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Review Article

Application and Current Trends of Biotechnology: a Brief Review

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Abstract

Biotechnology is defined as biology-based technology which uses organisms or their parts to make or modify products, or improve plants, animals and microorganisms. It is classified as animal biotechnology, environmental biotechnology, aquatic biotechnology, microbial biotechnology, medical biotechnology, and forensic biotechnology. The Modern biotechnology finds promising applications in different ways like environment protection, isolation of criminals, and production of food and drug. Its application is held in nanotechnology, cloning, gene therapy, recombinant DNA technology, embryonic stem cell research, biofuels, biobanks, and in biotechnological industries. Biotechnology and bioindustries are becoming an integral part of the knowledge-based economy, because they are closely associated with progress in the life sciences and in applied sciences and technologies linked to them. Today world economy is highly grown by the application of the latest biological technologies. Currently a biosafety regulatory regime has been developed in many countries to regulate the trans boundary movement of genetically modified organisms to avert their possible risks on biodiversity, human health and the environment in general.

Keywords: Application; Biotechnology; Current trends; Review

Introduction

A standard definition of biotechnology is any technique that uses living organisms or substances from those organisms to make or modify a product, to improve plants or animals, or to develop microorganisms for specific uses [1,2]. It ranges from the simplest such as baking, making use of yeast to the complex, the recombinant DNA technology or the classical to include bio fertilizers, biological nitrogen fixation and fermentation to the modern biotechnology which ranges from plant tissue culture, cell culture, recombinant diagnostic and genetic engineering [2,3]. Biotechnology uses science and engineering to process materials with biological agents. Biological agents such as enzymes, plant cells and microorganisms are used to produce pharmaceuticals, foods and biochemical used for warfare. Louis Pasteur used biotechnology to create vaccines in the late 19th century. Biotechnology is experiencing a second wave with rapid growth and advancement in the field. Modern biotechnology has a lot of potentials namely, increase in crop productivity, conservation of biodiversity, protection of environment, reduction of soil erosion, increase stability of production, and improve production of quality traits such as vitamins and proteins [2]. Today's biotechnology is largely identified with applications in medicine and agriculture based on the knowledge of the genetic code of life. Green biotechnology is a biotechnology applied to agricultural processes. An example would be the selection and domestication of plants *via* micropropagation. Biotechnology brings to mind many different things. Some thinks of developing new types of animals. Others dream of almost unlimited source of human therapeutic drugs. Still others envision the possibility of growing world population [4].

Industrial biotechnology (also known as white biotechnology) is the practice of using cells to generate industrially useful products. It has been applied in variety of industrial processes in different ways, particularly in the use of biocatalysts in manufacturing processes. Biomedical technology involves the application of engineering and technology principles to the domain of living or biological systems [5]. Economic Commission for Africa (Addis Ababa) in July 2002 discussed the status, limits and potential as well as the directions to develop biotechnology in Africa [6]. In African countries such as Burkina Faso and South Africa have already experienced and yield increases as a result of biotechnological adoption. Biotechnology has a role to overcome longstanding agricultural problems in Ethiopia. Ethiopia is already making progress toward biosafety regulations [7]. Therefore, the main objective of this seminar paper is to review the application areas and the current trends of biotechnology. Biotechnology is the integration of natural science and engineering in order to achieve the application of organisms, cells, parts thereof and molecular analogues for products and services. It is versatile and has been broadly classified as medical, microbial, animal, aquatic, forensic, and environmental biotechnology. This new wave of technological changes has determined dramatic improvements in various sectors [8].

Medical Biotechnology

Biomedical technology involves the application of engineering and technology principles to the domain of living or biological systems. Usually biomedical denotes a greater stress on problems related to human health and disease. Biomedical engineering combined with biotechnology is often called biomedical technology or bioengineering [5].

In medicine, modern biotechnology finds promising applications

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in pharmacogenomics, genetic testing, gene therapy, and drug production. Pharmacogenomics is the study of how the genetic inheritance of an individual affects his or her body's response to drugs. Gene testing involves the direct examination of the DNA molecule itself [9].

Microbial Biotechnology

Microorganisms are relevant to all of us in a multitude of ways. However, they are sometimes detrimental. Microorganisms are required for the production of antibiotics, (e.g., penicillin, streptomycin, Chloromycetin), vaccines, vitamins, enzymes, and many more important products. The use of microbes to reduce or degrade pollutants, industrial waste and house hold garbage, a new area referred to as bioremediation is being given substantial importance [10]. One of the important applications of recombinant DNA technology is the modification of bacterial cells to make substances useful to humans. To the bacterial cells to produce human proteins, a human DNA gene with the information for synthesizing the protein is inserted into the vector [11]. With the recognition of the unity of the biochemical life processes in microorganisms and higher forms of life, including human beings, the use of microorganisms as a tool to explore fundamental life processes become attractive due to the following facts: They reproduce very rapidly; They can be cultured in small and vast quantities conveniently and rapidly; Their growth can be manipulated easily by physical and chemicals means; and their cells can be broken apart or the contents can be separated into fractions of various particle sizes. Because of these characteristics microorganisms are used as research models to determine exactly how various life processes takes place [11].

Animal Biotechnology

Dolly is an icon of animal cloning. It held a certain fascination for participants who were curious to find out more about her and, in particular, whether she lived a normal life. The main concerns relating to Dolly were described as: Dolly died prematurely because her biological clock was six years old at birth (the age of the donor), scientist Aberystwyth states it was supposed to be a miracle thing that they had cloned this sheep, but she didn't live very long and the concern was that her DNA was already old compared to what they had cloned her to. Another scientist, Aberdeen states that Dolly died prematurely because of defects/problems that were brought on by the cloning process [3]. The cloning of dolly undergoes a series of procedures. First an udder cells was taken from a Finn-Dorset ewe; secondly the cells were placed in culture; on the third unfertilized egg cell was taken from a Scottish Blackface ewe; fourth the nucleus, holding the DNA, was taken out of the egg cell. This creates an empty egg cell, but still contains the necessary cellular parts to create an embryo; then at the fifth, the two cells were placed next to fuse together, thinking soap bubbles stitching together. Thus, a sheep embryo was started to grow. Finally after about six days, the embryo created, was placed in the uterus of another blackface ewe (implantation). Soon the pregnant black faced ewe gives birth to dolly. Although dolly was born from a black faced ewe, it is a Finn-Dorset because its DNA was originally taken from a Finn-Dorset [12].

The recent developments in biotechnology have opened up exciting possibilities for a rapid increase in productivity of domestic animals through its applications. Animal biotechnology can help to increase in animal productivity in several ways namely; By increasing the production of products by promoting growth and increasing nutrient intake efficiency; By increasing the reproduction rate of domestic animals; and by enhancing the quality of animal production [11].

Reproductive Biotechnology

Artificial insemination

Artificial Insemination (AI) has become the most widely spread biotechnology applied to livestock and especially in cattle production. It remains as one of the most important assisted reproductive technologies [11]. AI greatly increases the utilization of proven sire. About 90% of the genetic improvement in a commercial herd depends on the genetic improvement in the AI. It frequently results in improved record keeping. However, the disadvantage of AI should be recognized. Artificial insemination is simple, economical, and successful. Its success is highly relying on the viability of sperm [3]. Sperm cryopreservation is the technique applied for the sperm to be viable for a longer time. It refers to the long term preservation and storage of biological material at very low temperatures, usually at -196°C; the temperature of liquid nitrogen.

Multiple Ovulation and Embryo Transfer

Embryo transfer biotechnology generated a lot of interest among the people in the past. This bio technique enables achieving a greater number of offspring from selected females than was possible by applying traditional means of animal production. By increasing the number of offspring, multiple ovulation and embryo transfer has the potential to genetic improvement by enhancing the selection intensity on the female. Embryo transfer technique consists of three steps: superovulatin by using hormones, (e.g., equine chorionic gonadothropin); collection of embryo either surgically or non-surgically; and transfer of embryos to suitable recipients. Advantages of embryo transfer are; conservation and preservation of breeds, creation of disease free herd, economical transport of livestock, for rapid multiplication of the elite female breeding stock, and for research applications [3].

Embryo splitting

Slightly older embryos at the morale or blastocyt stages may be cut into two equal halves by using a micromanipulator and a microsurgical knife before transfer to a surrogate female. Genetically identical animals are produced by this method. This process seems to mimic the natural process of production of monozygotic twins [3].

Aquatic Biotechnology

The application of biotechnology in aquaculture can greatly enhance the productivity of open water bodies. It has the potential to help aquaculture enhance cultured organisms, growth rate, reproductive potential, disease resistance and ability to resist adverse environmental conditions such as warm and cold water [4]. Enhancing one or more economic traits like growth rate, disease resistance, better feed conversion, improved cold tolerance, etc. through the gene transfer technique or transgenesis is the latest biotechnological tool being worked upon. Successful gene transfers have been made in over 15 fish species. Transgenic salmon fish namely Aqua Advantage

TM which grows 4–6 times faster, but consumes 20% less food than the control, has been generated in Canada and United States of America (USA) [4].

Forensic Biotechnology

Forensic biotechnology refers as application of biotechnological techniques for isolation of a guilty from innocents. In modern forensic biotechnology DNA analysis can be used to protect and free innocents, as well as to convict the guilty. This technique is power forensic tool [11]. Extraction is the process of removing DNA from a stain and, if necessary, removing residual stain material from the DNA. If the stain is identified as semen, additional extraction steps are required to separate sperm cells from the other cells in the stain. Sperm separation doubles the time required for the extraction process and creates two independent subsamples that are carried through all subsequent processes [13]. DNA can be recovered and amplified by PCR [11]. The first subsample is predominantly composed of sperm DNA while the second subsample is from other cells. In a sexual assault case, this technique allows the separation of DNA from the male and female components. In most casework analyses, it is important to determine the amount of sperm and non-sperm DNA present in the extract. Steps of DNA extraction are: washing samples of cells example sperm cells; addition of extraction buffer; lyses of non sperm cells; centrifuging to pellet spermatozoa in the bottom of tube; transfer of supernatant (non sperm fractions); addition of extraction buffer with DTT to sperm fraction (The sperm pellet is washed several times before proceeding to this step); lyses of sperm cells; then the examiner now has the sperm DNA and in two separate tubes [13].

Environmental Biotechnology

Environmental biotechnology can be considered as the discipline that studies the application of biological systems and processes in waste treatment and management [14]. The use of biological-based processes to remediate environmental pollutants is known as Bioremediation. Biodegradation is defined as a natural process whereas bioremediation is developed as a way to encourage or accelerate the degradation of pollutants (liquid and solid wastes, contaminated ground water, and toxic and hazardous products), which renders the site region free from contamination. The technology offers the potential to treat contaminated soil and ground water [4]. Photosynthesis by plants is considered to be an obvious means of energy-efficient biotechnological reduction of CO_2 released to the environment.

Biotechnological approach for genetic improvement of photosynthetic CO_2 fixation is desirable. The enzyme RUBP-case is the one responsible for CO_2 fixation by plants. Attempts are already being made to genetically manipulate this enzyme in plants to increase the photosynthetic efficiency (increase potential to use more CO_2 at a time) [14]. Biotechnology can be used to achieve the selective remediation of the target contaminants present at low concentrations and can be carried out on site. The process of bioremediation may involve the following steps; examination of the contaminated site; site characterization which involves: analysis of physical characteristics of the site, source of pollutants, nature of contaminated soil or water, and the distribution and concentration of contaminants; isolation and characterization of naturally occurring microorganisms having potential for bioremediation; cultivation of the organisms to develop viable populations studying the catabolic potential of these organisms in contaminated material; monitoring, analyzing and testing in chemically contaminated media; field application of bioremediation treatment [4].

Biotechnology and Food Product

Population increases, especially in developing countries, create the need for an ever-larger food supply. Many observers have suggested that biotechnology has the potential to increase world food output and reduce food insecurity by improving crop yields and reducing crop loss. As with any improvement in technology, farmers in developing countries must find the new advances profitable. Consumers in developing countries will benefit if biotech crops are less expensive or more nutritious than traditional crops [15].

Genetically Modified Organisms

Animals and plants are continuously tried to be genetically modified for the aim of food production. When most people talk about bioengineered foods, they are referring to crops produced by utilizing the modern techniques of biotechnology. Researchers look for genes that will benefit the farmer, the food processor, or consumer. All of the proteins that have been placed into foods through the tools of biotechnology are non-toxic, rapidly digestible, and do not have the characteristics of proteins known to cause allergies [16]. In most oilseeds the major tocopherol is y-tocopherol which is a relatively inactive precursor of a-tocopherol which is the active form of this vitamin. Converting y- to a-tocopherol involves adding of Methyl ($-CH_3$) group. Recently, scientists have isolated the gene that codes to the enzyme catalyzing this methylation reaction in green plant tissues. Genetic engineers equipped the gene with a seed-specific promoror and introduced it into a test plant. The result was a plant in which 95% of the tocopherol in the active, methylated form; and 80 fold increase in active vitamin E level. Another example is, in times of food shortage, the diet of ruminants in pastures may be improved with high protein legume grains, but these are also a poor source of methionine. Efforts are now underway to create methionine-rich legumes using genetic modification technology. Scientists identified a protein in sunflower seeds that by digestive enzymes it can hydrolyze into amino acids including methionine, which the animal then uses to synthesize protein. Researchers introduced the gene coding for this protein into a lupin (legume) and targeted it for expression in the seeds. The result was a 100% increase in methionine content of the seed protein and when this grain was feed to sheep their weight gain increased by 7% and wool production by 8% as compared to sheep feed on unmodified seeds [17].

Animal Cloning for Food Production

A clone is a genetic copy of living organism. The genetic material of a cloned offspring is drawn from a single source, rather than being a combination of sperm and egg genes. Researchers around the world are investigating the potential for using cloned animals in livestock production. Animal cloning for food products has been offered as a commercial service. It is claimed that consumers will benefit simply because the offspring of clones will produce better meat and milk products. Cloning allows breeders to take animals with desirable traits and successfully have these new traits reproduced in the offspring.

Selective breeding using traditional practices does not always result in offspring with the desired traits [18]. Cloning could be used for a dairy cow that produces milk with an unusually high milk protein content (important in cheese manufacture) or an unusually low saturated fat content (potential human health benefits), for example. Cloning could also be used for a sheep identified as superior for a particular type of wool. Researchers have also suggested that cloning could be used to preserve a species nearing extinction or to enhance livestock resistance to diseases such as foot-and-mouth disease.

Biotechnology and Drug Discovery

Biomedical technology involves the application of engineering and technology principles to the domain of living or biological systems. Usually biomedical denotes a greater stress on problems related to human health and diseases [5]. The vast bulk of pharmaceutical drugs presently on sale are synthetic chemicals derived either directly by chemical synthesis or by chemically modified molecules derived from biological sources. For instance, Recombinant human insulin became the first manufactured, or commercial, recombinant pharmaceutical in 1982. Before the development of recombinant human insulin, animals (notably pigs and cattle) were the only nonhuman sources of insulin [2]. The initial success of the recombinant DNA technology is the insertion of the human insulin gene into E. coli, thereby enabling the bacterial colonies to produce insulin [19]. Human Growth Hormone is used to counter growth failure in children that is due to a lack of hGH production by the body. Before the introduction of recombinant hGH the hormone was derived from human cadavers. Cadaver- derived hGH was susceptible to contamination with slow viruses that attack nerve tissue. Such infective agents cause fatal illnesses in some patients. Recombinant hGH has greatly improved the long-term treatment of children whose bodies do not produce enough hGH [2]. Cells are then drawn from the cell banks and used in biopharmaceutical production. Broadly speaking, the production process is divided as: Cultivation: the cells are transferred from the cryogenic cell bank to a liquid nutrient medium, where they are allowed to reproduce. The length of this step depends on the type of cell used [9]. Under favorable conditions bacterial cells such as Escherichia coli usually divide once every 20 minutes; thus one cell gives multiple numbers of cells within 24 h. By contrast, mammalian cells divide about once every 24 h, and it takes correspondingly longer to obtain a sufficient number of cells. During the growth phase the cell culture is transferred to progressively larger culture vessels [11].

Fermentation

the actual production of the biopharmaceutical occurs during this phase. The culture medium contains substances needed for the synthesis of the desired therapeutic protein. In total, the medium contains around 80 different constituents at this stage, although manufacturers never disclose the exact composition [20]. The industrial-scale steel vessels in which fermentation takes place have capacities of 10,000 liters or more. There are not only technological but also biological constraints on the size of the reactor vessel: The bigger a fermenter is, the more difficult it becomes to create uniform conditions around all the cells within it [9].

Purification

In technical terms, the production of biopharmaceuticals in cells is a one-step process and the product can be purified immediately after fermentation [20]. In the simplest case the cultured cells will have secreted the product into the ambient solution. In this case the cells are separated from the culture medium, by centrifugation or filtration, and the desired product is then isolated. If the product remains in the cells following biosynthesis, the cells are first isolated and digested, and the cellular debris is then separated from the solution together with the product. The production steps, including purification, take several weeks. Several more weeks are then needed to test the product; each product batch is tested for purity to avoid quality fluctuations, and a 99.9 percent purity level is required for regulatory approval.

Formulation

The final steps in the production of biopharmaceuticals are also demanding. The sensitive proteins are converted to a stable pharmaceutical form and must be safely packaged, stored, transported and finally administered (Table 1) [9].

Biotechnology and Agriculture

In agriculture, what farmers want in their crops are traits such as high yield, disease resistance, insect pest resistance, and quality such as higher nutrients, color, texture, and taste. Agriculture in many parts of the world is undergoing a major strategic restructuring to achieve vertical integration between production and utilization. Genetic engineering is creating a revolution in agriculture allowing an ever-increasing range of plants and animals. Scientists are concerned with finding the earth's human production hope to use recombinant technology to improve productivity of plants and animals important to agriculture [4].

Recent Trends in Biotechnology

Nanotechnology

It is the term to define the creation and exploitation of materials with structural features in between those of atoms and bulk materials with at least one dimension in the nanometer range (1 nm=10-9m). Such size scale is very much relevant in biological system because the dimension of large biomolecules such as proteins and DNA as well as other subcellular structure falls in this range [4]. Now thinking about nanotechnology: Nanotechnology involves working with atoms and molecules to make new particles that are used in cosmetics to make better anti-aging creams, suntan oils for better protection against skin cancer and cleaning fluids to make the home more hygienic [18]. To demonstrate the viability of the nanotechnology-based treatments, let us consider melanoma for example. Melanoma, a form of skin cancer, is caused primarily by ultraviolet radiation from the Sun. The current method of preventive treatment against bombardment with this kind of harmful radiation involves suspending a substance that either absorbs or scatters ultraviolet radiation in a thick emulsion. We use this emulsion, called sunscreen, to coat our skin prior to prolonged exposure to sunlight [21].

Cloning: Cloning technology allows us to generate a population of genetically identical molecules, cells, plants or animals. Molecular or gene cloning, the process of creating genetically identical DNA molecules, provides the foundation of the molecular biology revolution and is a fundamental and essential tool of biotechnology

research, development and commercialization. Virtually all applications in biotechnology, from drug discovery and development to the production of transgenic crops, depend on gene cloning [22]. Cloning is at its most basic level, reproduction without sex. Sex does not refer to the act of intercourse but to sexual reproduction– the joining of genetic material from two parents into an embryo that may, if development goes well, give rise to a new adult organism. All humans alive today were born through sexual reproduction; a single sperm from the male joined with an egg from the female, creating an embryo with half its genetic material derived from each parent. This mixing of genetic material introduces an element of chance into reproduction, ensuring that children differ genetically from their parents. In cloning, offspring are genetically identical to their single parent. Such offspring are the products of asexual reproduction. Cloning by nuclear transfer involves the removal of the nucleus from one cell and its placement in an unfertilized egg cell whose nucleus has been removed [23].

Gene therapy

Gene therapy is the use of DNA as a pharmaceutical agent to treat disease. It derives its name from the idea that DNA can be used to supplement or alter genes within an individual's cells as a therapy to treat disease. The most common form of gene therapy involves using DNA that encodes a functional, therapeutic gene to replace a mutated gene [24]. In germ line gene therapy, germ cells (sperm or eggs) are modified by the introduction of functional genes, which are integrated into their genomes. This would allow the therapy to be heritable and passed on to later generations. In somatic gene therapy, the therapeutic genes are transferred into the somatic cells, or body, of a patient. Any modifications and effects will be restricted to the individual patient only, and will not be inherited by the patient's offspring or later generations [25]. Gene therapy is a molecular biotechnology technique for correcting genetic disorders by replacing defective genes with functional or normal genes. Gene therapy has some requirements, which should be met. First of all genes of interest must be cloned; treatment should deliver sufficient copies of normal genes to target cell; transferred genes should have stable expression; modified cells must have survival advantage over unmodified cells and finally gene expression must correct or reverse the disease [9]. The goal of the Pharmaceutical Industry is to have a gene therapy medical product that can be delivered systemically. There are basically two ways of implementing a gene therapy treatment: *in vitro*, which means outside the body, cells from the patient's blood or bone marrow are removed and grown in the laboratory. They are then exposed to a virus carrying the desired gene. The virus enters the cells, and the desired gene becomes part of the DNA of the cells. The cells are allowed to grow in the laboratory before being returned to the patient by injection into a vein. *In vivo*, which means inside the body, no cells are removed from the patient's body. Instead, vectors are used to deliver the desired gene to cells in the patient's body [26].

Recombinant DNA technology

Recombinant DNA technology or genetic engineering is a method that allows the combination of genes in a test tube to form a hybrid DNA. It allows the transfer of specific Gene (s) [from the same or another organism] to produce a new trait(s) in an organism. It has become a reality when the following elements were discovered one by one and finally.

Integrated: A method of breaking and joining DNA molecules derived from different sources forming the recombinant DNA; a suitable gene carrier that can replicate both itself and a foreign DNA segment attached to it; means of introducing the composite DNA molecule or chimera into a functional host cell; and a method of selecting from a large population of cells a clone of recipient cells that has acquired the molecular chimera [19]. The basic techniques in molecular cloning involve two general stages. First DNA from some particular source is cut to liberate a gene or other fragment of interest. This fragment is then cloned by inserting it into another DNA macromolecule, known as a vector [27]. The cloning vectors are defined as the vehicles which help in the transfer of foreign DNA molecule into the host cell. After cloning the chimeric DNA is inserted into an appropriate host cell. A chimeria is any hybrid molecule of DNA, such as a vector plus a cloned gene, which has been engineered from two different sources of DNA. Ultimately the cloned genes may be used in the manufacture of high levels of recombinant protein or may be applied in gene therapy to cure inherited defects [27].

Nucleases cut nucleic acid

Nucleases are enzymes that degrade nucleic acids. Ribonucleases attack RNA and deoxyribonucleases attack DNA. Most nucleases are specific, though the degree of specificity varies greatly. Some nucleases will only attack single stranded nucleic acids, others will only attack few double stranded nucleic acids and a few will attack either kind. Exonucleases attack at the end of nucleic acid molecules and usually remove just a single nucleotide, or sometimes a short oligonucleotide. Endonucleases cleave the nucleic acid chain in the middle. All these enzymes have proved extremely useful in both in genetic analysis and genetic engineering.

Inserting genes into vectors

Gene cloning is a complex and multistep process in which both, the gene to be cloned and the host genome are carefully manipulated. The simplest way to insert a segment of DNA into a vector is by cutting both the target DNA and the vector with the same restriction enzymes. Mixture of the two is then treated with DNA ligase, which links together DNA strands. The result is the ligation of the target DNA fragment into the vector [27].

Embryonic stem cell research

Stem cells are cells that have the ability to self replicate and give rise to specialized cells. It can be found at different stages of fetal development and are present in a wide range of adult tissues. Stem cells are manipulated in the laboratory in order to make them to accept new genes that can then change their behavior [3]. Embryonic stem cells are derived from the inner cell mass of the early embryo, which are harvested from the donor mother animal. This process includes removing the donor mother's ovaries and dosing her with progesterone, changing the hormone environment, which causes the embryos to remain free in the uterus. After 4–6 days of this intrauterine culture, the embryos are harvested and grown in *in vitro* culture until the inner cell mass forms egg cylinder-like structures [28].

There are three basic types of stem cells. Totipotent stem cells are cells that their potential is total, have the capacity to give raise every cell type of the body and to form an entire organism. Pluripotent

stem cells such as embryonic stem cells are capable of generating virtually all cell types of the body but are unable to form a functioning organism. Multipotent stem cells can give raise only a limited number of cell types. For example, adult stem cells also called organ or tissue-specific stem cells, are multipotent stem cells found in specialized organs and tissues after birth [3].

Pluripotent Embryonic Stem Cells (ESCs) could potentially generate specific cell types for treating serious diseases [3]. For example, several clinical trials targeting heart disease have shown that adult stem-cell therapy is safe, effective, and equally efficient in treating old and recent infarcts. Stem-cell therapy for treatment of myocardial infarction usually makes use of bone marrow stem cells; however, other types of adult stem cells may be used, such as adipose-derived stem cells. Possible mechanisms of recovery include: generation of heart muscle cells, stimulation of growth of new blood vessels to repopulate damaged heart tissue, secretion of growth factors, and assistance *via* some other mechanism [29]. A major problem limiting the clinical use of embryonic stem cells is the potential for tissues derived from these cells to be rejected by receiving patients (recipient). The most attractive solution for this problem is comprises transplanting tissues derived from embryonic stem cells genetically matched to each patient [3]. Many questions arise of this concern. It violates a person's right to individuality, autonomy, self-hood. Austria, France, Germany, and Ireland do not allow the production of embryonic stem cell lines but the creation of embryonic stem cell lines is permitted in Finland, Greece, Netherlands, Sweden, Italy and United Kingdom.

Biotechnology Industries

The various biotech products come in waves or generations as follows: First wave-agronomic traits such as biotic or abiotic stress and yield; most of the current commercial products belong to this Second wave- quality traits such as improved nutrition and functional properties; Third wave-factories, pharmaceuticals, and industrials; fourth wave renewable resources [19].

As stated in biotechnology industry statistics, there are 1, 457 biotechnology companies in the United States of which 342 are publicly held [16]. Biotechnology and bio industry are becoming an integral part of the knowledge-based economy, because they are closely associated with progress in the life sciences and in applied sciences and technologies linked to them. The bio-economy is defined as including all industries, economic activities and interests organized around living system. It can be divided into two primary industry segments: Bio-resource industries which directly exploit biotic resources, crop production, horticulture, forestry, livestock and poultry, aquaculture and fisheries; and related industries that have large stakes as either supplier or customers of bio-resource industries. Bio-industry- applied in food production, pharmaceuticals and health care, banking and insurance [30] (Table 2).

Biobanks

These are collections of biological materials (such as blood and/or tissues) and personal data (medical records, lifestyle data) from large numbers of people. Using biobanks, researchers will try to identify the genetic and environmental factors in diseases, to improve prevention, diagnosis and treatment. Participation in biobanks is voluntary. Biobanks collect data on biological and environmental/lifestyle characteristics of individuals. They do so, on a very large scale, with the aim of teasing apart genetic and lifestyle factors in the risk of diseases and the maintenance of health. Scientists hope to develop new methods for better understanding many common diseases and arrive at new effective treatments. The pharmaceutical industry is interested and likely to be a major investor in the development and maintenance of biobanks [18].

Public ethics and support in biotechnology

Bioethics is a subfield that explores ethical questions related to the life sciences. Bioethics helps people make decisions about how to the appropriate applications of biotechnology and biological science. The use of biotechnology has also raised various ethical concerns; like whether anything theoretically can go wrong with any of the technologies; whether the food and other products of animal biotechnology, whether genetically engineered, or from clones, are substantially different from those derived by traditional, extant technologies; whether the technologies result in environmental hazards; whether the technologies raise animal health and welfare issues; and whether ethical and policy aspects of this emerging technology have been adequately addressed [3]. In addition to discouraging the creation and use of embryos for purposes other than producing children, one commentator argues, the government also seeks to support the requirement for informed consent to all procedures involving human subjects and to discourage commercial trafficking in human materials [16]. The analysis is based on those questions in the survey that addressed moral and ethical sensitivity: the percentage of respondents who think that in a disagreement between science and ethics in the context of regenerative medicine, the ethical view should prevail (ethics over science or Science over ethics); for genetically modified food, nanotechnology and animal cloning, the average level of concern about distributional fairness; whether it will benefit some people but put others at risk and whether it will help people in developing nations. Rather than distributional equity we call this distributional fairness; the percentage of respondents who would want to know about the moral and ethical issues involved in synthetic biology if they were deciding how to vote in a referendum (interest in ethics); the percentage of respondents who think that the governance of science, in relation to synthetic biology, and separately, animal cloning, should be based on moral and ethical considerations rather than scientific evidence (moral governance versus scientific governance) [18].

Conventional biotechnology research as related to animal and plant breeding and selection, artificial insemination, multiple ovulation and *in vitro* transfer, vegetative and micropropagation, and tissue culture techniques, as well as biochemical, genetic, immunological and molecular studies of medicinal plants, livestock and microorganisms of interest by using basic biotechnology techniques and tools such as ELISA, PCR and sequencing were being carried out in the various research institutions, universities and colleagues [6]. Nevertheless, advanced biotechnology researches using recombinant DNA, cell fusion, cloning and other similar technologies are not available [6]. Government would take a list of measures to promote the development of biotechnology in the country: namely, ensure the coordination and networking of biotechnology activities in different institutions; allocate adequate budget for the

development and application of the technology; establish national biosafety guidelines and regulations; develop appropriate legal protection systems to foster inventions, innovations, knowledge and practices in biotechnology; and promote and support biotechnology [6,7]. Biotechnology has a role to overcome longstanding agricultural problems in Ethiopia [7]. The National Policy and Strategy was developed to: improve the knowledge base of biotechnology; utilize biotechnology in national development; develop national capacity in various areas of competence; and develop appropriate biosafety principles, guidelines and regulations. Thus, the Policy aspired to improve the living standards of Ethiopians by overcoming socio-economic and environmental problems through the development and utilization of biotechnology safely. Nonetheless, compared to biotechnology policies and strategies of other nations, Ethiopia's Biotechnology Policy and Strategy is so brief that: no directions and mechanisms of achieving the objectives were given; and no responsible body was identified to oversee the sector [6].

Biosafety should be a major concern in order to avoid or reduce the possible adverse impacts of GMOs on the conservation and sustainable use of biological diversity, human health as well as the socio-economic condition of Ethiopians. In line with this, currently a biosafety regulatory regime has been developed in Ethiopia to regulate the transboundary movement of GMOs to avert their possible risks on biodiversity, human health and the environment in general [31,32].

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