**Lecture**

**«Animal Biotechnology»**

**Lecture 1**

**The main directions and tasks of modern Animal biotechnology.**

**Bioethics issues in Animal biotechnology.**

**Aim of the lesson:** Acquaintance with the directions and tasks of modern Animal biotechnology and bioethics issues.

*Introduction to Biotechnology.*

Biotechnology helps to meet our basic needs:

- Food, clothing, shelter, health and safety.

- Improvements by using science. Science helps in production plants, animals and other organisms.

- Also used in maintaining a good environment that promotes our wellbeing.

- Using scientific processes to get new organisms or new products.

*Biotechnology* is technology that utilizes biological systems, living organisms or parts of this to develop or create different products. Biotechnology is the use of biological processes, organisms, or systems to manufacture products intended to improve the quality of human life. The earliest biotechnologists were farmers who developed improved species of plants and animals by cross pollenization or cross breeding. In recent years, biotechnology has expanded in sophistication, scope, and applicability.

*The interdisciplinary nature of Biotechnology.* Biotechnology involves many disciplines or branches of learning Includes all areas of Life Sciences. Depending on the tools and applications, it often overlaps with related scientific fields. Biotechnology is based on the basic biological sciences (e.g. molecular biology, biochemistry, cell biology, embryology, genetics, microbiology) and conversely provides methods to support and perform basic research in biology. Large area – Includes many approaches and methods in science and technology.

*Animal biotechnology* is an integral component of agriculture. Animal agriculture is being transformed by rapid advances in biotechnology " a term that encompasses a variety of technologies, including genetic engineering (GE), genetic modification, transgenics, recombinant DNA techniques, and cloning, among others.

Animal biotechnology is a branch of biotechnology in which molecular biology techniques are used to genetically engineer (i.e. modify the genome of) animals in order to improve their suitability for pharmaceutical, agricultural or industrial applications. Animals provide a number of products we use in everyday life. Animals provide a number of products we use in everyday life: –Milk –Leather –Meat –Wool –Egg –Enzymes –And many more e-g medicine.

Major areas of animal biotechnology: Animal breeding; Animal vaccines; Animal nutrition; Embryo transfer; Transgenic animal; Xenotransplfntation.

***Animal biotechnology*** is the use of science and engineering to modify living organisms. ***The goal*** is to make products, to improve animals and to develop microorganisms for specific agricultural uses. Examples of animal biotechnology include creating transgenic animals (animals with one or more genes introduced by human intervention), using gene knock out technology to make animals with a specific inactivated gene and producing nearly identical animals by somatic cell nuclear transfer (or cloning).

*History.* The animal biotechnology in use today is built on a long history. Some of the first biotechnology in use includes traditional breeding techniques that date back to 5000 B.C.E. Such techniques include crossing diverse strains of animals (known as hybridizing) to produce greater genetic variety. The offspring from these crosses then are bred selectively to produce the greatest number of desirable traits. For example, female horses have been bred with male donkeys to produce mules, and male horses have been bred with female donkeys to produce hinnies, for use as work animals, for the past 3,000 years. This method continues to be used today.

*Biotechnology in Animal Agriculture: Status and Current Issues.* Animal agriculture is being transformed by rapid advances in biotechnology—a term that encompasses a variety of technologies, including genetic engineering (GE), genetic modification, transgenics, recombinant DNA techniques, and cloning, among others.

Producers are interested in the application of biotechnology: to improve productivity, consistency, and quality; to introduce new food, fiber, and medical products; and to protect the environment.

Animal Biotech a) Improve animals or the products they produce. Animals may be used to produce products that promote human health. Increase milk productivity , Example Transgenic organisms are organisms that are injected with foreign DNA from another organism. Cows engineered to produce human hemoglobin.

b) Animal Cloning. Cloning is the copying animal gene into many copies,

Start with Embryo Twinning (splitting embryos in half). Advantage of cloning: preservation of endangered animals, studying the effect of drugs e.t.c. on duplicates, improve agricultural production Dolly and her surrogate mother.

c) Improvement animal Health. Animal health and wellbeing have become increasingly important issues for animal producers and consumers. Biotechnology can improve animal health by producing genetically engineered animal that resist disease. The development of genome resources and technologies allow for identification of several host resistance genes. Aim: to prepare and present about genetic bases of disease resistance in the livestock sector.

*Bioethics issues in Animal biotechnology.* Potential human health applications of transgenic animals include producing biopharmaceuticals and generating organs, tissues, and cells for xenotransplantation. Criticisms of such applications involve issues ranging from food safety and social resistance to potential negative impacts on animal welfare and on ecosystems. Questions also have arisen about the adequacy of the current regulatory structure to assess and manage any risks created by these technologies.

On January 15, 2009, the U.S. Food and Drug Administration (FDA) released final guidance on how it is to regulate GE animals and products. Consistent with the Coordinated Framework for Regulation of Biotechnology, FDA will do so under its existing statutory authority and regulations. Generally, GE-derived foods, for example, will be regulated like non-GE foods; if their composition does not differ from their conventional counterparts, they will not have to be labeled. Nonetheless, developers of GE animals and of GE-derived products must gain FDA pre-market approval.

On February 6, 2009, FDA announced the first approval of a drug from a GE animal. The drug is a human anti-clotting agent produced in the milk of transgenic goats. FDA is also currently considering approval of the first genetically modified animal for human consumption, having declared in August 2010 that a GE salmon—AquaAdvantage Salmon—is safe to eat and poses no threat to the environment.

FDA is considering environmental and labeling issues, and has not issued a final decision on the commercialization of the GE salmon. In letters from both houses, 40 Members have asked the FDA Commissioner to halt the approval process for the GE salmon, citing serious concerns with FDA’s review and approval process. The congressional letters have been endorsed by over 50 consumer and environmental groups.

Although animal biotechnology involves many techniques other than cloning, this latter technology has attracted widespread attention. A final risk assessment and industry guidance on the safety of meat and milk from cloned cattle, pigs, and goats and their offspring were released January 15, 2008, by FDA.

The documents generally echoed FDA’s December 28, 2006, draft risk assessment, which found that such products are as safe to eat as those of conventionally bred animals. FDA also concluded that cloning poses the same risks to animal health as those found in animals created through other assisted reproductive technologies—although the frequency of such problems is higher in cloning. (Scientists stress that cloning is an assisted reproduction technique that does not involve any transfer or alteration of genes through GE.). The agency said it was no longer asking industry to refrain voluntarily from marketing the products of cloned animals and their offspring, although the U.S. Department of Agriculture (USDA) did ask that it be continued for products from clones (but not from the offspring of clones).

Bills on animal cloning introduced in the 110th and 111th Congresses would have required all food from cloned animals or their offspring to be labeled, and prohibited food from cloned animals from being labeled as organic. The bills have not been reintroduced in the 112th Congress. A bill that would amend the Food, Drug, and Cosmetic Act to prevent the approval of genetically engineered fish (H.R. 521/S. 230) was introduced in the 112th Congress.

*Regulation of the release of genetic modified organisms.* The regulation of genetic engineering concerns approaches taken by governments to assess and manage the risks associated with the use of genetic engineering technology, and the development and release of genetically modified organisms (GMO), including genetically modified crops and genetically modified fish. There are differences in the regulation of GMOs between countries, with some of the most marked differences occurring between the US and Europe. Regulation varies in a given country depending on the intended use of the products of the genetic engineering. For example, a crop not intended for food use is generally not reviewed by authorities responsible for food safety. Biotechnology can be good or bad for animals - and it may also produce an answer to the ethical problems of experimenting on animals. Transgenic animals raise a particularly difficult problem.

*Human problems.* Newspaper articles about the ethical problems of genetically engineered animals are usually concerned about the danger these animals may pose to human beings (usually to human health), rather than any implications for the animals themselves.

*Animal rights.* Genetic engineering and selective breeding appear to violate animal rights, because they involve manipulating animals for human ends as if the animals were nothing more than human property, rather than treating the animals as being of value in themselves. Recent action to allow animals to be patented reinforces the idea of animals as human property, rather than beings in their own right.

Animal welfare. Biotechnology can be good for animals. Selective breeding and genetic engineering can benefit animals in many ways:

* Improving resistance to disease

Breeding to remove characteristics that cause injury e.g. selecting cattle without horns.

But biotechnology can also be bad for animals - the good effects for the breeder can offset by painful side-effects for the animals:

* Modern pigs have been bred to grow extra fast - some breeds now grow too fast for their hearts, causing discomfort when animals are too active
* Broiler chickens are bred to grow fast - some now grow too fast for their legs.

*Regulating genetic engineering.* Profitability is one of the major drivers of both selective breeding and genetic engineering. If animal welfare is not to be compromised, research must be restricted by a counter-balancing ethical principle that prevents altering animals in a way that was bad for the animal.

*Biotechnology and experimental animals.* It's been suggested that genetic engineering may solve all the ethical problems of laboratory experiments on animals. The goal is to create a genetically engineered mammal that lacks sentience, but is otherwise identical to normal experimental animals. Such an animal could not suffer whatever was done to it, so there should be no ethical difficulty in performing experiments on it.

*Transgenic animals*. Transgenic animals are animals that have been deliberately bred for research and that contain elements of two different species - they are creatures that blur the barrier between species. These animals are often deliberately created with genetic defects, and these defects may well cause the animal to have a bad quality of life. A mouse has been created, for example, that has been genetically modified to develop cancer.

**Control questions:**

1. Introduction to Biotechnology.

2. Animal biotechnology.

The goal and tasks of Animal Biotechnology.

3. The main directions and tasks of modern Animal biotechnology.

4. Bioethics issues in Animal biotechnology.

**Lecture 2**

**Animal cell culture technology. Primary Culture. Subculturing. Cell line. Maintenance. Cell potency. Totipotency, multipotency, pluripotency of animal cells.**

**Aim of the lesson:** Acquaintance with the animal cell culture and different types of cell potency.

Cell culture is one of the major tools used in cellular and molecular biology, providing excellent model systems for studying the normal physiology and biochemistry of cells (e.g., metabolic studies, aging), the effects of drugs and toxic compounds on the cells, and mutagenesis and carcinogenesis. It is also used in drug screening and development, and large scale manufacturing of biological compounds (e.g., vaccines, therapeutic proteins). The major advantage of using cell culture for any of these applications is the consistency and reproducibility of results that can be obtained from using a batch of clonal cells.

*Model systems:* Cell cultures provide a good model system for studying 1) basic cell biology and biochemistry, 2) the interactions between disease-causing agents and cells, 3) the effects of drugs on cells, 4) the process and triggers for aging, and 5) nutritional studies.

Cell potency is a cell's ability to differentiate into other cell types. The more cell types a cell can differentiate into, the greater its potency. *Potency* is also described as the gene activation potential within a cell, which like a continuum, begins with *totipotency* to designate a cell with the most differentiation potential, *pluripotency, multipotency, oligopotency*, and finally *unipotency*.

***Totipotency*** (Lat. totipotentia, "ability for all [things]") is the ability of a single cell to divide and produce all of the differentiated cells in an organism. *Spores and zygotes are examples of totipotent cells.* In the spectrum of cell potency, totipotency represents the cell with the greatest differentiation potential, being able to differentiate into any embryonic cell, as well as extraembryonic cells. In contrast, pluripotent cells can only differentiate into embryonic cells.

*The human development model* is one which can be used to describe how totipotent cells arise. Human development begins when a sperm fertilizes an egg and the resulting fertilized egg creates a single ***totipotent cell****, a zygote*. In the first hours after fertilization, this zygote divides into identical totipotent cells, which can later develop into any of the three germ layers of a human (endoderm, mesoderm, or ectoderm), or into cells of the placenta (cytotrophoblast or syncytiotrophoblast). After reaching a 16-cell stage, the totipotent cells of the morula differentiate into cells that will eventually become either the blastocyst's Inner cell mass or the outer trophoblasts. Approximately four days after fertilization and after several cycles of cell division, *these totipotent cells begin to specialize*. The inner cell mass, the source of embryonic stem cells, becomes pluripotent.

In cell biology, ***pluripotency*** (Lat. pluripotentia, "ability for many [things]") refers to a ***stem cell*** that *has the potential to differentiate into any of the three germ layers: endoderm* (interior stomach lining, gastrointestinal tract, the lungs), *mesoderm* (muscle, bone, blood, urogenital), *or ectoderm* (epidermal tissues and nervous system), but not into extra-embryonic tissues like the placenta.[19] However, cell pluripotency is a continuum, ranging from the completely pluripotent cell that can form every cell of the embryo proper, e.g., embryonic stem cells and iPSCs (see below), to the incompletely or partially pluripotent cell that can form cells of all three germ layers but that may not exhibit all the characteristics of completely pluripotent cells.

***Multipotency*** describes progenitor cells which have the gene activation potential to differentiate into discrete cell types. For example, a multipotent blood stem cell —and this cell type can differentiate itself into several types of blood cell like lymphocytes, monocytes, neutrophils, etc., but it is still ambiguous whether HSC possess the ability to differentiate into brain cells, bone cells or other non-blood cell types.

Multipotency describes progenitor cells which have the gene activation potential to differentiate into discrete cell types. For example, a multipotent blood stem cell —and this cell type can differentiate itself into several types of blood cell like lymphocytes, monocytes, neutrophils, etc., but it is still ambiguous whether HSC possess the ability to differentiate into brain cells, bone cells or other non-blood cell types.[citation needed] New research related to multipotent cells suggests that multipotent cells may be capable of conversion into unrelated cell types. In another case, human umbilical cord blood stem cells were converted into human neurons.[36] Research is also focusing on converting multipotent cells into pluripotent cells.[37] Multipotent cells are found in many, but not all human cell types. Multipotent cells have been found in cord blood,[38] adipose tissue,[39] cardiac cells,[40] bone marrow, and mesenchymal stem cells (MSCs) which are found in the third molar.[41]

Hematopoietic stem cells are an example of multipotency. When they differentiate into myeloid or lymphoid progenitor cells, they lose potency and become oligopotent cells with the ability to give rise to all cells of its lineage.

In biology, ***oligopotency*** is the ability of progenitor cells to differentiate into a few cell types. It is a degree of potency. Examples of oligopotent stem cells are the lymphoid or myeloid stem cells.[2] A lymphoid cell specifically, can give rise to various blood cells such as B and T cells, however, not to a different blood cell type like a red blood cell.[43] Examples of progenitor cells are vascular stem cells that have the capacity to become both endothelial or smooth muscle cells.

In cell biology, a ***unipotent cell*** is the concept that one stem cell has the capacity to differentiate into only one cell type. It is currently unclear if true unipotent stem cells exist. Hepatoblasts, which differentiate into hepatocytes (which constitute most of the liver) or cholangiocytes (epithelial cells of the bile duct), are bipotent.[44] A close synonym for unipotent cell is precursor cell. <https://en.wikipedia.org/wiki/Cell_potency>

**Control questions:**

1. Animal cell culture technology.

2. What is Cell Culture?

3. Primary Culture.

4. Subculturing. Cell line. Maintenance.

5. Cell Potency: Totipotent vs Pluripotent vs Multipotent Stem Cells

6. What is the difference between totipotent, pluripotent, and multipotent?

**Lecture 3**

**Cryopreservation of gametes and embryos. Guidelines for Cryopreservation. Freezing Medium. Cryopreservation Medium. Protocol for Cryopreserving Cultured Cells.**

**Aim of the lesson:** Acquaintance with the method of cryopreservation of gametes and embryos. Guidelines for Cryopreservation. Freezing Medium. Cryopreservation Medium. Protocol for Cryopreserving Cultured Cells.

*Cryopreservation Cell lines* in continuous culture are prone to genetic drift, finite cell lines are fated for senescence, all cell cultures are susceptible to microbial contamination, and even the best-run laboratories can experience equipment failure. Because an established cell line is a valuable resource and its replacement is expensive and time consuming, it is vitally important that they are frozen down and preserved for long-term storage. As soon as a small surplus of cells becomes available from subculturing, they should be frozen as a seed stock, protected, and not be made available for general laboratory use.

Working stocks can be prepared and replenished from frozen seed stocks. If the seed stocks become depleted, cryopreserved working stocks can then serve as a source for preparing a fresh seed stock with a minimum increase in generation number from the initial freezing. The best method for cryopreserving cultured cells is storing them in liquid nitrogen in complete medium in the presence of a cryoprotective agent such as dimethylsulfoxide (DMSO). *Cryoprotective agents* reduce the freezing point of the medium and also allow a slower cooling rate, greatly reducing the risk of ice crystal formation, which can damage cells and cause cell death. Note: DMSO is known to facilitate the entry of organic molecules into tissues. Handle reagents containing DMSO using equipment and practices appropriate for the hazards posed by such materials. Dispose of the reagents in compliance with local regulations.

*Guidelines for Cryopreservation.* Following the guidelines below is essential for cryopreserving your cell lines for future use. As with other cell culture procedures, we recommend that you closely follow the instructions provided with your cell line for best results.

- Freeze your cultured cells at a high concentration and at as low a passage number as possible. Make sure that the cells are at least 90% viable before freezing. Note that the optimal freezing conditions depend on the cell line in use.

- Freeze the cells slowly by reducing the temperature at approximately 1oC per minute using a controlled rate cryo-freezer or a cryo-freezing container such as “Mr. Frosty,” available from NALGENE labware (Nalgene Nunc)

- Always use the recommended freezing medium. The freezing medium should contain a cryoprotective agent such as DMSO or glycerol.

- Store the frozen cells below –70oC; frozen cells begin to deteriorate above –50oC.

- Always use sterile cryovials for storing frozen cells. Cryovials containing the frozen cells may be stored immersed in liquid nitrogen or in the gas phase above the liquid nitrogen.

- Always wear personal protective equipment.

- All solutions and equipment that come in contact with the cells must be sterile. Always use proper sterile technique and work in a laminar flow hood.

*Freezing Medium:* Always use the recommended freezing medium for cryopreserving your cells. The freezing medium should contain a cryoprotective agent such as DMSO or glycerol.

*Cryopreservation Medium*

Recovery™: Cell Culture Freezing Medium is a ready-to-use complete cryopreservation medium for mammalian cell cultures, containing an optimized ratio of fetal bovine serum to bovine serum for improved cell viability and cell recovery after thawing.

*Synth-a-Freeze:* Cryopreservation Medium is a chemically defined, protein free, sterile cryopreservation medium containing 10% DMSO that is suitable for the cryopreservation of many stem and primary cell types with the exception of melanocytes.

Cryopreservation Medium.*Protocol for Cryopreserving Cultured Cells*

The following protocol describes a general procedure for cryopreserving cultured cells. For detailed protocols, always refer to the cell-specific product insert.

1. Prepare freezing medium and store at 2oC to 8oC until use. Note that the appropriate freezing medium depends on the cell line.

2. For adherent cells, gently detach cells from the tissue culture vessel following the procedure used during the subculture. Resuspend the cells in complete medium required for that cell type.

3. Determine the total number of cells and percent viability using a hemacytometer, cell counter and Trypan Blue exclusion, or the Countess, Automated Cell Counter. According to the desired viable cell density, calculate the required volume of freezing medium.

4. Centrifuge the cell suspension at approximately 100–200 g for 5 to 10 minutes; aseptically decant supernatant without disturbing the cell pellet.

Note: Centrifugation speed and duration varies depending on the cell type.

5. Resuspend the cell pellet in cold freezing medium at the recommended viable cell density for the specific cell type.

6. Dispense aliquots of the cell suspension into cryogenic storage vials. As you aliquot them, frequently and gently mix the cells to maintain a homogeneous cell suspension.

7. Freeze the cells in a controlled rate freezing apparatus, decreasing the temperature approximately 1oC per minute. Alternatively, place the cryovials containing the cells in an isopropanol chamber and store them at –80oC overnight.

8. Transfer frozen cells to liquid nitrogen, and store them in the gas phase above the liquid nitrogen.

**Control questions:**

1. Cryopreservation Cell lines.
2. Cryoprotective agents.
3. Guidelines for Cryopreservation.
4. Freezing Medium. Cryopreservation Medium.
5. Protocol for Cryopreserving Cultured Cells.

**Lecture 4**

**Animal cloning. Stem cells and the perspectives of practical application.**

**Aim of the lesson:** Acquaintance with the method of animal cloning. Stem cells and the perspectives of practical application.

Cloning is the most recent evolution of selective assisted breeding in animal husbandry. Cloning animals is a reliable way of reproducing superior livestock genetics and ensuring herds are maintained at the highest quality possible.

It’s important to remember that cloning does not manipulate the animal’s genetic makeup nor change an animal’s DNA. It is simply another form of assisted reproduction. Cloning allows livestock breeders to create an exact genetic copy of an existing animal, essentially an identical twin. Clones are superior breeding animals used to produce healthier offspring.

*Methods.* Reproductive cloning generally uses *"somatic cell nuclear transfer" (SCNT)* to create animals that are genetically identical. This process entails the transfer of a nucleus from a donor adult cell (somatic cell) to an egg from which the nucleus has been removed, or to a cell from a blastocyst from which the nucleus has been removed.[23] If the egg begins to divide normally it is transferred into the uterus of the surrogate mother. Such clones are not strictly identical since the somatic cells may contain mutations in their nuclear DNA. Additionally, the mitochondria in the cytoplasm also contains DNA and during SCNT this mitochondrial DNA is wholly from the cytoplasmic donor's egg, thus the mitochondrial genome is not the same as that of the nucleus donor cell from which it was produced. This may have important implications for cross-species nuclear transfer in which nuclear-mitochondrial incompatibilities may lead to death.

*Artificial embryo splitting or embryo twinning,* a technique that creates monozygotic twins from a single embryo, is not considered in the same fashion as other methods of cloning. During that procedure, a donor embryo is split in two distinct embryos, that can then be transferred via embryo transfer. It is optimally performed at the 6- to 8-cell stage, where it can be used as an expansion of IVF to increase the number of available embryos.[24] If both embryos are successful, it gives rise to monozygotic (identical) twins.

*What are the unique properties of all stem cells*? Stem cells differ from other types of cells in the body. All stem cells regardless of their source have three general properties: 1) they are capable of dividing and renewing themselves for long periods; 2) they are unspecialized; and 3) they can give rise to specialized cell types.

Stem cells are capable of dividing and renewing themselves for long periods. Unlike muscle cells, blood cells, or nerve cells which do not normally replicate themselves, stem cells may replicate many times, or proliferate. A starting population of stem cells that proliferates for many months in the laboratory can yield millions of cells. If the resulting cells continue to be unspecialized, like the parent stem cells, the cells are said to be capable of long-term selfrenewal.

Scientists are trying to understand two fundamental properties of stem cells that relate to their long-term self-renewal: Discovering the answers to these questions may make it possible to understand how cell proliferation is regulated during normal embryonic development or during the abnormal cell division that leads to cancer. Such information would also enable scientists to grow embryonic and non-embryonic stem cells more efficiently in the laboratory.

The specific factors and conditions that allow stem cells to remain unspecialized are of great interest to scientists. It has taken many years of trial and error to learn to derive and maintain stem cells in the laboratory without them spontaneously differentiating into specific cell types.

For example, it took two decades to learn how to grow human embryonic stem cells in the laboratory following the development of conditions for growing mouse stem cells. Likewise, scientists must first understand the signals that enable a non-embryonic (adult) stem cell population to proliferate and remain unspecialized before they will be able to grow large numbers of unspecialized adult stem cells in the laboratory.

**Control questions:**

1. What is animal cloning?
2. The methods of animal cloning.
3. Method of "somatic cell nuclear transfer" (SCNT).
4. Artificial embryo splitting or embryo twinning technique.
5. What are the unique properties of all stem cells?
6. Perspectives of stem cells practical application.

**Lecture 5**

**Genetic transformation of animal somatic cells.**

**Gene Transfer to Animal Cells.**

**Aim of the lesson:** Acquaintance with the method of genetic transformation of animal somatic cells. Genetic transformation of animals.

A somatic cell (from Ancient Greek σῶμα sôma, meaning "body"), or vegetal cell, is any biological cell forming the body of an organism; that is, in a multicellular organism, any cell other than a gamete, germ cell, gametocyte or undifferentiated stem cell.

In contrast, gametes are cells that fuse during sexual reproduction, germ cells are cells that give rise to gametes, and stem cells are cells that can divide through mitosis and differentiate into diverse specialized cell types. For example, in mammals, somatic cells make up all the internal organs, skin, bones, blood and connective tissue, while mammalian germ cells give rise to spermatozoa and ova which fuse during fertilization to produce a cell called a zygote, which divides and differentiates into the cells of an embryo. There are approximately 220 types of somatic cell in the human body.

Theoretically, these cells are not germ cells (the source of gametes); they transmit their mutations, to their cellular descendants (if they have any), but not to the organism's descendants. However, in sponges, non-differentiated somatic cells form the germ line and, in Cnidaria, differentiated somatic cells are the source of the germline. Mitotic cell division is only seen in diploid somatic cells.

Development of biotechnology has allowed for the genetic manipulation of somatic cells, whether for the modelling of chronic disease or for the prevention of malaise conditions.

Genetic engineering of somatic cells has resulted in some controversies, although the International Summit on Human Gene Editing has released a statement in support of genetic modification of somatic cells, as the modifications thereof are not passed on to offspring.

*Gene transformation in animals.* "Transformation" may also be used to describe the insertion of new genetic material into nonbacterial cells, including animal and plant cells; however, because "transformation" has a special meaning in relation to animal cells, indicating progression to a cancerous state, the process is usually called "transfection".

In molecular biology and genetics, transformation is the genetic alteration of a cell resulting from the direct uptake and incorporation of exogenous genetic material from its surroundings through the cell membrane(s). For transformation to take place, the recipient bacterium must be in a state of competence, which might occur in nature as a time-limited response to environmental conditions such as starvation and cell density, and may also be induced in a laboratory.

Transformation is one of three processes for horizontal gene transfer, in which exogenous genetic material passes from one bacterium to another, the other two being conjugation (transfer of genetic material between two bacterial cells in direct contact) and transduction (injection of foreign DNA by a bacteriophage virus into the host bacterium). In transformation, the genetic material passes through the intervening medium, and uptake is completely dependent on the recipient bacterium.

As of 2014 about 80 species of bacteria were known to be capable of transformation, about evenly divided between Gram-positive and Gram-negative bacteria; the number might be an overestimate since several of the reports are supported by single papers.

"Transformation" may also be used to describe the insertion of new genetic material into nonbacterial cells, including animal and plant cells; however, because "transformation" has a special meaning in relation to animal cells, indicating progression to a cancerous state, the process is usually called "transfection".

Introduction of DNA into animal cells is usually called transfection. In animal cells, transfection is the preferred term as transformation is also used to refer to progression to a cancerous state (carcinogenesis) in these cells. Transduction is often used to describe virus-mediated gene transfer into eukaryotic cells.

**Control questions:**

1. Animal somatic cells.
2. Genetic manipulation of somatic cells.
3. Genetic engineering of somatic cells.
4. Gene transformation in animals.
5. What are transfection and transduction?