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MATHEMATICAL MODELING IN MEDICINE

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Problems of the mathematical modeling of human body organs are considered. Mathematical method allow to contract computational algorithms that is proved to be very important under diseases diagnostics.

Keywords: mathematical modeling, systems of the human body, gene level, medicine.

In this note we analyze the mathematical statements of problems that are currently used in the mathematical modeling of medical and biological problems.

The choice of some mathematical models in the description and research of medical facilities depends on the individual knowledge of the specialist and the characteristics of the tasks being solved. The object of research in modern mathematical modeling is practically all the basic organs and systems of the human body: (i) the circulatory and respiratory system; (ii) the central and peripheral nervous systems; (iii) the digestive system; (iv) the kidneys and the liver; (v) the musculoskeletal system; (vi) the organs of vision and the skin, etc. Processes taking place at the cellular and gene levels cause significant interest. In so doing, the mechanisms of the onset and progression of diseases are studied numerically. Mathematical models of organs and parts of body are based on mechanical models.

Mathematical methods appear to be not only the most accurate, but also allow to create the most correct construction of computational algorithms, which is very important under diseases diagnostics.

The mathematical approach not only facilitates an accurate quantitative description of a particular problem by constructing one or another suitable model, but also provides the way of solving the task.

This review presents the most typical mathematical models which are currently used for the given class of problems.

ALLELIC DISCRIMINATION AS A METHOD FOR THE ESTIMATION OF SOCIAL INTERACTION

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Allelic discrimination gives the possibility to indicate a single nucleotide polymorphism (SNP) that may shed a clearer light on the correlation between genetic variation and its effect on the observed phenotype. Current method was used for identifying the oxytocin receptor gene polymorphism, which determines the degree of sociality.

Keywords: allelic discrimination, single nucleotide polymorphism, sociality, social interaction, polymerase chain reaction, genotyping, population genetics.

In the last few years, the method of allelic discrimination has been developed in molecular genetics. The assay detects variants of a single nucleic acid sequence. Single nucleotide polymorphisms (SNP) are one of the most

common forms of human genetic variation [1]. SNPs are biallelic and occur about every 1,000 base pairs throughout the human genome. SNP are powerful markers for mapping genes that cause disease.

Oxytocin is a hormone of the hypothalamus, which is closely related to human social behavior. Intranasal administration of oxytocin improves the ability to differentiate the mental state of others and increases attention to the eye region of the other human and improves the ability to understand their mental state [2]. Genetic variations in the gene of the oxytocin receptor (OXTR) are related to individual differences in responses to social cues.

The SNPs are located in the non-coding regions of the oxytocin receptor gene. Most of the OXTR gene is the same for all people, but for different nucleotides, different versions of the gene may be present. The gene of this receptor exists in two versions: in a certain section of the DNA sequence there can exist either adenine (A-version) or guanine (G-version). It is believed that the presence of one or another variant of the gene corresponds to the psychological profile of a person: how resistant it is to stress and whether it is easy to be depressed.

Allelic analysis of discrimination classifies unknown samples as homozygotes (samples having only allele 1 or allele 2) and heterozygotes (samples having both allele 1 and allele 2). Analysis of AD measures the change in fluorescence of dyes associated with probes.

We analyzed the rs53576 single nucleotide polymorphism in the samples of buccal epithelium obtained from 20 people (age range 20–25 years). Their DNA was isolated using a standard protocol. Polymerase chain reaction (PCR) master mix was prepared by mixing PCR buffer, ddH2O, nucleotides (dNTPs), TaqMan probe (which contains two fluorescent dyes: ROX dye-specific for allele G and FAM dye-specific for allele A), two primers, enzyme Taq polymerase and DNA. Each DNA sample was analyzed in 3 repetitions together and the 4th one, without DNA, was the negative control.

The results had shown that from 20 people, 9 of them are GG homozygotes, 1 is AA homozygote, and 10 people are G/A heterozygotes.

The results obtained from RT-PCR were confirmed by incubating samples with the restriction enzyme (BamHI) and the number of fragments was determined using electrophoresis. In the case of GG homozygote – we had one fragment at 118 bp, AA homozygote – two fragments at 43bp and 75bp, and in the case of heterozygotes – 3 fragments at 43, 75 and 118bp.

Our results lead to an important insight about the great efficiency of the designed system of genotyping SNP. Selected primers, probes, fluorophores and quenchers matched to the probes work well, allowing to definitely distinguish both homozygotes and heterozygotes from each other. As a result, this method is capable to detect associations between the genetic variation and its effect on the observed phenotype (in our case, the correlation between OXTR gene rs53576 polymorphism and the degree of social interaction).Thus, the method of allelic discrimination can be used both for population analysis and for the estimation of SNP in individuals.

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BLOOD ADRENOCORTICOTROPIC HORMONE LEVEL IN WHITE MICE UPON HEAT AND COLD EXPOSURE

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In order to study the functioning of hypothalamic–pituitary–adrenal (HPA) axis under temperature stress, the level of adrenocorticotropic hormone in white mice plasma was investigated during exposure to various strengths of heat and cold. The study revealed that upon the lethal effect of temperature stress the degree of HPA axis response rapidly increases without returning to basal activity, while exposure to weaker ambient temperature effect evokes a short-term activation of the HPA axis with a subsequent return to the basal level.

Keywords: hypothalamic-pituitary-adrenal axis, heat stress, cold stress, adrenocorticotropic hormone.