol 28, 1963, pp 595-601.

FOR OFFICIAL USE ONLY

13. Kritskiy, G. A., Lakhtin, V. M., Aleksandrov, S. V., and Kopylov, V. A., RADIOBIOLOGIYA, Vol 15, 1975, pp 803-806.
14. Kritskiy, G. A., in "Nukleinovyye kisloty i biologicheskoye deystviye ioniziruyushchey radiatsii" [Nucleic Acids and the Biological Action of Ionizing Radiation], Moscow, Izd-vo Nauka, 1967, pp 44-56.
15. Kritskiy, G. A., RADIOBIOLOGIYA, Vol 7, 1967, pp 193-198.
16. Kritskiy, G. A., and Aleksandrov, S. V., DOKL. AN SSSR, Vol 209, 1973, pp 728-731.

COPYRIGHT: Izdatel'stvo "Nauka", 1980
[432-11004]

11004
CSO: 1840

FOR OFFICIAL USE ONLY

FOR OFFICIAL USE ONLY

UDC 577.3

BIOPHYSICS OF COMPLEX SYSTEMS AND RADIATION INJURIES

Moscow BIOFIZIKA SLOZHNYKH SISTEM I RADIATSIONNYKH NARUSHENIY in Russian
1977 signed to press 17 Jun 77 pp 2-4, 272-287

/Annotation, foreword, table of contents and abstracts from book edited by
G. M. Frank, USSR Academy of Sciences, Institute of Biological Physics,
Izdatel'stvo Nauka, 4,750 copies, 287 pages/

/Text/ The collection widely presents the results of theoretical and ex-
perimental investigations of four major sections of modern biophysics,
that is, ionic permeability and structure of biomembranes, mathematical
biophysics, radiobiology and bioenergetics. All these sections are uni-
fied by a common approach to the study of problems connected with vitally
important processes occurring in the body. The collection describes origi-
nal methods, some of which are connected with the use of computer e-
quipment.

This book will be useful for a wide circle of biologists, as well as for
undergraduate and graduate students at biological faculties of higher edu-
cational institutions.

Foreword

The formation of a new science in the series of biological disciplines is
always a complex process and in some respects contradictory. This is what
happens today with the development of biological physics. Sometimes skepti-
cal views are expressed--is the formation of this new science not arti-
ficial to some extent? However, if we look attentively, we will see that
this process is progressive for biology as a whole and it can no longer be
stopped.

Several decades ago almost the same happened during the birth of biochem-
istry. However, the formation of biochemistry at the very beginning was
facilitated by the separation of "physiological chemistry" from physiology,
a term little remembered at present.

FOR OFFICIAL USE ONLY

FOR OFFICIAL USE ONLY

Nevertheless, the living system is primarily a "chemical machine." However, it is not difficult to present a number of proofs of the fact that the "chemical language," however complex it may be, is not yet adequate for the description of even individual links of vital phenomena. Hence an organic need arose for a physical examination of biological phenomena with the entire powerful apparatus of modern physics including both general theoretical ideas, in particular the mathematical apparatus, and modern methods of experimental physics.

At first there was optimism in connection with the fact that the participation of physics would lead to a rapid solution of biological problems. However, soon it became clear that with this approach it is impossible to do without some simplifications and schematization. Thus, investigators once again became convinced of the great complexity characterizing the tasks of biology.

At present it can be stated that, owing to the joint development of biochemistry and biophysics, a big leap was made in understanding the material essence of vital phenomena.

We should not be disturbed by the fact that, apparently, biological physics does not have its specific objects or problems limiting its competence, like, for example, microbiology or the science of photosynthesis. The same biophysics is needed for a successful development of these two sciences and depending on the formulation of a task biophysical approaches are used in the solution of problems of both microbiology and photosynthesis. Nevertheless, it is not ruled out and even inevitable that such problems, where the participation of biophysics is predominant and the research results decisive, will arise (and are already arising) gradually.

From this point of view one should not attempt to separate from biology individual problems in which biophysics operates "absolutely." The role of biophysics will be significant only if its sound coexistence with biochemical and general biological approaches is realized.

This collection presents the results of experimental investigations in four groups of studies conducted at the Institute of Biological Physics of the USSR Academy of Sciences in the last few years. The 25th anniversary of the institute's existence is the incentive for their summation and joint publication.

The first section of the collection presents a number of investigations largely pertaining to the physical aspect of the function of membranes. Among many other problems the mechanisms of ion transport through membranes, in particular in the so-called single ion canal, are examined here. In this case we encounter the manifestation of elementary processes. The study of the optical properties of membranes during functioning also pertains here.

FOR OFFICIAL USE ONLY

FOR OFFICIAL USE ONLY

The next section--biophysics of complex systems (or it can also be called mathematical biophysics)--is diverse in its content. I would like to note the article devoted to the mathematical modeling of polyenzymatic processes. The entire material examined in this article is profoundly connected with experimental biochemical data, makes it possible to draw conclusions for further investigations and is not abstract mathematical modeling. This also applies to the complex interpretation of the spread of excitation in a multicellular medium and its disturbance. The part of this section devoted to an analysis of biological structures is extremely important in theory and practice. The articles of the third section are devoted to radiation biology. They reflect the results of study of the mechanisms of radiation effect on macromolecules and cell viability. Disturbances in the structure and physicochemical processes, as well as the possibility for reparation, are examined.

Finally, the fourth section presents bioenergetics. It touches only upon the most important part of the problem connected with the function of mitochondria. Having familiarized himself with this section, the reader can once again be convinced that, in practice, biochemical and biophysical approaches are indiscernible.

On the whole, the content of this collection confirms the above stated about the inseparability of biophysical investigations from biochemical approaches or, in general form, from the physicochemical ideas of the properties of live structures.

On its 25th anniversary the Institute of Biological Physics of the USSR Academy of Sciences, utilizing the capabilities of theoretical and experimental physics, develops modern ideas of biophysics so that it may continue to hold an appropriate place in the rank of other biological disciplines.

FOR OFFICIAL USE ONLY

FOR OFFICIAL USE ONLY

Table of Contents	Page
Foreword	3
Biomembranes	
(Ionic Permeability and Structure)	
Introduction	5
Brezhestovskiy, P. D., Veprintsev, B. N., Vul'fiyus, Ye. A., Il'in, V. I., and Yurchenko, O. P., "Mechanisms of Functioning and the Molecular Structure of Cholinoreceptors of Mollusk Neurons"	7
Veprintsev, B. N., Krasts, I. V., and Chemeris, N. K., "Electroexcitable Membrane of Neuron Soma. Ionic Mechanisms"	12
Kislov, A. N., and Kazachenko, V. N., "Chemoexcitable Somatic Neuron Membrane Controlled by Alkaline Cations"	14
Kazachenko, V. N., and Kislov, A. N., "The Effect of Membrane Potential on the Functioning of a Cholinoreceptor"	16
Kostenko, M. A., Geletyuk, V. I., and Venrintsev, B. N., "Electro- and Chemoexcitable Somatic Neuron Membranes. Completely Isolated Neurons"	18
Veprintsev, B. N., "The Connection Between the Electric Activity of a Nerve Cell and the Synthesis of RNA in it"	22
Fesenko, Ye. Ye., Novoselov, V. I., Lyubarskiy, A. L., Fesenko, N. K., Zhavoronok, A. I., and Pervukhin, G. Ya., "Modeling of Photo-reception and Olfactory Reception of Artificial Lipid Membranes Modified by Components of Receptor Systems"	25
Kuznetsov, V. I., Kolomytkin, O. V., and Yermishkin, L. N., "Isolation of a Partially Purified Glutamate Receptor and Its Study on Bilayer Phospholipid Membranes"	29
Aleksandrov, A. A., Berestovskiy, G. N., Volkova, S. P., Vostrikov, I. Ya., Kravchik, S., Lunevskiy, V. Z., and Zherelova, O. M., "Reconstruction of a Single Potential Dependent Calcium-Sodium Cell Canal in a Lipid Bilayer"	33
Borisova, M. P., Grigor'yev, P. A., Yermishkin, L. N., Zil'bershteyn, A. Ya., and Topaly, V. P., "Mechanisms of Induced Ionic Permeability of Lipid Membranes"	39

FOR OFFICIAL USE ONLY

Kremlev, I. N., "Conformational Readjustments of the Ionizing Type--Possible Basis for the Regulation of Ion Flow in the Canals of Excitable Membranes"	44
Borovyagin, V. L., Varton', S. S., Galushchenko, I. V., Ivanina, T. A., Moshkov, D. A., and Severina, Ye. P., "Ultrastructural and Molecular Organization of Cellular and Artificial Membranes"	50
Berestovskiy, G. N., Gyul'khandanyan, M. Z., Yelkin, A. P., Kremlev, I. N., Nenashev, V. A., and Razhin, V. D., "Physical Properties of Bilayer Lipid Membranes and Their Contact Interaction"	62
Cherkashin, A. N., Budantsev, A. Yu., Petukhov, V. V., Kuznetsov, V. I., Azarashvili, A. A., Shchipakina, T. G., Karanova, M. V., Zuravleva, Z. N., Godukhin, O. V., Zharikov, S. I., Kalmykov, V. L., and Arkhipov, V. I., "Mediators of Synaptic Transmission in the Central Nervous System"	69

Mathematical Biophysics

Introduction	73
Sel'kov, Ye. Ye., "Mathematical Modeling of Polyzymatic Systems"	76
L. N. Yermishkin, "Mathematical Models and Mechanisms of Induced Ion Transport"	89
Krinskiy, V. I., Kokoz, Yu. M., and Pertsov, A. M., "Ion Currents and the Properties of Excitable Membranes"	93
Krinskiy, V. I., "Autowave Processes in Excitable Media"	101
Zaikin, A. N., and Zhabotinskiy, A. M., "Autowave Processes in Active Concentration Media"	107
Sakson, M. Ye., and Kukushkin, N. I., "Regulation of Intercellular Electric Connection and Arrhythmia by Cardioactive Agents"	112
Baum, O. V., "Modeling of Electric Activity of the Heart"	119
Ivanitskiy, G. R., and Kuniskiy, A. S., "Quantitative Methods of Investigation of the Spatial Organization of Ultrastructures"	129
Smetanich, Ya. S., "Method of Determining the Primary Structure of Biopolymers"	142

Problems of Radiobiology

Introduction	144
--------------	-----

FOR OFFICIAL USE ONLY

Strazhevskaya, N. B., "Mechanisms of Effect of Ionizing Radiation on the Hypomolecular DNA Complexes of Eukaryotes"	145
Gaziyev, A. I., "Molecular Mechanisms of Reparation of Single-Strand DNA Breaks Induced by γ -Radiation"	150
Vilenchik, M. M., "Investigation of the Role of DNA Reparation in the Maintenance of Cell Viability"	161
Tokarskaya, V. I., and Umanskiy, S. R., "Radiation Disturbance in Transcription Regulation"	163
Kolomiytseva, I. K., and Medvedev, B. I., "The Role of Lipids in Radiation Injury to and Restoration of Biomembranes"	168
Kopylov, V. A., Kuzin, A. M., Medvedev, A. I., and Yurov, S. S., "The Problem of Radiotoxins. Nature, Biological Effect and Role in Postradiation Formation of Radiobiological Effects"	176
Eydus, L. Kh., Veksler, A. M., Ganassi, Ye. E., and Plotnikova, Ye. D., "The Problem of Protection, Sensibilization and Restoration"	188
Akoyev, I. G., and Tyazhelova, V. G., "Kinetic Patterns and Theoretical Analysis of Formation of Radiation Injury to the Organism"	202
Bioenergetics	
Introduction	206
Gyul'khandanyan, A. V., Gaynutdinov, M. Kh., and Yevtodiyenko, Yu. V., "The Conditions, Mechanism and Physiological Significance of the Yield of Calcium Ions From Mitochondria"	208
Kudzina, L. Yu., Medvedev, B. I., Sotnikova, V. S., and Yevtodiyenko, Yu. V., "The Isolation and Reconstruction on an Artificial Phospholipid Membrane of K ⁺ -Transporting System of Mitochondria"	218
Mironova, G. D., Pronevich, L. A., Fedotcheva, N. I., and Sirota, T. V., "Properties of Membrane Active Substances Isolated From Animal Tissues Affecting Oxidative Phosphorylation and Ion Transport Through Membranes"	223
Mironova, G. D., and Sirota, T. V., "The Participation of Peroxidase and of the Effect of Oxygen Not Mediated by Cytochrome Oxidase in the Processes of ATP Formation"	228
Mironov, G. P., "Reactions of Thiol-Disulfide Transition in Oxidative Phosphorylation"	237

FOR OFFICIAL USE ONLY

Fishov, I. L., "Regulatory Interconnection of the Respiratory Chain and ATP-ase in Mitochondria"

244

Kondrashova, M. N., Yevtodiynko, Yu. V., Mironova, G. D., Kaminskiy, Yu. G., Akhmerov, R. N., Kudzina, L. Yu., Pronevich, L. A., Fedotcheva, N. I., Kosenko, Ye. A., Dil'man, V. M., Anisimov, V. N., Ostroumova, M. N., Nartsissov, R. P., Komissarova, I. A., Mayevskiy, Ye. I., Shishlo, M. A., Mokhova, Ye. N., Alekseyev, M. Yu., and Serebrennikova, G. A., "Norm and Pathology From the Standpoint of Energetics of Mitochondria" 249

Abstracts

UDC 612.814:612.815:547.96:54-4

MECHANISMS OF FUNCTIONING AND MOLECULAR STRUCTURE OF CHOLINORECEPTORS OF MOLLUSK NEURONS

Abstract of article by Brezhnevskiy, P. D., Veprintsev, B. N., Vul'fiyus, Ye. A., et al.

Text The properties of the cholinoreceptive membrane of isolated neurons of the pond and apple snail were investigated by the method of fixation of the membrane potential. It was shown that the rate of desensitization of cholinoreceptors to acetylcholine depended neither on the membrane potential, nor on the concentration of Ca^{2+} in the external medium in contrast to the cholinoreceptors of skeletal muscles of vertebrates. The results of experiments with a set of cholinomimetics and with irreversibly acting (alkylating) antagonists of cholinoreceptors indicate that desensitization develops at the level of the active center of cholinoreceptors or the block of control of the selective filter of the ion canal. The data of experiments with mono- and bifunctional alkylating antagonists of cholinoreceptors speak in favor of the dimeric structure of cholinoreceptors and a cooperative interaction between protomers. Functionally important S-S connections and carboxylic groups in the cholinoreceptors of neurons of the pond snail were detected by means of group specific modifying reagents with an affinity for cholinoreceptors.

4 illustrations; 11 bibliographic entries.

UDC 577.352.5

ELECTROEXCITABLE MEMBRANE OF NEURON SOMA. IONIC MECHANISMS

Abstract of article by Veprintsev, B. N., Krasts, I. V., and Chemeris, N. K.

Text By the method of factor experiments in the measurement of the extent of overshooting with various ion concentrations in a medium it has been shown that calcium and magnesium ions play the principal role in the

61

FOR OFFICIAL USE ONLY

FOR OFFICIAL USE ONLY

formation of incoming current during the action potential. It is assumed that there are separate conductivity canals for these ions.

3 bibliographic entries.

UDC 577.352.5

CHEMOEXCITABLE SOMATIC NEURON MEMBRANE CONTROLLED BY ALKALINE CATIONS

[Abstract of article by Kislov, A. N., and Kazachenko, V. N.]

[Text] It has been found that, when the concentration of ions of alkaline metals--K⁺, Rb⁺ and Cs⁺--is increased in a medium, the chlorine canals of a somatic neuron membrane are activated. The volt-ampere characteristics of chlorine and potassium potential dependent canals are described.

1 illustration; 4 bibliographic entries.

UDC 577.352.5

THE EFFECT OF MEMBRANE POTENTIAL ON THE FUNCTIONING OF A CHOLINORECEPTOR

[Abstract of article by Kazachenko, V. N., and Kislov, A. N.]

[Text] This study establishes that, in practice, the depolarization of a neuron membrane leads to a complete "disconnection" of a cholinoreceptor. The kinetics of inactivation and reactivation of a cholinoreceptive membrane during a shift of the membrane potential is described.

1 illustration; 9 bibliographic entries.

UDC 594

ELECTRO- AND CHEMOEXCITABLE SOMATIC NEURON MEMBRANES. COMPLETELY ISOLATED NEURONS

[Abstract of article by Kostenko, M. A., Geletyuk, V. I., and Veprintsev, B. N.]

[Text] A unique method of obtaining completely isolated nerve cells of a mollusk has been developed. Extensive factual data on the viability of these neurons are presented. The electric, chemoreceptive and morphological characteristics of isolated neurons are retained for several weeks. Isolated neurons not only are capable of surviving in vitro, but also of forming axons and functional nerve chains from several nerve cells.

11 bibliographic entries.

FOR OFFICIAL USE ONLY

FOR OFFICIAL USE ONLY

UDC 612.822.816.015

THE CONNECTION BETWEEN THE ELECTRIC ACTIVITY OF A NERVE CELL AND THE SYNTHESIS OF RNA IN IT

Abstract of article by Veprintsev, B. N.

Text The object of this investigation was to determine the effect of various types of excitation of the membrane of a nerve cell on RNA metabolism. The study was performed on giant neurons of the nervous system of mollusks. The effect in vitro of the application of adrenaline and acetylcholine, current polarization, synaptic stimulation and generation of action potentials on RNA synthesis, which was determined according to the inclusion of labeled uridine by neurons, was compared. During stimulation the inclusion in RNA dropped to 50%. After the cessation of stimulation synthesis returned to the control level and activation of synthesis to 200% was noted only after the generation of action potentials. Changes in the ultrastructure of neurons reflecting the activation of substances between the nucleus and cytoplasm and the intensification of protein synthesis as a consequence of stimulation were described.

10 bibliographic entries.

UDC 577.3

MODELING OF PHOTORECEPTION AND OLFACTORY RECEPTION ON ARTIFICIAL LIPID MEMBRANES MODIFIED BY COMPONENTS OF RECEPTOR SYSTEMS

Abstract of article by Fesenko, Ye. Ye., Novoselov, V. I., Lyubarskiy, A. L., Fesenko, N. K., Zhavoronok, A. I., and Pervukhin, G. Ya.

Text The primary processes of visual and olfactory reception were modeled on artificial lipid membranes modified by components of external segments of rods of the retina and of the scraping of the olfactory lining subjected to ultrasonic treatment. Model membranes changed conductivity in response to light and the addition of fragrant substances. The possible mechanisms of excitation of the appropriate receptor systems were discussed on the basis of the data obtained.

2 illustrations; 5 bibliographic entries.

UDC 577.37

ISOLATION OF A PARTIALLY PURIFIED GLUTAMATE RECEPTOR AND ITS STUDY ON BILAYER PHOSPHOLIPID MEMBRANES

Abstract of article by Kuznetsov, V. I., Kolomytkin, O. V., and Yermishkin, L. N.

FOR OFFICIAL USE ONLY

Text A partially purified glutamate receptor was isolated from the synaptic endings of mossy fibers of the rat hippocampus. The bilayer lipid membrane with an imbedded receptor increased conductivity for ions in response to the addition of glutamate. The increase in conductivity produced by glutamate was blocked 50% when diethyl ether of glutamic acid was added. Discrete jumps of two types of conductivity, that is, about 15 pmho and multiple 55 pmho, were observed on the bilayer lipid membrane modified by the glutamate receptor. The receptor bound glutamate in the ratio of 1 mole of glutamate per 320,000 g of protein.

4 illustrations

UDC 577.37

RECONSTRUCTION OF A SINGLE POTENTIAL DEPENDENT CALCIUM SODIUM CELL CANAL IN A LIPID BILAYER

Abstract of article by Aleksandrov, A. A., Berestovskiy, G. N., Volkova, S. P., Vostrikov, I. Ya., Kravchik, S., Lunevskiy, V. Z., and Zherelova, O. M.

Text The ion canals of excitable membranes (plasmalemma and topoplast) of the cells of the Charophyta were studied. It was shown that they contained potential dependent calcium-potassium (Ca-Na) canals and chlorine canals activated by calcium on the part of the protoplasm.

During the modification of bilayer lipid membranes with certain fractions of the cell protoplasm potential dependent ion canals are formed. The closeness of the properties of the selective filter and the activating mechanism of the canal in bilayer lipid membranes to similar parameters of Ca-Na cell canals makes it possible to believe that a Ca-Na cell canal is reconstructed in bilayer lipid membranes.

The spectrum of effect of the irradiation of the optical range on the ion canals of the cell plasmalemma and the effect of pronase on the reconstructed canal speak in favor of the presence of protein in the molecular complex of the canal.

6 illustrations; 11 bibliographic entries.

UDC 577.3

MECHANISMS OF INDUCED IONIC PERMEABILITY OF LIPID MEMBRANES

Abstract of article by Borisova, M. P., Grigor'yev, P. A., Yermishkin, L. N., Zil'bershteyn, A. Ya., and Topaly, V. P.

Text All membrane active substances inducing the ionic permeability of lipid membranes can be included in two different categories: carrying and canal forming substances. The mechanism of operation of a carrying

FOR OFFICIAL USE ONLY

substance--an effective protonophore--tetrachloro-trifluoromethylbenzimidazole--was studied. The properties of a single ion canal formed by a bacterial ribonucleoprotein--a substance of the second category--were also described. It was also shown that some enzymes adsorbed in the membrane during interaction with the substrate led to the formation of ion canals with discrete levels of conductivity.

4 illustrations; 8 bibliographic entries.

UDC 577.3

CONFORMATIONAL READJUSTMENTS OF THE IONIZING TYPE--POSSIBLE BASIS FOR THE REGULATION OF ION FLOWS IN THE CANALS OF EXCITABLE MEMBRANES

[Abstract of article by Kremlev, I. N.]

[Text] Molecular models of regulatory sections of ion canals are offered. Ion flows are regulated as a result of the potential dependent readjustment of complexes of imidazole and carboxylic residues. The selective function is modeled according to the principle of selectiveness of cyclo-depsipeptides of the enniatin group. The system of regulatory sections built according to this principle permits a description within the framework of Hodgkin-Huxley formalism.

For the purpose of studying the connection between the conformational readjustments of polypeptide structures and polar residues and changes in conductivity the effect of pH and D₂O on the electric characteristics of bilayer membranes modified by polyaminoacids was investigated.

5 illustrations; 12 bibliographic entries.

UDC 577.352

ULTRASTRUCTURAL AND MOLECULAR ORGANIZATION OF CELLULAR AND ARTIFICIAL MEMBRANES

[Abstract of article by Borovyagin, V. L., Varton', S. S., Galushchenko, I. V., Ivanina, T. A., Moshkov, D. A., and Severina, Ye. P.]

[Text] A series of investigations devoted to the clarification of various aspects of the structural organization of model and cellular membranes are presented. The results of a study of the processes of development and transformation of various multimembrane cytoplasmatic systems in the cells of the nervous system of various animals are summed up. The results of experiments in the study of the structure of membranes (model and cellular) by the method of electron microscopy of a high resolution with a parallel use of various methodological techniques and nonstandard conditions

65

FOR OFFICIAL USE ONLY

FOR OFFICIAL USE ONLY

for the processing of preparations are presented. The promising nature of such experimental approaches in the study of the structural organization of complex biological systems is stressed.

1 table; 8 illustrations; 28 bibliographic entries.

UDC 577.30.043:047

PHYSICAL PROPERTIES OF BILAYER LIPID MEMBRANES AND THEIR CONTACT INTERACTION

Abstract of article by Berestovskiy, G. N., Gyl'khandanyan, M. Z., Yelkin, A. P., Kremlev, I. N., Nenashev, V. A., and Razhin, V. D./

Text The results of investigation of the effect of an electric field on the thickness and optical parameters of bilayer lipid membranes, as well as of the nature of change in these values and the tension of bilayer lipid membranes in the process of emergence of the bilayer after formation on a stationary level, are presented. A new method making it possible to determine the magnitude of double refraction of bilayer lipid membranes and the results obtained by this method are described. An optical method of measuring the distance between two contacting bilayer lipid membranes is also presented. Knowledge of this magnitude and other characteristics of the system has made it possible to determine the physical forces of interaction of bilayer lipid membranes. The contribution of physical forces to the contact interaction of cells is discussed.

5 illustrations; 14 bibliographic entries.

UDC 577.3

MEDIATORS OF SYNAPTIC TRANSMISSION IN THE CENTRAL NERVOUS SYSTEM

Abstract of article by Cherkashin, A. N., Budantsev, A. Yu., Petukhov, V. V., et al./

Text An analysis of the mechanisms of action and functional importance of chemical mediators was made. In the study of acetylcholine and γ -aminobutyric acid sections of the hippocampal formation, septum, mamillary bodies, caudate nucleus and cerebral cortex of the rabbit were used. The possibility of the participation of glutamate as a mediator in zinc containing giant synapses was shown. Special attention was given to an examination of cholinergic and adrenergic brain systems, as well as to the elements of system brain analysis.

5 bibliographic entries.

FOR OFFICIAL USE ONLY

FOR OFFICIAL USE ONLY

UDC 577.150.001

MATHEMATICAL MODELING OF POLYENZYMATIC SYSTEMS

Abstract of article by Sel'kov, Ye. Ye.

Text Open one- and two-substrate enzymatic reactions with various types of effect of regulatory substances on the reaction rate were investigated. A generalized form of Monod, Wyman and Changeux equations of the quasi-stationary rate of an enzymatic reaction for an arbitrary number of substrates and products is presented. Attention is drawn to the role of quick reversible enzymatic reactions participating in a reversible deposit of various intracellular metabolites. Quick reversible reactions can also greatly increase the period of self-vibration of biochemical reactions. The role of the primary stoichiometric structure of polyenzymatic systems in the appearance of various nonlinear effects--hysteresis and multiplicity of stationary states--is stressed. An allosteric regulation of the activity of enzymes intensifies these nonlinear effects.

One- and two-period self-vibrations in glycolysis observed in an experiment are described with mathematical models. The mathematical equivalence of models of a wide category of biochemical reactions is discussed.

3 illustrations; 18 bibliographic entries.

UDC 577.37

MATHEMATICAL MODELS AND MECHANISMS OF INDUCED ION TRANSPORT

Abstract of article by Yermishkin, L. N.

Text A specific example of clarification of the mechanism of proton transport through a lipid membrane in the presence of one of the effective disconnectors of oxidative phosphorylation is examined. It is shown how a joint use of experimental and model approaches makes it possible to come closer to understanding the nature of the most important property of excitable membranes--nonmonotony of volt-ampere characteristics.

2 illustrations; 2 bibliographic entries.

UDC 577.3

ION CURRENTS AND THE PROPERTIES OF EXCITABLE MEMBRANES

Abstract of article by Krinskiy, V. I., Kokoz, Yu. M., and Pertsov, A. M.

Text A method making it possible to use qualitative methods of the vibration theory for analyzing the characteristics of excitable membranes and their connection with ion currents was developed. This method is

FOR OFFICIAL USE ONLY

FOR OFFICIAL USE ONLY

based on the construction of zero-isoclines of differential equations of the second order describing the investigated membranes according to the records of rapid and slow currents.

Hodgkin-Huxley and Nobel equations were investigated by this method. A number of new electrophysiological effects on cardiac muscle preparations were predicted and experimentally detected. This method is convenient in the search for and selection of biologically active compounds affecting excitable membranes.

10 illustrations; 14 bibliographic entries.

UDC 577.3

AUTOWAVE PROCESSES IN EXCITABLE MEDIA

Abstract of article by Krinskiy, V. I.

Text Two types of wave sources--a reverberator sending spiral waves and an echo--the source of concentric waves--are described in models of excitable media. The mechanisms of emergence of these sources were investigated. Both theoretically forecast types of sources could be subsequently observed in the Zhabotinskiy-Zaikin chemical vibrating reaction.

7 illustrations; 17 bibliographic entries.

UDC 541.128.7

AUTOWAVE PROCESSES IN ACTIVE CONCENTRATION MEDIA

Abstract of article by Zaikin, A. N., and Zhabotinskiy, A. M.

Text In a homogenous distributed active chemical system the authors detected the effect of propagation of undamped concentration waves, whose sources were autowave formations of the types of guiding center and reverberator. The study presents the results of an experimental investigation of the system and a mathematical model of the guiding center. The applied significance of the open effect is discussed.

4 illustrations; 4 bibliographic entries

UDC 577.3

REGULATION OF INTERCELLULAR ELECTRIC CONNECTION AND ARRHYTHMIA BY CARDIO-ACTIVE AGENTS

Abstract of article by Sakson, M. Ye., and Kukushkin, N. I.

Text Disturbance in the conductivity of contact membranes between heart cells holds an important place in the process of desynchronization of systoles. One of the directions in the medicinal regulation of systoles is

68

FOR OFFICIAL USE ONLY

FOR OFFICIAL USE ONLY

connected with the effect on contact membranes and intensification of intercellular electric connection. Such a direction of antiarrhythmic effects is exemplified by the clinical preparations quinidine and inderal.

Previously it was considered that the fibers of a working myocardium were not capable of automatic activity. This work shows that autorhythmical activity is readily initiated in contraction fibers under the effect of direct depolarizing current. Automatics under current is connected mainly with the activity of slow calcium canals of cardiac cells.

8 illustrations; 12 bibliographic entries.

UDC 612.014.423

MODELING OF ELECTRIC ACTIVITY OF THE HEART

Abstract of article by Baum, O. V.

Text A system approach to problems of electrocardiology in the modeling of the electric activity of the heart at various structural levels of an object was examined. A model of genesis of electrocardiograms describing the heart generator in the form of a piecewise smooth double electric layer along the surface of the epicardium and endocardium, as well as along the surfaces of intramural regions, whose electric properties differ from the properties of the surrounding myocardium, was proposed. The model was realized as a set of programs for a digital computer.

9 illustrations; 9 bibliographic entries.

UDC 578.086:681.142

QUANTITATIVE METHODS OF INVESTIGATION OF THE SPATIAL ORGANIZATION OF ULTRASTRUCTURES

Abstract of article by Ivanitskiy, G. R., and Kuniskiy, A. S.

Text The possibilities of quantitative methods of a three-dimensional interpretation of biological structures on the basis of electron microscope data were investigated. A set of computation and apparatus methods on the basis of a general-purpose digital computer was developed. Examples of its use for the solution of specific problems are presented.

10 illustrations; 5 bibliographic entries.

UDC 577.3

METHOD OF DETERMINING THE PRIMARY STRUCTURE OF BIOPOLYMERS

Abstract of article by Smetanich, Ya. S.

69

FOR OFFICIAL USE ONLY

FOR OFFICIAL USE ONLY

Text A brief summary of the results obtained in the Institute of Biophysics of the USSR Academy of Sciences from 1971 through 1975 on mathematical methods connected with the determination of the primary structure of linear biopolymers is given. The possible applicability of the obtained algorithms is pointed out.

11 bibliographic entries

UDC 577.391

MECHANISMS OF EFFECT OF IONIZING RADIATION ON THE HYPOMOLECULAR DNA COMPLEXES OF EUKARYOTES

Abstract of article by Strazhevskaya, N. B.

Text A comparative analysis of injuries to the structure and function of hypomolecular DNA complexes in the cells of gamma irradiated rats (thymus and liver) different in their radiosensitivity is given. Three new methods are proposed: 1) method for investigating the DNA-nonhistone protein, which made it possible to first reveal the direct effect of radiation on DNA in vivo and to demonstrate the role of strengthening the bond of nonhistone protein with DNA with biological radiation doses; 2) method of isolating euchromatin and heterochromatin DNA, which made it possible for the first time with biological doses of irradiation of animals not only to detect single-strand breaks in DNA, but also to determine their primary localization in heterochromatin; 3) method of obtaining animal DNA subunits with a molecular weight of $2 \cdot 10^8$ daltons. It is concluded that postradiation changes in hypomolecular DNA complexes in the thymus and liver have two similar periods (primary degradation and latent period), but differ in the third period--secondary degradation in the thymus, but reparation of hypomolecular DNA complexes in the liver. It is postulated that radiation not only disturbs the primary and secondary structure of DNA, but also damages the native connection of DNA with the specific lipoproteins of membranes.

3 illustrations; 9 bibliographic entries.

UDC 577.15

MOLECULAR MECHANISMS OF REPARATION OF SINGLE-STRAND DNA BREAKS INDUCED BY γ -RADIATION

Abstract of article by Gaziyev, A. I.

Text The chemical nature of terminal groups of breaks induced by γ -radiation in DNA, using enzymes--DNA-polymerase I, DNA ligases, polynucleotidekinase, alkali phosphatase and exonuclease III--was investigated. The mechanism of the process of "super fast" reparation of breaks in the DNA of cells subjected to γ -radiation was established. It was shown that

70

FOR OFFICIAL USE ONLY

FOR OFFICIAL USE ONLY

DNA polymerases I, II and III participated in the reparative synthesis of the DNA of γ -irradiated cells. Reparative synthesis with the participation of DNA-polymerases I and III is completed with the restoration of single-strand breaks in DNA. γ -Radiation induced in bacterial cells additional synthesis of the enzymes participating in the reparation of single-strand breaks in DNA.

2 illustrations; 19 bibliographic entries.

UDC 571.547.963.32

INVESTIGATION OF THE ROLE OF DNA REPARATION IN THE MAINTENANCE OF CELL VIABILITY

Abstract of article by Vilenchik, M. M.

Text It has been calculated that the rate of spontaneous depurinization of DNA under physicochemical conditions close to those under which DNA is in a cell is on the order of 10^{-10} sec⁻¹. Therefore, genome stability should be ensured by the system of reparation of apurine sections of DNA. This assumption is indirectly confirmed by the data that DNA synthesis differing from reduplicative DNA synthesis in its sensitivity to oxyurea (that is, probably, this is reparative DNA synthesis) occurs in the nerve cells of the brain of adult rats. An assumption is formulated that a disturbance in the function (especially, accuracy of operation) of the system of DNA reparation and (or) change in the nature of packaging (superstructure) of DNA in a cell is one of the determining mechanisms of aging and cancerogenesis.

7 bibliographic entries.

UDC 577.391:547:963.3

RADIATION DISTURBANCE IN TRANSCRIPTION REGULATION

Abstract of article by Tokarskaya, V. I., and Umanskiy, S. R.

Text The results of investigations of early stages in radiation disturbance in the structure of chromatin and metabolism of ribonucleic acids conducted for 5 years were summed up. A significant activation of RNA biosynthesis in the liver and spleen of rats during the first 30 min after irradiation in a dose of 800 R was detected. The processing of nuclear RNA in the liver does not change during the first 60 min and greatly accelerates by the second hour after irradiation. The ripening of RNA in the thymus is inhibited and in the spleen is activated by irradiation. It has been shown that the irradiation of chromatin in vitro in doses of 0.5 to 5 Ci increases its matrix activity in the RNA-polymerase system. The effect is connected both with an increase in the rate of elongation of RNA chains and with RNA synthesis at previously inactive sections of

71

FOR OFFICIAL USE ONLY

FOR OFFICIAL USE ONLY

the genome. Apparently, the detected disturbance in the nucleohistone structure connected with the appearance of denatured sections in irradiated DNA is the reason for the appearance of additional initiation points. The properties of complexes of nonhistone proteins of chromatin with DNA are described. Irradiated DNA binds nonhistone proteins more effectively than a native DNA. The capacity of nonhistone protein for a specific interaction with DNA is disturbed more easily under the effect of radiation than nonspecific binding. A correlation between radiation disturbance in the process of transcription and the rate of phosphorylation of chromatin cells was detected both in vivo and in vitro.

3 illustrations; 17 bibliographic entries.

UDC 577.391

THE ROLE OF LIPIDS IN RADIATION INJURY TO AND RESTORATION OF BIOMEMBRANES

Abstract of article by Kolomiytseva, I. K., and Medvedev, B. I.

Text The effect of irradiation of animals in lethal doses on the lipid structure of subcellular organelles and membranes of liver mitochondrias, biosynthesis of lipids of subcellular organelles and transport of lipids among organelles, as well as radiation disturbances in ion transport through the mitochondrial membrane, was investigated. Activation of the biosynthesis of structural lipids in the liver cells of irradiated rats, inhibition of the transport of phospholipids, activation of the transport of cholesterol, change in the lipid composition of subcellular organelles and inhibition of potassium transport through the mitochondrial membrane brought about by the disappearance of the lipid carrier were shown. It was detected that potassium transport through the mitochondrial membrane occurred with the participation of the lysoform of cardiolipin. An assumption about the participation of lipids in the postirradiation restoration of biomembranes was expressed.

4 tables; 2 illustrations; 13 bibliographic entries.

UDC 616.9-098

THE PROBLEM OF RADIOTOXINS. NATURE, BIOLOGICAL EFFECT AND ROLE IN POST-RADIATION FORMATION OF RADIOBIOLOGICAL EFFECTS

Abstract of article by Kopylov, V. A., Kuzin, A. M., Medvedev, A. I., and Yurov, S. S.

Text The latest experimental data devoted to the problem of formation in the cells of γ -irradiated tissues of low molecular substances (radiotoxins) possessing a biological activity for the cell genome and biomembranes are presented. The investigation of this problem makes it possible

FOR OFFICIAL USE ONLY

FOR OFFICIAL USE ONLY

to understand both the general mechanisms of the inhibiting and stimulating effect of ionizing radiation and the problems of a possible utilization of irradiated food products.

4 tables; 6 illustrations; 11 bibliographic entries.

UDC 577.391+576.32

THE PROBLEM OF PROTECTION, SENSIBILIZATION AND RESTORATION

Article by Eydus, L. Kh., Veksler, A. M., Ganassi, Ye. E., and Plotnikova, Ye. D.

Text The present state of the problem of protection, sensibilization and restoration under the effect of radiation on divisible cells is analyzed. A new explanation of the biophysical mechanisms of nonspecific cell reaction to external effects bringing about a radioprotective effect is offered. The results of study of the dynamics of development of nonspecific cell reaction in correlation with the protective effect, as well as data demonstrating the connection between modification and a change in the volume of reparation of the potential injuries to unique cell structures, are presented.

10 illustrations; 22 bibliographic entries.

UDC 577.391+519.95

KINETIC PATTERNS AND THEORETICAL ANALYSIS OF FORMATION OF RADIATION INJURY TO THE ORGANISM

Abstract of article by Akoyev, I. G., and Tyazhelova, V. G.

Text An analysis of the basic indicators of formation of radiation injury made it possible to single out the difference in injury of structural-morphological and controlling signs. The sequence on a hierarchic plane and patterns in the development of injury and restoration on an intracellular and tissue level were established by cybernetic methods for the former. The effect of the second group of factors on the processes of restoration was disclosed.

12 bibliographic entries.

UDC 577.3

THE CONDITIONS, MECHANISM AND PHYSIOLOGICAL SIGNIFICANCE OF THE YIELD OF CALCIUM IONS FROM MITOCHONDRIA

Abstract of article by Gyul'khandaryan, A. V., Gaynutdinov, M. Kh., and Yevtodiyenko, Yu. V.

FOR OFFICIAL USE ONLY

/Text/ It was shown that the Ca^{2+} -selective electrode could be successfully used for an investigation of the kinetics of transfer of ions Ca^{2+} through the membrane of mitochondria. It was shown that in the presence of ATP an active transport of ions Ca^{2+} in mitochondria could be carried out against the electrochemical potential, because potassium was transported against the concentration gradient when, in practice, the membrane potential was equal to zero. A series of model experiments with isolated mitochondria for an investigation of the characteristics of ions Ca^{2+} from mitochondria according to the concentration gradient was conducted. It was shown that under the conditions of binding of ionized potassium in extramitochondrial space by addition to EGTA the yield of ions Ca^{2+} according to the concentration gradient was associated with an increase in the concentration of ATP. Under these conditions the yield of ions Ca^{2+} from mitochondria led to the generation of the membrane potential.

The reversibility of the damaging effect of ions Ca^{2+} on the function of mitochondria under the conditions of the so-called "spontaneous yield" of ions Ca^{2+} , which was accompanied by the swelling of mitochondria and a complete loss of energy conjugation, was investigated in another series of experiments. The addition of EGTA led to the restoration of the capacity of mitochondria for the generation of the membrane potential in the presence of oxidation substrates. Restoration increased in the presence of Mg^{2+} and ATP.

8 illustrations; 5 bibliographic entries.

UDC 577.3

THE ISOLATION AND RECONSTRUCTION ON AN ARTIFICIAL PHOSPHOLIPID MEMBRANE OF K^{+} -TRANSPORTING SYSTEM OF MITOCHONDRIA

/Abstract of article by Kudzina, L. Yu., Medvedev, B. I., Sotnikova, V. S., and Yevtodiyenko, Yu. V./

/Text/ It was shown that during the preincubation of mitochondria in vitro at room temperature a decrease in the rate of ATP synthesis and a yield of ions K^{+} from mitochondria occurred. The compounds inducing oxidating processes (ions Fe , H_2O_2 and so forth) and phospholipid hydrolysis (ions Ca and alkali pH) increased the K^{+} -conductivity of the mitochondrial membrane. Furthermore, antioxidants and inhibitors of phospholipase (local anesthetics binding Ca^{2+} in a complex) lowered the permeability of the membrane for K^{+} . On the basis of the assumption that the transport of K^{+} through the membrane catalyzed the products of oxidation and hydrolysis of phospholipids preparations of mitochondrial phospholipids were prepared. Bilayer lipid membranes were formed from the preparations obtained. It was established that the extract of mitochondrial lipids contained a fraction inducing the transfer of ions K^{+} through bilayer lipid membranes. K^{+} -transporting compounds migrated during the thin-layer chromatography of

FOR OFFICIAL USE ONLY

FOR OFFICIAL USE ONLY

extracts between phosphatidylethanolamine and cardiolipin and their localization on a chromatogram coincided with the localization of lysocardiolipin.

4 illustrations; 3 bibliographic entries.

UDC 591.104

PROPERTIES OF MEMBRANE ACTIVE SUBSTANCES ISOLATED FROM ANIMAL TISSUES AFFECTING OXIDATIVE PHOSPHORYLATION AND TRANSPORT OF IONS THROUGH MEMBRANES

Abstract of article by Mironova, G. D., Pronevich, L. A., Fedotcheva, N. I., and Sirota, T. V.

Text Three substances possessing a specific effect on oxidative phosphorylation and ion transfer through an artificial lipid membrane--separator and activator of the transfer of one- and two-valent cations--were separated from the tissues and blood of various types of animals. It was found that their quantitative distribution in tissues depended on the level of energy metabolism and could change in various physiological states of the organism, that is, cold adaptation, physical load and so forth. The properties of isolated membrane active factors were discussed from the point of view of their role in the processes of regulation of ATP synthesis in mitochondria.

1 table; 4 illustrations; 5 bibliographic entries.

UDC 591.104

THE PARTICIPATION OF PEROXIDASE AND OF THE EFFECT OF OXYGEN NOT MEDIATED BY CYTOCHROME OXIDASE IN THE PROCESSES OF ATP FORMATION

Abstract of article by Mironova, G. D., and Sirota, T. V.

Text Experimental data pointing to the participation of peroxidase systems in processes connected with the synthesis of energy rich compounds in mitochondria are presented.

It is shown that in the process of phosphorylation the amount of hydrogen peroxide in mitochondria is reduced and the activity of peroxidases is increased. The peroxidase added to mitochondria produces a conjugating effect and the inhibition of peroxidase leads to the suppression of breathing. When peroxide is excluded from the incubation medium, inhibition of ATP-synthetase and ATP-ase activity is noted. Antioxidants also inhibit the isolated ATP-ase. The fraction of oligomycin sensitive ATP-ase is the place of peroxidase localization.

5 illustrations; 23 bibliographic entries.

75

FOR OFFICIAL USE ONLY

FOR OFFICIAL USE ONLY

UDC 591.104

REACTIONS OF THIOL-DISULFIDE TRANSITION IN OXIDATIVE PHOSPHORYLATION

Abstract of article by Mironov, G. P.

Text Clarification of the role of sulfur containing groups of compounds participating in the processes of energy transformation in mitochondria was the object of this investigation.

The presence in mitochondria of a large (up to 50% of the total amount) mobile fraction of sulfur containing groups, in which changes in the level of SH- and S-S components correlating with each other occurred and whose general change was closely connected with the indicators of conjugation and metabolic state of mitochondria, was discovered by means of a sensitive fluorimetric method of selective determination of sulfhydryl and disulfide groups in their joint presence.

The reactions of thiol-disulfide transition observed in functioning mitochondria at least partially can be connected with the manifestation of enzymatic activity of mitochondrial ATP-synthetase. Apparently, peroxide compounds are the other participants in these oxidation-reduction reactions.

It is suggested that there is a need for the occurrence of reactions $SR \rightleftharpoons S-S$ -transition--as sources of oxidation-reduction and conformational transformations--for the realization of the processes of synthesis and hydrolysis of energy rich compounds in mitochondria.

Peroxide compounds, whose level can be regulated by the Fe^{2+}/Fe^{3+} relationship, are the other participants in the reactions of dithiol-disulfide transition.

1 table; 5 illustrations; 22 bibliographic entries.

UDC 577.3

REGULATORY INTERCONNECTION OF THE RESPIRATORY CHAIN AND ATP-ASE IN MITOCHONDRIA

Article by Fishov, I. L.

Text A reciprocal relationship between the kinetics of breathing and hydrolysis of ATP, which was interpreted as evidence of the regulation of activity of respiratory and ATP-ase proton pumps of a magnitude of a membrane potential difference, was detected during an investigation of the ATP-ase activity of breathing mitochondria under the conditions of a weak separation. Respiratory standstill by an inhibitor or by the exhaustion of oxygen led to a slow decrease in ATP-ase activity regardless of the degree of separation.

4 illustrations; 14 bibliographic entries.

76
FOR OFFICIAL USE ONLY

FOR OFFICIAL USE ONLY

UDC 591.104

NORM AND PATHOLOGY FROM THE STANDPOINT OF ENERGETICS OF MITOCHONDRIA

Abstract of article by Kondrashova, M. N., Yevtodiyeiko, Yu. V., Mironova, G. D., et al.

Text An original approach to the study and normalization of pathological states from the standpoint of regulation of the energy metabolism of mitochondria is presented. Pathological states are classified as deviations from the middle zone of the norm and toward the weakening and strengthening of mitochondrial energy processes. The weakening of energy reactions of mitochondria is normalized by energy producing substances--succinic acid, carrier of potassium ions with an effect similar to that of oligomycin and activators of succinate dehydrogenase with an effect similar to that of rotenone--dimedrol and so forth. The hyperergic reactions of mitochondria are restricted by the natural polypeptides of endocrine glands inhibiting the respiratory chain and by endogenous regulators of mitochondria--activator of the transport of potassium ion and activator of the transport of hydrogen ion acting like a separator. The use of substances regulating mitochondrial processes for the normalization of pathological states is proposed.

2 tables; 11 illustrations; 52 bibliographic entries.

COPYRIGHT: Izdatel'stvo "Nauka", 1977
[8044/0351-11,439]

11,439
CSO: 8044/0351

FOR OFFICIAL USE ONLY

UDC 577.3:539.12.04

RADIOACTIVE AGENTS AND WOUNDS

Moscow RADIOAKTIVNYYE VESHCHESTVA I RANY in Russian 1979 signed to press
24 Aug 79 pp 2, 3-4, 254-255

[Annotation, foreword and table of contents from book by Leonid Andreyevich
Il'in and Aleksandr Tikhonovich Ivanikov, Atomizdat, 2350 copies, 255
pages]

[Text] The book deals with one of the pressing problems of contemporary
radiobiology--protection of the organism from the action of radioactive
substances. Materials for the first time are systematized and generalized
on the metabolism of radioactive substances coming in contact with wound
or burn surfaces. Ideas are presented on the mechanism of absorption
of radionuclides through the trauma of the skin, and recommendations
are made on diagnosis of contamination of wounds with radioactive sub-
stances.

On the basis of personal experiments and data in the literature, general
principles have been worked out for providing assistance in contamination
of wounds with radioactive substances and recommendations are given on
decontamination in contamination of wounds and burns with radionuclides.

The book is intended for specialists working in the field of radiation
medicine, physicians-hygienists, surgeons, occupational pathologists
[profpatologi] and radiobiologists.

51 figures. 57 tables. 197 references.

FOR OFFICIAL USE ONLY

FOR OFFICIAL USE ONLY

Foreword

In recent years, a large number of studies have been done on the development of principles and means of modification of the metabolism of radionuclides in the organism. Data have been obtained on the principles of metabolism of radionuclides, and a number of effective preparations have been created for the prevention of incorporation and stimulation of removal of many radionuclides from the organism. Radiation-hygiene studies conducted in industry and in laboratories show the role of different pathways of possible entry of radioactive substances into the organism of occupational personnel.

It should be emphasized that up to the present time three ways of radionuclides affecting the organism have been traditionally considered: through inhalation, perorally and percutaneously (on uninjured skin covers). But at the present time increasing attention is being given to hygienic and clinicoradiometric assessments of the wound pathway of radionuclides entering the organism. Some researchers put this pathway of entry of radionuclides into the organism on the same level as inhalation, which plays a leading role in the process of man's contact with radioactive materials.

In the last decade many experimental and clinical studies dealing with a discussion of separate aspects of this problem have been published.

In the book being proffered to the reader, a first attempt has been made to examine the problem on the plane of analysis of two interrelated questions; general laws of behavior of radionuclides on coming in contact with damaged skin covers and principles, tactics and methods of given first and emergency aid in comparable types of incidents. The results of many years of research by authors serve as the basis; its program provides for the study of special features of the metabolism of radionuclides as representatives of elements of groups of D.I. Mendeleev's periodic system (I--¹³⁷Cs, II--^{98.90}Sr, III--¹⁴⁴Ce, VI--¹²⁰Po, VII--¹³¹I, transplutonium elements--²⁴¹Am). In addition to personal materials of researches, data include all the information obtained from other authors accessible to us.

We studied the special features of the behavior of radionuclides in the field of trauma, the character and level of transcutaneous resorption in subsequent traumatic injuries: excoriations and scratches of the skin, stab and cut skin and muscular wounds, thermal and chemical burns of the skin. Various methods and means of dealing with radioactive contamination were used in the experiments. Many findings were obtained for the first time.

The generalization of personal and literature information makes it possible, we believe, to make a number of valid judgments on the general principles of behavior of emitters in the field of trauma and to prognosticate the character of behavior of radionuclides of other elements--representatives of the corresponding groups of the periodic system.

FOR OFFICIAL USE ONLY

At the same time there is disclosed the practically complete absence of experimental data pertaining to other elements (radionuclides), particularly representatives of group II (subgroup of gallium), group IV, group V (subgroup of vanadium), group VI (including subgroup of chromium), VII (subgroup of manganese) and VIII (subgroup of platinum elements).

It would be appropriate here to direct attention to the necessity of a further study of the following important parts of the problem under examination: special features of the behavior of radionuclides and development of effective methods of prevention of radioactive contamination of microtraumas of skin covers and chemical burns of the skin.

The authors express their gratitude to associates at the laboratory G.A. Al-tukhova, A.G. Bazhin, I.M. Perfenova, B.A. Popov, Z.Ye. Turusina and M.A. Karpenkova for their assistance in the performance of researches.

Contents

Foreword	3
Chapter 1. Radiological Danger of Contamination of Wounds with Radioactive Substances	5
Chapter 2. Resorption of Radionuclides Through the Wound Surface	22
2.1. Materials and Methods of Research	23
2.2. Alkaline elements	28
2.3. Alkali Earth Elements	34
2.4. Rare Earth Elements	47
2.5. Phosphorus	50
2.6. Polonium	52
2.7. Iodine	67
2.8. Cobalt	72
2.9. Uranium	76
2.10. Plutonium	79
2.11. Transplutonium elements	89
2.12. On the Mechanism and Laws of Resorption of Radionuclides Through Wounds and Burns of the Skin	106
Chapter 3. General Principles of Prevention of Incorporation of Radionuclides on Them Coming in Contact with Traumatized Skin Covers	134
3.1. Initial Considerations	134
3.2. Temporary Restriction or Cessation of Drainage of Blood	135
3.3. Decontamination of Wounds	140
Bandaging Materials	140
Sorption Materials	144
Decontaminating Solutions	152

FOR OFFICIAL USE ONLY

3.4. On Decontamination of Burns of Skin Contaminated with Radioactive Substances	169
3.5. Surgical Treatment of Wounds and Burns of Skin Contaminated with Radioactive Substances	191
3.6. Decorporation of Radionuclides Resorbed in Wounds	196
3.7. Clinical Experience of Treating Wounds Contaminated with Radioactive Substances	206
Chapter 4. Questions of Organization and Tactics of Rendering Aid in Instances of Radioactive Substances Getting into Wounds and on Burn Surfaces	225
4.1. General Comments	225
4.2. Providing Aid at Place of Accident	226
4.3. Volume of Medical Aid at a Health Center	227
4.4. Medical Measures in a Specialized Department	229
4.5. Radiometry of Wounds Contaminated with Radioactive Substances	234
4.6. Determination of Content of Plutonium in Wounds	241
List of Literature	241

COPYRIGHT: Ministerstvo zdravookhraneniya LatvSSR, 1977
[257-7697]

7697
CSO: 1840

FOR OFFICIAL USE ONLY

PREDICTION OF IONIZING RADIATION TRANSFER BY PHOTOMETRIC METHODS

Moscow PROGNOZIROVANIYE PERENOSA IONIZIRUYUSHCHEGO IZLUCHENIYA METODAMI FOTOMETRII in Russian 1979 signed to press 10 Oct 79 pp 2, 3-4, 113

[Annotation, introduction and table of contents from book by V. N. Mironov and Ye. A. Panov, Atomizdat, 1000 copies, 116 pages]

[Text] First the matter of the use of theoretical photometric methods and the theory of heat exchange for the transfer of ionizing radiation is considered and generalized. Theoretical photometry is used to analyze the radiation of volume sources and the characteristics of ionizing radiation transfer from sources with different geometrical shapes. The possibility of using photometric methods to predict the field of ionizing radiation is shown. Examples are given from the practice of design and study of nonuniformities in the biological shielding of nuclear power plants and research reactors.

This book is intended for engineers and scientific workers dealing with problems of radiation safety in nuclear power plants, the design and study of biological shielding in nuclear power plants, reactor installations, prototypes and testing units with sources of ionizing radiation. It may also be useful to students and post-graduates specializing in this field. 54 figures. 2 tables. Bibliography, 28 references.

Introduction

The study of the transfer of ionizing radiation is an integral part of research being conducted on the physics of ionizing radiations. The establishment and development of the theory of ionizing radiation transfer is based on a generalized Boltzmann equation, by means of which problems of neutron and gamma-quanta transfer in nonabsorbing, absorbing and dispersive media are solved. Advances in electrodynamics, astrophysics and other fields of physics were used in the development of the theory. But the methods of theoretical photometry and the theory of radiant heat exchange are not yet used to the proper extent in the physics of ionizing radiation transfer, even though light, heat and gamma-radiation are identical in nature. The generality of the principles of geometrical attenuation and absorption in a medium unites these forms of radiation. In many cases the angular distribution of a volume source is similar whether it be a luminous volume of ionized gas, an incandescent metal, or the active zone

FOR OFFICIAL USE ONLY

FOR OFFICIAL USE ONLY

of a nuclear reactor. The basis of theoretical photometry is the cosine law of radiation distribution at the surface of a radiation source. It is inherent to transfer processes of light, heat and ionizing radiations including gamma-radiation, neutrons, alpha and beta particles. The cosinusoidal surface source is universal. This source reflects the character of the angular distribution of particles escaping from a radiator surface at large angles relative to the surface normal.

The theoretical and experimental data reported in this book indicate the possible use of principles and methods of theoretical photometry (3, 24) in the physics of ionizing radiation transfer. In some cases the same methods developed in the theory of radiant heat exchange (24,25) are used.

This book generalizes the experience of the authors in applying the methods of photometry and the theory of radiant heat exchange to the solution of such practical problems as determining the source characteristics at the surface of volume radiators and predicting the radiation field from sources of different geometrical shapes and the transfer of ionizing radiation through channels, cracks and cavities in the biological shielding of reactors (1, 2, 4, 5, 9-19, 23, 26). The authors hope that the data reported in this book will help readers to creatively apply the principles and methods of theoretical photometry in different areas of the physics of ionizing radiation transfer.

Contents

Introduction 3

Chapter 1. General Information about Theoretical Photometry 5

 1.1. Radiation intensities for volume luminescence 6

 1.2. Analogs of photometric values 8

Chapter 2. Volume and Surface Sources of Ionizing Radiation 12

 2.1. A volume radiator with a nondispersive medium and uniform isotropic sources 13

 2.2. Volume sources of different shapes 16

 2.3. Generalizing the exchange of a volume source by surfaces 21

Chapter 3. Theoretical Photometry Methods in the Problem of Ionizing Radiation Transfer 24

 3.1. The irradiation coefficient. Properties of surfaces radiating according to the law of cosines 24

 3.2. The radiation vector 31

 3.3. The radiation vector field 34

 3.4. The method of contour integrals 38

 3.5. The algebraic method 42

 3.6. Radiation values at a local point of space 45

Chapter 4. Radiation Transfer in a System of Unshielded Surfaces 52

 4.1. Disks and Cylindrical surfaces 53

 4.2. Cylindrical surfaces 56

 4.3. Rectangular and planar surfaces 69

FOR OFFICIAL USE ONLY

FOR OFFICIAL USE ONLY

Chapter 5. Radiation Transfer in a System of Shielded Surfaces 72

- 5.1. Disks and cylindrical surfaces 72
- 5.2. Cylindrical surfaces 83
- 5.3. Rectangular and planar surfaces 93

Chapter 6. Examples of the Practical Use of Theoretical Photometry Methods
in the Physics of Reactor Shielding 97

- 6.1. Experimental determination of the angle of radiation distribution
at the surface of volume sources 97
- 6.2. Channels passing near the active zone of a reactor 101
- 6.3. The spreading component 104
- 6.4. Channels with shielding plugs 106

References 110

COPYRIGHT: Atomizdat, 1979
[433-9342]

9342
CSO: 1840

FOR OFFICIAL USE ONLY

FOR OFFICIAL USE ONLY

UDC: 621.039.58

RADIATION SAFETY AND SHIELDING OF NUCLEAR POWER PLANTS

Moscow RADIATIONNAYA BEZOPASNOST' I ZASHCHITA AES in Russian No 4, 1980
signed to press 15 Feb 80 pp 2, 3-4, 265-267

[Annotation foreword and table of contents from book edited by Yu. A. Yegorov, V. P. Mashkovich, Yu. V. Pankrat'yev, A. P. Suvorov and S. G. Tsypin, Atomizdat, 1150 copies, 272 pages]

[Text] New and original works are submitted that deal with radiation safety and shielding of AES [nuclear power plants], experimental and theoretical studies of shielding, which were performed in 1977-1978.

There is discussion of the results of studies of sources of radiation and waste from functional AES, methods of estimating the activity of coolants, accumulation of active nuclides in AES personnel and a number of other questions related to radiation safety of AES. There are descriptions of the results of theoretical and experimental studies of spread of radiation in shielding, programs for the design of shielding, and information is furnished about multigroup nuclear-physical constants. Several of the articles deal with shielding materials.

This book is intended for specialists concerned with radiation safety of AES, design and estimation of shielding, as well as undergraduate and graduate students in the relevant specialties.

There are 143 figures and 47 tables. Bibliography lists 313 items.

Foreword

This collection contains original works dealing with the study of radiation safety and shielding of nuclear power plants in the USSR in 1977-1978.

The unwaning interest of specialists in these matters is attributable to the ever increasing construction of AES and the desire to render them as safe as possible, for both service personnel and the public. The data published in the literature (see, for example, "Atomic Science and Technology in the USSR," Moscow, Atomizdat, 1977) indicate that, even now, the annual

FOR OFFICIAL USE ONLY

FOR OFFICIAL USE ONLY

dose to which personnel is exposed does not exceed, on the average, the maximum permissible level. The rate of active waste discharge from AES and, consequently, the dose burden on the public, also do not exceed permissible levels. However, the increase in number of AES and consequent involvement of an increasing number of people in servicing AES, and construction of AES in densely populated areas prompt specialists to search for additional means of lowering exposure of personnel and rate of active discharge of waste. The new "Sanitary Rules for Designing and Operating AES" are also oriented in this direction. The works included in this collection are the result of this search. The additional means of protection, which are unquestionably available, can and must be disclosed only through a comprehensive study of the sources of radiation at AES, the causes thereof, comprehensive study of AES as the source of radioactive substances in the environment, and this will help render AES even safer, from the standpoint of radiation.

Nor has interest waned in the study of shielding, examination of passage of radiation through different media, refinement of methods and programs for designing shielding, searching for and studying new shielding materials. The results of such studies are needed by practice, since perfect protection assures safe and convenient working conditions at AES.

The collection consists of four sections.

"Studies of Radiation Safety of AES" refer to work done at functioning AES in the USSR, as well as work dealing with methods of forecasting radiation sources and radiation conditions at AES, investigation of accumulation of radiation sources in the body and setting standards for exposure levels.

"Experimental and Theoretical Studies of Shielding" refer to articles on basic and applied problems of passage of radiation through various media, as well as methods of studying shielding.

"Methods and Programs for Designing Shielding" refer to new methods, new programs for determining the spatial and energy-related distribution of radiations in shielding.

"Studies of Shielding Materials" refer to works containing information about the properties of shielding materials when exposed to radiation.

In offering this collection of articles to the reader, the editorial board hopes that the information it contains will find practical application in solving problems of radiation safety and shielding of AES.

FOR OFFICIAL USE ONLY

Contents	Page
Annotation	2
Foreword	3
1. Studies of Radiation Safety of AES	5
Study of Effectiveness of Biological Protection of First Circuit of AES with VVER-440 [Water-Cooled Power Reactor, 440 MW] (Ya. A. Bychkov, V. A. Grigor'yev, I. A. Yengovatov, O. V. Koltun, V. A. Krest'yaninov, P. A. Lavdanskiy, A. M. Luzhnov, A. I. Rymarenko, N. F. Smorchkov and S. G. Tsypin)	5
Measurement of Flux Density and Spectra of Fast Neutrons in Reactor Channels of Second Unit of the Leningrad AES (A. L. Barinov, N. I. Bel'kovskiy, O. A. Koryakin, Yu. V. Orlov, M. V. Razumovskiy and V. G. Shevchenko)	14
Experimental Estimation of Specific Activity of Coolant in First Circuit of AES with VVER-440 According to ^{16}N Radioactive Nuclide (I. A. Bochvar, V. N. Vlasenko, A. N. Kozhevnikov, A. M. Luzhnov, A. I. Rymarenko and S. G. Tsypin)	23
Method for Estimating Localization of Radioactive Iodine in the Postaccident Period by Means of Sprinkler Systems (V. A. Kazakov, A. V. Tkachenko, V. F. Fedulov and S. G. Tsypin)	30
Use of Radiation Monitoring to Determine the Causes of Increased Discharge of Radioactive Gas-Aerosol Waste From AES with VVER reactor (V. S. Zhernov and T. S. Mordovskaya)	35
Estimation of Permissible Concentrations of ^{88}Rb , ^{89}Rb , ^{138}Cs and ^{139}Cs Radionuclides in Air (N. G. Gusev, A. Ya. Blekher, A. A. Moiseyev and I. L. Shalayev)	40
Radiation Heat Emission in Elements of the RBMK Reactor (V. N. Avayev, Yu. V. Garusov, Yu. E. Khandamirov, Ye. P. Yefimov, S. M. Belov and V. M. Dorofeyev)	50
Use of Technological Monitoring Instruments to Forecast Radiation Conditions at AES with VVER-440 (V. P. Romanov and S. G. Tsypin)	55
Results of Screening NVAES Personnel Using a Human Radiation Counter (M. P. Gerasimova and A. A. Moiseyev)	59
Study of Levels of α -Emitters in Some AES Media (N. P. Starodonova and A. N. Yefimova)	62
Solubility of Radioactive Aerosols at Nuclear Power Plants (A. M. Vorob'yev and A. N. Yefimova)	66
2. Experimental and Theoretical Studies of Shielding	70
Basic Experiment on Distribution of Neutrons in Heterogeneous Shielding of a Reactor (V. V. Bolyatko, M. Yu. Vyurskiy, V. P. Mashkovich, R. Kh. Nagayev, A. P. Prit'mov, V. K. Sakharov, V. S. Troshin and Ye. G. Tikhonov)	70

FOR OFFICIAL USE ONLY

	Page
Color Modeling of the Problem of Transfer of Ionizing Radiation Into Attenuating Medium With Heterogeneities (A. S. Iz'yurov, Yu. N. Kuz'min, N. Ye. Kurakin, V. N. Mironov and S. G. Tsypin)	78
Study of Optimum Compositions of Flat Iron and Water Shielding (A. A. Abagyan, A. A. Dorofeyev, A. A. Dubinin, V. I. Zhuravlev, Yu. A. Kurachenko and Yu. G. Fedorov)	86
Semiempirical Model for Calculation of Differential and Integral Characteristics of a Quasi-Albedo Type of Neutron--Gamma Quantum (A. A. Abagyan, T. A. Germogenova, A. A. Dubinin, V. I. Zhuravlev, V. A. Klimanov, V. P. Mashkovich and A. A. Stroganov)	94
Albedo Characteristics of Fast Neutrons for Two-Layer Deflectors (Yu. N. Borisov and B. V. Sazykin)	101
Albedo of Gamma Radiation for an Isotropic Point Source (Yu. A. Zinov'yev, Yu. V. Orlov and B. V. Sazykin)	107
Experimental Study of Neutron Distribution on the Earth-Air Boundary (Yu. I. Kolevatov, V. P. Semenov and L. A. Trykov)	112
Some Aspects of Development of the Multisphere Method for Neutron Spectrometry (V. P. Semenov and L. A. Trykov)	120
Effect of Geometry of Source and Shielding on Fast Neutron Distribution in Extended Media (D. L. Broder, K. K. Popkov, I. N. Trofimov and S. A. Tsvetkova)	134
Determination of Optimum Form of Shadow Shielding and Parameters of Radiation Field Shielded by the FORMA Program Using the Monte Carlo Method (V. L. Generozov, V. A. Sakovich and A. N. Khmylev)	142
Investigation of the Possibility of Using the Method of Integral Equations to Estimate Spatial and Angular Distribution of Neutrons (A. N. Barkovskiy and K. K. Popkov)	149
Transfer of Neutrons Into Hollow Part of a Cylindrical, Limited Shield (A. I. Vdovin, V. V. Karyukin, I. I. Loshchakov and V. I. Ostroumov)	162
Albedo Characteristics of Gamma Quanta for Two-Layer Deflectors (Yu. N. Borisov and B. V. Sazykin)	164
3. Methods and Programs for Designing Reactor Shielding	169
ATIKA, a Multigroup, Two-Dimensional Program for Designing Shielding (A. I. Bazykov, V. P. Zharkov and V. G. Kravchuk)	169
Use of Modifications of the Monte Carlo Method to Estimate the Field of Gamma Radiation in Three-Dimensional Geometric Shields (A. M. Zhezlov, V. A. Klimanov, A. S. Makhon'kov, V. P. Mashkovich and B. N. Meshcherin)	187

FOR OFFICIAL USE ONLY

FOR OFFICIAL USE ONLY

	Page
Complex RNZ-1 Program for Computer Forecasting of Fields of Neutron and Gamma Radiation in Hollow Channels of Different Types in Shielding (V. A. Klimanov, A. S. Makhon'kov and V. P. Mashkovich)	191
Multigroup Constants for the Output Unit of a Two-Dimensional Program for the Design of Shielding (A. I. Bazykov and V. P. Zharkov)	199
Development of Subgroup Method to Estimate Nonscattered Neutrons and Correct Differential Cross Section of Scatter With Consideration of Intragroup Spectrum (M. Yu. Vyrskiy, A. I. Ilyushkin, I. P. Markelov, M. N. Nikolayev, A. P. Prit'mov and M. M. Savos'kin)	209
High-Speed Set of Programs for Approximate Design of Shielding Against Radiation (A. A. Dubinin and Yu. A. Kurachenko)	219
Modification of Monte Carlo Method for Estimation of Passage of Gamma Radiation From Source With Wide Spectrum in Very Thick Shields (A. M. Zhezlov, V. A. Klimanov, A. A. Stroganov and B. N. Meshcherin)	227
Effectiveness of Axial Symmetry of Problem in Planning Reactor Shielding by the Monte Carlo Method (A. M. Zhezlov, V.A. Klimanov and B. N. Meshcherin)	232
One Criterion for Minimizing of Functional From Radiation Field, Calculated by the Monte Carlo Method (P. A. Barsov and V. A. Sakovich)	235
4. Studies of Shielding Materials	240
Radiation-Proof Concrete for Reactor Shielding (V. B. Dubrovskiy, V. V. Korenevskiy, L. P. Muzalevskiy, B. K. Pergamenshchik and Ye. B. Sugak)	240
Evaluation of Gas Emission From Concrete Under the Influence of Reactor Radiation (N. N. Alekseyenko, Ye. I. Blednykh, P. V. Volobuyev, Yu. A. Yegorov, A. P. Zyryanov and Yu. V. Pankrat'yev)	254
Experimental Study of Gas Emission From Polyethylene With Boron During Exposure to Gamma Radiation (N. N. Alekseyenko, P. V. Volobuyev, Yu. A. Yegorov, A. P. Zyryanov, Yu. V. Pankrat'yev and S. B. Trubin)	258

COPYRIGHT: Atomizdat, 1980
[002-10,657]

10,657
CSO: 1840

FOR OFFICIAL USE ONLY

FOR OFFICIAL USE ONLY

BIOLOGICAL ASPECTS OF RADIOACTIVE CONTAMINATION OF THE SEAS

Moscow BIOLOGICHESKIYE ASPEKTY RADIOAKTIVNOGO ZAGRYAZNENIYA MORYA in Russian 1978
signed to press 11 Aug 77 pp 2-6, 159-160

[Annotation, foreword, and table of contents from book by Lev Aleksandrovich Pertsov,
Atomizdat, 1978, 1950 copies, 160 pages]

[Text] The book summarizes the numerous data available on migration of natural radionuclides in water, their accumulation in marine flora and fauna, and the formation of natural dose loading in various species of aquatic organisms. The points of entry of artificial radionuclides into seas and oceans and characteristic accumulation of radionuclides of an anthropogenic origin in aquatic organisms are described. The mechanism of action of ionizing radiation on the most important marine plants and animals is elucidated. Applied aspects of marine radioecology are discussed in terms of radiological situations and goals of radioecological forecasts upon the entry of radionuclides into the hydrosphere.

There are 43 illustrations, 43 tables, 376 references.

Foreword

The development of atomic power engineering, on the one hand, and the growing danger from man's widening influence on the biosphere which has now assumed global proportions, on the other hand, require a scientific analysis due to the consequences of the shift from fossil fuel to nuclear power. The most important of the economic, sociopolitical, psychological, and ecological problems arising from the present transition from fossil fuels to nuclear power is the effect of nuclear power engineering on the environment.

The increased natural radiation background caused by man's exploitation of nuclear energy has led to the development of a number of scientific disciplines such as radioecology, radiation hygiene, and nuclear meteorology, which study all aspects of the behavior of radionuclides in the environment and the effects of ionizing radiation on environmental objects and humans. Radiological research has shed considerable light by now on the principal characteristics of the migration of the radiologically most important nuclides in natural ecosystems, including marine associations, and on the effects of irradiation on living organisms, including marine plants and animals. As a result, it is possible to assess the radiation

FOR OFFICIAL USE ONLY

FOR OFFICIAL USE ONLY

situation in different parts of the world and collect scientific information for use in forecasting the possible radiological consequences of the entry of radioactive substances into the environment.

The earth's hydrosphere has been the object of intensive radioecological research during the last 15 to 20 years. The problems of marine radioecology are of interest for a number of reasons. First, the seas and oceans are the main points of entry of radionuclides (fallout, runoff of liquid and solid wastes from land). Second, some species of organisms characterized by comparatively high radiosensitivity inhabit the hydrosphere. Third, the specific physicochemical properties of the hydrosphere ensure an exceptionally high accumulation of some radionuclides in marine plants and animals (the coefficients of accumulation of certain radionuclides in aquatic organisms are in the tens and hundreds of thousands, i.e., the concentrations of the radionuclides in these organisms are 10^4 to 10^5 times higher than in the water). In general, the accumulation of radioactive substances in living things in water relative to the environment is much higher than on land. Fourth, in recent years the World Ocean has steadily grown in importance as a source of man's food resources, and in the not too distant future the hydrosphere is likely to become the main supplier of proteins and other valuable nutrients. Hence the accumulation of radionuclides in sea foods is a matter of major concern. Fifth, advances in marine radioecology virtually guarantee the solution to such major problems as the removal of radioactive wastes. Mankind has had unfortunate experience with the uncontrolled discharge of radioactive wastes into the World Ocean. The growing concern with the fate of the biosphere and particularly the hydrosphere urgently requires a ban on the uncontrolled discharge of toxic, including radioactive, substances into the seas and oceans. Helping to solve the problem, specifically, the regulation, limitation, or complete banning of such discharges is the conclusion of some international agreements (e.g., the 1972 London Convention) of which the Soviet Union was the initiator and active participant. The basic unwavering position of our country, which favors worldwide efforts to keep the World Ocean clean on the basis of international cooperation and agreements, is well known.

This book deals with all the timely problems of marine radioecology mentioned above. It can be divided into more or less three parts. The first (chapters 1 to 4) describes the sources of the natural radiation background in the seas, the mechanism of accumulation of radionuclides in aquatic organisms, and the quantitative characteristics of the radiation load in marine plants and animals from the natural radiation background. The second part (chapters 5 to 7) sets forth the characteristics of radioactive contamination of aquatic organisms and describes the injury they suffer from radiation. The third part (chapters 8 and 9) takes up the practical aspects of marine radioecology as it examines various radiation situations and discusses radiological monitoring of the hydrosphere.

The most significant aspects of radioactive contamination of the seas are fully discussed from the biological standpoint. Thus, a reader interested in protecting the environment against radioactive contamination will get a clear idea of the migration of radioactive substances in seas and oceans and of the effect of ionizing radiation on marine life.

FOR OFFICIAL USE ONLY

FOR OFFICIAL USE ONLY

It is characteristic of nuclear power engineering that serious attention was paid from the very beginning of its development to the ecological aspect of its influence on man's environment, including the watery envelope of the planet. It is possible, therefore, that the world may escape the undesirable side effects on nature that once resulted from the development of certain branches of industry.

The forecasts and scientific assessments of the worldwide use of nuclear energy on a steadily increasing scale, chiefly nuclear power engineering, are quite optimistic from the ecological standpoint. However, continued research is needed in the field of radioecology and radiation hygiene in order to obtain a deeper understanding of the consequences of the increasing use of nuclear energy. Only then will it be possible to guarantee both the complete satisfaction of the growing energy requirements based on nuclear fuel and the preservation of the purity of the biosphere of which the earth's hydrosphere, a unique formation of permanent value, is an inseparable part.

From the author

A great deal of information is available regarding the effect of radioactive contamination of the seas on their inhabitants, but the main radiobiological dose-effect dependence, now used to evaluate quantitatively the action of ionizing radiation on living organisms, has not been adequately studied. Most reports deal with the radionuclide concentration-effect relationship from which the intermediate element, the tissue dose, was omitted, thereby rendering the research unconvincing and the results incomparable. We attempted to fill the gap with our book. For this purpose we discussed both our own data and published material in the light of the functional relationship existing between the nature of the reaction of an aquatic organism and ionizing radiation dosage.

In evaluating the effects of low level doses of radiation, we emphasized the fact that natural and artificial radionuclides are unevenly deposited in tissues. We examined in this connection the creation of natural and anthropogenic radiation loads in aquatic organisms and their quantitative characteristics.

In keeping with the main purpose of the book, the sections based on published data were arranged according to the analytical principle and they include what we regarded as the most valuable and rigorous works. Hence we do not claim for them the exhaustive completeness of a typical review of the literature.

Contents	Page
Foreword	3
From the author	6
Chapter 1. Ionizing Radiation in the Biosphere	7
1.1. Components of a radiation field	7
1.2. Interaction of space radiation factors with the ocean	9
1.3. Contribution of continental radiation factors	12

FOR OFFICIAL USE ONLY

FOR OFFICIAL USE ONLY

Chapter 2.	Natural Activity of the Oceans	17
2.1.	Radionuclides in ocean water	17
2.2.	Radiation characteristics of the seas around the Soviet Union	21
2.3.	Radioactivity of bottom deposits	25
Chapter 3.	Radioactivity of Aquatic Organisms	29
3.1.	Radionuclides Uptake	29
3.2.	Radioactivity of the marine flora	30
3.3.	Radioactivity of zooplankton and zoobenthos	32
3.4.	Radioactivity of nectonic organisms	33
Chapter 4.	The Natural Radiation Background Dose	39
4.1.	Factors affecting dose formation	39
4.2.	Dose rate of external irradiation	39
4.3.	Dose rate of internal irradiation	41
4.4.	Vagueness of the indices used to calculate the internal irradiation dose	46
Chapter 5.	Sources of Radioactive Contamination of the Seas	48
5.1.	General characteristics of the sources of radioactive contamination of the seas	48
5.2.	Characteristics of the sources of radioactive contamination of the seas	52
5.3.	Physicochemical properties of fission products	59
5.4.	Principal neutron activation products	63
Chapter 6.	Characteristics of Contamination of Aquatic Organisms by Anthropogenic Radionuclides	67
6.1.	Mechanisms of accumulation of radionuclides in the tissues of aquatic organisms	67
6.2.	Accumulation of radionuclides in planktonic organisms	74
6.3.	Accumulation of radionuclides in benthic organisms	80
6.4.	Accumulation of radionuclides in fish	84
Chapter 7.	Reaction of Aquatic Organisms to Irradiation	90
7.1.	Mechanisms of radiation effects	90
7.2.	Radiosensitivity of living organisms	92
7.3.	Radiation reactions of algae and invertebrates	96
7.4.	Radiation effects on fish embryos and larvae	101
7.5.	Radiation injury to mature fish	107
Chapter 8.	Radiation Situations on the Seas	112
8.1.	Radioactive cloud	112
8.2.	Modern radiation situation	115
8.3.	Radiation situation on the Pacific Ocean after the thermometer blast of 1 March 1954	121
8.4.	Radiation situation following an accident to a ship's nuclear reactor	125

FOR OFFICIAL USE ONLY

FOR OFFICIAL USE ONLY

Chapter 9. Objectives of a Radioecological Forecast and Its	
Starting Data	133
9.1. Main content of a forecast	133
9.2. General characteristics of the data used for forecasts	135
9.3. Plan for a radioecological survey of a body of water	136
9.4. Some data for a method of forecasting	138
Bibliography	142

COPYRIGHT: Atomizdat, 1978
[259-5214]

5214
CSO: 1840

- END -

FOR OFFICIAL USE ONLY

FOR OFFICIAL USE ONLY

JPRS L/9501

23 January 1981

USSR Report

LIFE SCIENCES

BIOMEDICAL AND BEHAVIORAL SCIENCES

(FOUO 1/81)



FOREIGN BROADCAST INFORMATION SERVICE

FOR OFFICIAL USE ONLY

NOTE

JPRS publications contain information primarily from foreign newspapers, periodicals and books, but also from news agency transmissions and broadcasts. Materials from foreign-language sources are translated; those from English-language sources are transcribed or reprinted, with the original phrasing and other characteristics retained.

Headlines, editorial reports, and material enclosed in brackets [] are supplied by JPRS. Processing indicators such as [Text] or [Excerpt] in the first line of each item, or following the last line of a brief, indicate how the original information was processed. Where no processing indicator is given, the information was summarized or extracted.

Unfamiliar names rendered phonetically or transliterated are enclosed in parentheses. Words or names preceded by a question mark and enclosed in parentheses were not clear in the original but have been supplied as appropriate in context. Other unattributed parenthetical notes within the body of an item originate with the source. Times within items are as given by source.

The contents of this publication in no way represent the policies, views or attitudes of the U.S. Government.

COPYRIGHT LAWS AND REGULATIONS GOVERNING OWNERSHIP OF MATERIALS REPRODUCED HEREIN REQUIRE THAT DISSEMINATION OF THIS PUBLICATION BE RESTRICTED FOR OFFICIAL USE ONLY.

FOR OFFICIAL USE ONLY

JPRS L/9501

23 January 1981

USSR REPORT
LIFE SCIENCES
BIOMEDICAL AND BEHAVIORAL SCIENCES
(FOUO 1/81)

CONTENTS

ADVANCED BIOTECHNOLOGY

The Development of Molecular-Biological Research and Multilateral Cooperation	1
Some Questions of the Theory of Swimming of Fishes and Dolphins	8
Book on Biological Bases of Behavior Control of Fish in Flowing Water	13
Applied Mathematics in Biology	24

ADVANCED MEDICAL TECHNOLOGY

Mathematical Descriptions of Cardiac Bioelectrical Activity	27
Applications of Focused Ultrasound	30
Monograph Analyzes Cryogenic Preservatives	35
Lasers in Traumatology and Orthopedics	38

ENVIRONMENTAL HAZARDS

Radiation Exposure, Reduction of and Methods for Chemical Protection	41
Radiation Injury Diagnosis Based on Analysis of Blood Nucleic Acids	50
Biophysics of Complex Systems and Radiation Injuries	55

- a - [III - USSR - 21a S&T FOUO]

FOR OFFICIAL USE ONLY

Radioactive Agents and Wounds	78
Prediction of Ionizing Radiation Transfer by Photometric Methods	82
Radiation Safety and Shielding of Nuclear Power Plants	85
Biological Aspects of Radioactive Contamination of the Seas	90

-b-

FOR OFFICIAL USE ONLY

FOR OFFICIAL USE ONLY

ADVANCED BIOTECHNOLOGY

UDC 577.23

THE DEVELOPMENT OF MOLECULAR-BIOLOGICAL RESEARCH AND MULTILATERAL COOPERATION

Moscow VESTNIK AKADEMII NAUK SSSR in Russian No 6, 1980 pp 82-88

[Paper presented by Academician J. Říman of the Czechoslovak Academy of Sciences at the XI Meeting of Representatives of the Academies of Sciences of the Socialist Countries in Tallinn]

[Text] The topic of this presentation is closely related to one of the most important tasks of bilateral and multilateral cooperation among socialist countries in the field of natural sciences, which is to ensure the foremost development of the most promising scientific investigations. Specifically, the discussion will focus on the necessary, in our opinion, measures that must be taken to ensure the development of molecular-biological research currently being coordinated by the New Program of Multilateral Cooperation.

As part of the topic which interests us, we would first like to briefly characterize the goals and methods of those studies which are basically molecular-genetic in nature. In general the goal of this research is to explain the molecular basis of the various functions of biological systems--from the simplest forms, i.e., functionally active biological macromolecules (nucleic acids and proteins) and molecular complexes (nucleoproteides and phages, viruses, procaryotic and eucaryotic cells to multicellular plant and animal organisms.

Biological phenomena, which serve as the subject of molecular biology, are simultaneously studied as phenomena by other biological disciplines. This involves the fundamental behavior of living systems, such as nourishment, growth, reproduction, mobility, irritability, secretability and specific characteristics such as infectability, resistance, differentiation, abnormal cell transformations, immunity and tissue histocompatibility as well.

The spectrum of experimental methods used in molecular-biological research is very wide and attests to the complexity of the problems being investigated.

Molecular-biological analysis, based on the biochemistry of nucleic acids and proteins, requires, in addition to complex physical-chemical and physical methods, x-ray diffraction techniques, neutron scattering and nuclear magnetic resonance, and now, mathematical models, not only the necessary equipment but also a wide assortment of special reactants, enzymes and radioactive isotopes. The application of this arsenal of techniques can be effective only if there is a well characterized experimental biological model, whose value increases the more its genetic structure is defined.

FOR OFFICIAL USE ONLY

FOR OFFICIAL USE ONLY

It is necessary to emphasize the qualitative specifics of the experimental model in molecular-biological research in comparison to that used in other areas of biological research. If the model is biologically and genetically simple enough, then it becomes not only the subject of the research, but its instrument as well, since it becomes necessary at all stages of research - from the statement of the problem to the interpretation of the results. This approach allowed us to postulate the existence of a nucleotide triplet as the basic unit of the genetic code some 20 years ago, while direct biochemical proof of this was obtained only in 1961.

In the last decade, the application of this relatively simple experimental biological model was partially responsible for the transformation of oncogenic viruses and their host cells into valuable tools in the study of not only malignant cell changes but of several normal cell functions and the structure of cell genome as well. Therefore we now have numerous data on the molecular basis of virus and microbe functions.

Today this approach, together with the wide application of recombinant DNA techniques as well as the whole complex of immunological, immunogenetic, cytological, physico-chemical analysis and mathematical models, offers wide possibilities for the study of the molecular basis of fundamental and specialized functions of eucaryotic cells, among these human cells. This is supported by the wealth of new data obtained in the past few years which have substantially changed our ideas.

This in part includes the data on the dual role of biological molecularly functioning elements, i.e., those transmitted in replication and those replicating in transmission, and data on nucleases in replication (after the discovery of functioning macromolecule complexes).

These are also data obtained by virtue of the discovery of reversible transcriptase (1970) and the restriction enzymes, and later by the development of techniques for determining DNA and RNA sequences, by obtaining recombinant DNA, in other words, data obtained by virtue of the application of the technology of genetic engineering (after 1972).

In addition, these are new data on the "maturity" of the information transcript and primarily on the previously unknown technique of genetic recombination by combining information carrying RNA fragments after a preliminary breakdown of the molecular predecessors (splicing). This relatively simple technique of genetic recombination in eucaryotic cells, which was also probably the earliest evolutionary phenomenon, allows us to postulate that specifically RNA and not DNA serves as the primary information material. It is probable that a simple ribonucleotide (for example, nicotinamidadenine-dinucleotide) could have become in the process of evolution the primary information unit, the genetic monomer which served as the basis of cell metabolism as the precursor of reactions which are catalyzed by enzymes which evolved later. This new idea about the primary information function of RNA is not even contradicted by data on protein which recognize nucleotides. To these proteins, in addition to the already known lac-repressor, belong the enzymes of RNA-RNase II maturation which is a nucleotide and probably also the proteins of membranes which are responsible for the transport of specific nucleic acids within the cell.

FOR OFFICIAL USE ONLY