HUNGARIAN STUDIES YEARBOOK
2019 (I)

sciendo

DOI: 10.2478/HSY-2019-0009

Genetics and Ethics: "Do not Go Alone"!

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ABSTRACT:
In his article "Genetics and ethics: 'Do not go alone'"! András Falus presents genomics as a network science triggering an entirely new trend in contemporary biology. Based on the advent of molecular biology the complete sequence of human and other genomes has been determined and since all information is available on internet-based databanks, the huge mass of data is being analysed by advanced methods of informatics. The author is focusing on the upcoming ethical aspect of genetics and genomics, then,in the second part of the article he answers the questions of the editor concerning the genetic approach to ethics and ethical approach to genetics.

Keywords: genomics, biotechnology, medical genetics, ethical limits, practical orientation.

In the last decades, by means of the rapid development in biomedical biology, we have a quickly growing genetic information on the structure and functions of the organisms, enhanced by the rapidly developing molecular biology research. The evolution of genetic knowledge has been dramatically accelerated by the "Human Genome Project" (HGP), uncovering the primary structure of whole human (and others') genome, financed and motivated by the US, the British government and others in a large international effort. The physical structure of the human genetic code, the linear sequence of four nucleotide "letters" represents the basic sequence of DNA. The new technologies of genetic engineering made it possible to find many defective gene variants in the background of certain diseases and to correct the defective gene in the close future, as well.

Nowadays, there are an increasing number of ethical and privacy rights issues related to genetic/genomic research, such those appearing in the process of genetic diagnostics and gene therapy. In order to understand the relevance of new results in human genetics, it is necessary

to clarify some basic scientific concepts (obviously without completeness) previously.

The living organisms are built up from carbohydrates, lipids, nucleic acids and protein molecules, actively preserving the compartmental independence from the environment of the organism and transforming chemical substances, metabolizing energy and changing the environment. The structure and function of the organisms are primarily determined by genetic information stored in the nucleus encoding proteins and regulatory nucleic acids that determine the overall structure and functions of the organisms.

Deoxyribonucleic acid (DNA) is a large (chromosomes, see later) macromolecule, each human cell nuclei contain about 2m (!) DNA in its genome. It consists of DNA nucleotide bases (adenine, guanine, cytosine, thymine), five-carbon desoxyribose sugar residues and phosphoric acid. The cells of the diploid tissues each contain 2x3.2 billion nucleotides per cell; haploid gametes (oocyte, sperm) contain "only" a single set of chromosomes containing 3.2 billion nucleotide bases (see below). We learned recently that within the DNA, only a small fraction (1.5%, about 3 cm from 2 m) encodes the amino acid sequence of the proteins (polypeptide chain) and the major part of DNA has mostly control functions. One has to consider, however, that the exact function of a large part of genetic material is far not precisely understood.

Ribonucleic acid (RNA) is a large molecule similar to DNA, built up from sugar molecules (ribose), organic bases (adenine, cytosine, guanine and uracil) and a phosphate groups. The DNA is transcribed either to RNA (messenger mRNA) molecules or a heterogeneous set of regulatory ("non-coding") RNAs. Messenger RNAs are translated to proteins. Our knowledge is gradually increasing on the role of (non-coding) regulatory RNA molecules (e.g. microRNA) proved to have regulatory function in protein synthesis.

Gene is the separate unit of inheritance, a section of the DNA molecule that determines the production of a protein. According to molecular interpretation, the gene is a section of the DNA molecule that encodes a polypeptide chain sequence by mRNA, thereby determining the information needed for the organism (e.g., structural genes). Likewise, the DNA sequences encoding regulatory RNAs (e.g. micro RNA) are nowadays called genes, as well.

We call genome the sum of the genetic material of the individual.

Chromosome: during cell division, the structure of the DNA chains in the nucleus changes. The DNA molecules in chromatin threads are spiralised, rolled, become shorter and thicker, and visible by light microscopy. People's somatic cells have 23 pair of chromosomes, of which one pair of chromosomes are called as sex chromosomes, XY in men, and XX chromosomes in women.

Diploid cells are somatic cells, which possess both paternal and maternal chromosomes. Within the organism, the transmission of genetic information (DNA) through cell proliferation occurs in the cell

division cycle. Avoiding the detailed description, it should be emphasized that the DNA of the nucleus is accurately duplicated, then the chromosomes are split up, so that by dividing two genetically identical cells are produced.

The mature male and female gametes are haploid cells with one chromosome set in each. During the fertilization, the two haploid chromosome sets of the two parents are fused, the fertilized egg (oocyte) already has both DNA strains. The fusion of haploid gametes initiates cell division, generating a unique, new life with genetic diversity that is different from the parent genes.

Mutations are suddenly occurring hereditary changes in the genetic material, DNA, with a frequency less than 1% in the population, based on international biobank data (Elger, Biller-Adorno, Mauron and Capron, ed., *Ethical Issues*; Gitter, "The challenges"). The change may affect the small portion of DNA (point mutation – SNP = single nucleotide polymorphism). One should consider, however that there are existing "error correction mechanisms" as well, which restore the original DNA structure. These molecular systems ensure a certain genome stability in higher organisms.

Gender-bound inheritance: in sex chromosomes there are several genes in addition to gender-determining genes. These attributes are inherited from gender.

Considering these basic concepts, we can proceed with the application of medical genetics results in medicine. The rapid development of biomedical biology, biotechnology, information technology and molecular nanotechnology has also accelerated genetic research, the main areas of application of which are biotechnology, diagnostics and therapeutics in practical medicine. All three areas are exploding and at the same time their specific costs are significantly reduced.

The arsenal of biotechnology (e.g. stem cell research – Cahill, "Stem cells") is growing fast, and today many biologically important substances (such as insulin, interferons, enzymes, plasma proteins are produced in living cells) available from synthetic sources. In addition, in recent years the advances in synthetic biology and the 3D production of biological structures are becoming increasingly *ready-for-market*. Series of highly sophisticated techniques (gene chips, micro beads, automatic –"new generation" DNA sequencing, gene editing technologies (CRISPR/CAS) are at the disposal of scientific community.

By means of these high-performance methods and genetic tools one may quickly and accurately determine genetic variants including inherited clinical risk factors. Molecular genetic tests can be used to identify genes or even short DNA threads in order to identify variations or mutations leading to genetic disorders. The novel molecular ("high-throughput") tests complete earlier approaches on chromosomes (cytogenetic technologies). The leap-to-date development of genetic diagnostics is also fundamentally completed by the analytical and optimization applications of information technology (IT) systems based on artificial

intelligence. Some of the results of gene diagnostics can be utilized in daily practice, using this molecular and IT toolkit, for example, forensic medicine, such as clarifying paternity or criminal issues.

The development of medical genetics is very promising in the future in day-to-day medical practice, so) "precision" medicine (Ormond and Cho, "Translating personalized medicine") allows us to choose the medication most suitable for the patient based on the genetic characterization of the subject before medication. The evolution of genetically-based biotechnology has enabled the development of new biological pharmacy therapies avoiding the genetically predictable adverse side-effects. This strategy provides significantly better efficacy than their predecessors and hope that future-to-treat diseases will be curable soon.

Genetic investigation (oncogenetics) have a major role in cancer research as well (Easton, Pooley and Dunning, "Genome-wide association study"). Most of the tumors are sporadic, i.e. not inherited, but genetic defect(s) are likely in the background of the somatic cells of a given tissue (lung, intestine, liver, etc.). The genetic defect from the sample of diseased tissue (or recently even from a single cell) can be detected and this new method of choice for advanced therapy is promoted. In our view this approach in oncology diagnostics is clearly ethical and is to be supported.

The second area for the application of medical genetics results in medicine is medical diagnostics for disease detection. Gene diagnostic tests are abundantly applied in diseases caused by a genetic disorder. It is especially recommended for individuals who were proved to carry a genetic disorder in their family, cumulatively. Promisingly, in addition to well selected pharmacological interventions it can be expected, that the data from genetic tests may find some modifications in lifestyle to prevent or at least delay the onset of the disease.

Newborn screening is used after birth to identify genetic disorders that can be treated at an early age. As an example, infants are screened in several countries after birth for phenylketonuria. This genetic disorder causes an intellectual disability if it is not treated by alimentary solutions.) Prenatal, pre-birth genetic testing cannot identify all possible hereditary disorders (Allys, Minear Berson, "Non-invasive prenatal testing"; Richardson and Ormond, "Ethical considerations"). For these studies genetic differences should be determined from the samples of fetal cells.

The method of pre-implantation genetic diagnostics (PGD) enabled the introduction of assisted reproduction technology. In this case, the genetic examination is carried out on 1 to 2 cells from a proliferating fertilized egg. In the case of a properly documented family history for high-risk cases of genetic disease in, one may make a decision to avoid implantation of an embryo bearing the genetic defect.

Results of genetic testing are communicated during the genetic counselling. There are differences between different cultures, due to traditions and general considerations about personal autonomy and individualism (Ruhnke, Wilson, Akamatsu, Kinoue, Takashima , Goldstein, Koenig, Hornberger and Raffin, "Ethical decision making"). Depending on the

purpose of the test, the genetic finding may confirm the diagnosis, but it must also take into account the history of the individual and his family, and the type of test performed. A person carrying a particular genetic mutation has a higher risk of a particular disease, but it does not necessarily indicate an infallible appearance of the disease. Informing people with a tendency to have some illness needs to be highly empathetic. Improper utilization of information obtained from genetic data may heavily harm the individual's rights, dignity and interests, and may be followed by discrimination and exclusion. Before genetic testing, it is important to emphasize in genetic counselling that some genetic features have only a certain, and probably not precisely known probability of developing certain diseases. Prospective parents with a tendency toward genetic disorder should also be prepared during pre-marriage counselling to address the problem solving.

There are ethical limits of gene diagnostics (Hébert and Saginur, "Research ethics review"; Ezzat, Ross, von Dadelszen, Morris, Liston, Magee; CPN Collaborative Group, "Ethics review"). Diagnostic genetic testing is always voluntary and a detailed information of the patient has to be followed by a consent (Dudenhausen, "Non-invasive"; Burns, "Writing the history"; Capron, Mauron, Elger, Boggio, Ganguli-Mitra and Biller-Andorno, "Ethical norms"; Falus and Oberfrank, "A genetikai kutatás [Genetic research]"). It is even more emphasized in the case if the data from the test is included in subsequent scientific research. Because of its genetic condition, no one can suffer any disadvantage, as it would be an unfair distinction between people by seriously hurting one's human dignity. Genetic examination of adults is not justified in cases where the disease to be detected is incurable or lifestyle-impaired.

The detection of a genetic disorder in an embryo or a foetus only makes sense if the disease is treatable, especially when treatment can begin in the pre-natal (prenatal) period (e.g. cortisol in the absence of the 21-hydroxylase enzyme). If the diagnostic activity supports to cure the disease, there is no or minimal ethical problem. If genetic diagnosis is not used to cure the disease, but to use the indication of abortion, then we face a serious ethical challenge. Pregnancy genetic testing can never justify eugenic abortion ("champion").

Pre-implantation Genetic Screening (PGS), designed to enhance the effectiveness of artificial insemination (in vitro fertilization, IVF), is clearly to be considered ethically. PGTA (prenatal genetic screening for aneuploidy) that is performed to prevent the transfer of a non-viable embryo should be allowed as it prevents a miscarriage that might have serious side effects for the mother.

Therapies for repairing abnormal genetic alterations – the third area of application of medical genetics results in medicine – have long been far less successful than the spectacular results of biotechnology and genetic diagnostics. There were at least three reasons for this.1) In the huge genome stock (see: 2x3.2 billion nucleotide letters, 2 m DNA/cell) to find the defect finding the problem of "needle in the haystack". 2)

Almost all abnormalities are caused by several genetic defects, and even most of the genetic disorders behind the pathophysiology.

3) Science has also provided molecular evidence that genetic (inherited or acquired) DNA level changes are influenced by many non-genetic (epigenetic) factors (nutrition, infection, hygiene, movement, stress, social and mental conditions etc.).

Taking all these into consideration, there is also a fundamental need for a more accurate "targeting". After a number of attempts, a whole new approach of genetic engineering (gene editing-CRISPR/Cas) has been developed a few years ago, which has made a leap-to-gain success in the previously practically unsuccessful method of finding a needle, and even in the possibility of fixing the problem.

The most important goal of genetic engineering is to know the location, operation and correction of the genes responsible for the development of certain diseases. In recent decades, genetic therapy has undergone tremendous development, but it has to be known that for the time being, it is still in an experimental stage. So far hundreds of studies have been conducted with a gene therapy method, especially in cases where the severity of the disease exceeds the risk of therapy. For ethical and medical reasons, patients can continue their treatment, so the success of gene therapy alone is not easy to judge.

The goal of gene therapy is to replace, modify, or remove a defective disease-causing gene variant with the nucleic acids delivered to the cell. By replacing the defective gene, some serious hereditary diseases may replace the function of the missing protein (e.g. enzyme). Transfer (i.e. inoculation) of the genes into the nucleus of the cells carrying the affected defective gene is most commonly done driven by viral vectors. One of the key question is to assure that the viral carrier is safe.

Somatic cell gene therapy in somatic (body) cells affects cells of an already developed, differentiated organism (e.g. lymphocytes, bone marrow cells) with the aim of restoring patient cell function. Serious diseases with a mutation of a gene have been reported successfully with gene therapy findings that currently have no other effective therapy (e.g. adenosine desaminese (ADA) deficiency, Lesch-Nyhan syndrome, cystic fibrosis, severe combined immunodeficiency (SCID)).

However, a distinction should be made between gene therapy in somatic cells and germ cell therapy. Gene therapy affecting the germ line modifies the genetic stock of gametes or embryos of early development (zygote or even multipotent cells). The effect of interfering with the genetic material of the gametes, zygotes or early embryos appears in every cell of the later organism and even in the offspring.

Much of the current genetic therapies are still in the experimental stage, despite the progress of the procedures (genetic engineering, see above), there has been no major breakthrough in this area, and so it is only in cases where the severity of the disease significantly exceeds the risk of treatment. Further research and development are needed to increase the efficiency and safety of gene therapy. If weighs heavily

into the efficiency side, gene therapy can be ethically supported because it serves the prevention and treatment of diseases. Conversely, using genetic engineering techniques to increase abilities, mental functions (Ryan, Virani and Austin, "Ethical issues", 2015; Lázaro-Muñoz, Farrell, Crowley, Filmyer, Shaughnessy, Josiassen and Sullivan, "Improved ethical guidance",) and intelligence would have unethical and dangerous consequences and "contradict the personal dignity, integrity and identity of the human being" (Kosugi, "Ethical issues").

The usability and risk of genetic research results require further analysis. Due to professional risks and ethical threats to bioethics (Lantos, "Reconsidering action"; McCullogh, Wilson, Rhymes and Teasdale, "Ethical issues"), genetic testing and interventions are under strict control. Several Declarations, Directives, National and International Law Documents, Treaties deal with this topic (e.g. Nuremberg Codex, Helsinki Declaration, Belmont Report, CIOMS, UN, UNESCO, Council of Europe Documents, National and International Law). Genetic manipulation on gametes is also prohibited by law11.

We can sum up the following situations and ethical issues: 1) The evolution of genetic engineering has made it possible to find and correct the defective gene that is causing each disease and its defective variant. 2) Diagnostic genetic testing is always voluntary. 3) Genetic examination of adults is not justified in cases where the disease to be detected is not cured or lifestyle-impaired. 4) Because of its genetic condition, no one can suffer any disadvantage, as it would be an unfair distinction between people who seriously hurt human dignity. 5) There is no justification for detecting a genetic disorder in an embryo or a foetus when the disease can be treated. 6) If genetic diagnosis is not used to cure the disease, but to use the indication of abortion, then we face a serious ethical problem and challenge. Pregnancy genetic testing can never justify eugenic abortion ("champion"). 7) Preimplantation genetic screening in artificial insemination is clearly ethical in the moral sense.8) The purpose of gene therapy in somatic cells is to restore the functioning of the patient's cells and thus to prevent and cure the disease. According to our present knowledge, it can only be considered if the severity of the disease significantly exceeds the risk of treatment. In contrast, using genetic techniques to increase abilities, psychic functions, intelligence, and unethical, dangerous consequences would be detrimental to the human dignity, integrity. The situation is similar with certain outcomes to check the identity of a human being. 9) The effect of interfering with the genetic material of the gametes, the zygote or the early embryo appears in all the cells and offspring of the later organism, and law in most countries prohibits these interventions (Knoppers, Thorogood and Chadwick, "The Human Genome Organisation"; Knoppers, Harris, Budin-Ljøsne and Dove, "A human rights approach"). 10) The urgent necessity to teach principal basics of new challenges in medical ethics (Zawati, Cohen, Parry, Avard and Syncox, "Ethics_education", ; Carter, Roberts, Martin, Fincher, "A longitudinal_ethics_curriculum").

Although the technology advances, there are more and more sophisticated genetic improvement techniques, but we are still far from the true success of genetic healing. Caution and moderation are also needed because due to genetic heterogeneity not all interventions are beneficial for everyone (Solbakk, Holm and Hofmann, *The Ethics*).

After taking into account the ethical aspects of genetics and genomics, we also have to orientate ourselves in-between the totally different kinetic spaces of the connected research practices. The second part of the article is an attempt to search for such practicable passages by an interdisciplinary dialog of the editor and author.

Berszán: If all our actions are determined by genetic codes, how can ethical problems arise?

Falus: Since the statement in the question ("all our actions are determined by genetic codes") has been refuted several times, it turned out that epigenetic and environmental effects may slow down or accelerate the expression of the genetic "hardware". In other words the genetic heritage, being fundamentally finetuned by epigenetic conditions represent rather a probability than fate. Back to the history of the genetics for a very long time, scientists believed (as a dogma), that only the acquired habits may be inherited. Then, by the discovery of DNA, the earlier concept had been forgotten, and the new "faith" focused on DNA alone, given by our parents during fertilization of an oocyte by a spermatocyte. This "dogma" claimed, that this is the only source of biological habits of an individual. Recently we guess, that both the genetic code in the gametes and the environmental effects matter. Moreover, the biology science is on the way to uncover the significance of biological networks, such as gene-, messenger RNA-, protein- networks.

Berszán: Can the functioning of the body be distinguishable exercise?

Falus: Yes, definitely yes. The body's functions are specified by both innate (inborne) genetic determinations inherited from the parents and by epigenetic regulation. The major difference between this two is, that the genetic determinations are irreversible and the most of the environmental effects are reversible. Nevertheless, the exercise itself is essentially involved in manifestation of epigenetic influences.

Berszán: How are these two related to genetic engineering?

Falus: The phenomena of genetic engineering recently have been completed by synthetic biology, rapidly developing digital technologies, artificial intelligence, remote robotic solutions, 3D constructions, nanosensors, etc. In the sense of these revolutionary changes a quickly changing medicine (both diagnostics and therapy), pharmacology and pharmacogenomics (Gershon, Alliey-Rodriguez and Grennan, "Ethical and public policy"), artificial replacement of body parts will may be predicted and fundamentally modify (and democratize) the involvement of new digital technology in our life. A special case should also be mentioned, some years ago an rather new technology – gene editing – has been raised. The scientific name of this method is CRISPR/Cas.

The technology is based on the so called "immunology" of bacteria, the pathway, how the bacs are protected against viral (bacteriophage) infection. This solution has been applied in mammalian biology and a very precise "targeting" in DNA became possible.

This technology, and its application in therapy obviously raises serious ethical problems. The reality of the ethical concerns is exemplified by the recent news about application of gene editing in Chinese twin girls, in order to inactivate a gene encoding a protein involved in cathing HIV (human immunodeficiency virus). Since the father of the twin girls was HIV-positive, the primary motivation was to protect the embryos from HIV infection. Regardless the tentative protection, the risk is still very high, that the "targeting" is not precise enough and an "off-targeting" accident may occur, destroying some other genes.

I would say, this gene therapy technology is not yet suitable for human medicine. Hopefully these concerns will be eliminated by further studies.

Berszán: If ethics is defined as the practical orientation of time(s), how and in what sense can it be regarded as genetically defined?

Falus: In my personal view, the ethical issues rather belong to memetics than genetics. Memetics involves a set of traditions, customs, social expectations, fashion, as well as defined by the actual age (epoch) and society (Ferencz, Kosztolányi, Falus, Kellermayer, Somfai, Jelenits and Hámori, *Biogenetika és etika [Boigenetics and ethics]*; Wood, "The_ethics"). From this point of view, it is obviously determined by memetics and not by genetic features.

Berszán: Can we say that chromosomes mark the scope of ethics?

Falus: I have to firmly deny this concept. I guess this presumption is represented by the so called "geneticism" a kind of meaningless overestimation (and intolerable simplification) of genetics as a complex branch of natural life sciences.

Berszán: Does the genetically permissible excessive scope (e.g. too general instincts that do not decide the specific directions of our tendencies) requires ethical consideration and regulation?

Falus: If I understood correctly this raising, similarly, to my view, mentioned above, this supposition (too general instincts that do not decide the specific directions of our tendencies) does not represent a life-like situation. Anyway, extremist consequences of a genetically determined behavioral abashment requires ethical considerations and should be limited by psychological (or medical) tools.

Berszán: How do genetic and socio-cultural determinants relate to the practical orientation of an individual? Whether or not the extent of the practical (ethical) orientation in the genetic or socio-cultural conditions depends on the individual practice?

Falus: I am convinced that both the inherited features of the neuronal and neuronal network capacity of a single person, and the memetics (i.e. sociocultural), due to his/her education and the everyday as well as long lasting practice influences the (practical) orientation. It is rather

hard to decide the ratio between those three "components", they rather complete each other than could be thought as alternative competencies.

Berszán: How do we think about the relationship between the three competencies listed (genetic, socio-cultural and practical)? Are they levels of modular units, combinations or configurations, or does the idea of such connections depend on our orientation practices?

Falus: It is hard to answer, but likely our orientation practices are affecting the manifestations of genetic and epigenetic traits. Moreover, the orientation practices are seemingly varying in time, which makes any further statement harder.

Berszán: What does it mean if we say that "pre-implantation genetic screening (PGS), which aims at enhancing the effectiveness of artificial fertilization (in vitro fertilization; IVF) is clearly ethical"?

Falus: Yes, I agree, that based on strict compliance with legal environment and medical indications PGS does not hurt the ethical requirements. IVF (and if necessary PGS) supports intensified probability of birth of healthy newborns Dimmock, 2014) in elevated number.

Berszán: Are genetic researches just as ethical as are other practices?

Falus: Even if, obviously the genetic topic is a more sensitive issue that many medical intervention, I believe, that the geneticists are as ethical as others in different practices.

Berszán: Do ethics try to limit the effective use of scientific discoveries that go beyond ethical efficiency?

Falus: In general, according my experiences ethics does not limit the effective use of scientific discoveries by genetic researcher. Time to time (e.g. based a new discovery) the voices by representatives of ethics raise concerns. However, so far most of the ambiguities come from too few information and misunderstood consequences. These are preferentially raised by tabloid journalists.

Berszán: Are genetic research and ethical orientation non-negotiable practices, even if genetic research is ethically judged, and the genetic conditions of ethical orientation can be investigated?

Falus: Just opposite: genetic conditions (research and application) has to be screened and commented by ethical experts. The best solution if these experts are "bilingual", they have knowledge and experiences in both practices.

Berszán: Is the caution and moderation required by ethics justified only because of the current level of development and reliability of the gene-correcting technique, or is our ethical responsibility directly proportional to the increase in gene technology, or our medical efficacy?

Falus: The caution and control by ethics is fully justified regardless of current stage of our abilities in genetics. However, obviously the scientific development permanently raises new challenges and doubts. It has to be incessantly communicated for the public and to show both the advantages and potential risks.

Berszán: How do you differentiate the scope of genetic functions from the scope of practical (eg research or ethics) orientation?

Falus: Genetics is only one, but very important element of the functions, and by its principals it belongs to the category of natural life sciences. This truth does not exclude the philosophical, sociological and ethical aspects of heredity science.

Berszán: Is there an irreversible difference between them?

Falus: Yes and no, at the same time. Our genetic habits is determined in the moment of fertilization (except mutations during the life, but repair mechanisms usually eliminate them). This is the irreversible feature. The reversible element is the epigenetic (e.g. environmental, socio-cultural) set, which is capable to silence or upregulate the manifestation (expression) of the genetic content.

Berszán: Does the substrate (e.g. genetic stock) in all respects be more fundamental than the high-level phenomena (e.g. ethical principles) supported by this substrate?

Falus: I disagree with the judgement suggested by the question. Both are fundamental and involve dissimilar approaches.

Berszán: Does it matter to the question of phenomena that not only the genetic conditions are indispensable in the practice of scientific research, but the practice of scientific research is also indispensable in exploring the genetic conditions?

Falus: Yes, both are mutually affecting each other.

Berszán: Is it relevant from your point that we have to learn certain practices to explore the genetic resources and very different ones in our (genetically influenced) legal, ethical, artistic, religious, etc. orientation?

Falus: Different practices (legal, religious, artistic, social, ethical) are strictly related to the people who are personally involved. The people's practices are closely influenced by their genetic, traditional backgrounds.

Berszán: Are the exercises listed in the preceding question traceable to each other (or one of them)?

Falus: Yes, I feel that all exercises seem to be mutually impressed by each other.

Berszán: What does it mean in your proposal for the title that 'Do not go alone'? Do you mean genetics without ethics? Or ethics without genetics?

Falus: In my view, all sciences are affected by ethics, however, since our genetics is related to our parents and grandparents, we are tempted to think that our genes are predetermining our (and moreover our children's) "faith" (Newson and Schonstein, "Genomic Testing"). Even if this is not fully true thinking about genetics is one of the most sensitive topic. The ethical approach is indispensable. However, I guess that ethics as a science of morality is existing without genetic knowledge. Nevertheless, when we assume an individual's ethics, genetic considerations may be taking into account, but only in a restricted extent.

Berszán: If genetics and ethics cannot be the same, what does it mean to cross between them?

Falus: Our personal attitude which may cross between them, based on both our rational, emotional and traditional habit.

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