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Number 1

Biopharming in plants and animals.

 Biopharming is the production and use of transgenic plants and animals genetically engineered to produce pharmaceutical substances for use in humans or animals. It often involves the insertion of gene constructs derived from humans. Biopharming exists on a spectrum of activity and is not clearly demarcated from its nearest neighbors. For example, genetically modified yeast, bacteria, and animal cell cultures have for some time been used to produce pharmaceutical substances in enclosed bioreactor systems, but are generally not included in the definition of biopharming. On the other hand, plant cell cultures, a newer development but also involving enclosed bioreactors, are typically included together with whole-plant methods in plant biopharming. While animals are also being genetically modified to alter their nutritional composition, to make them better models for human disease, and to provide more compatible organs for transplantation into humans, these are typically excluded from the definition of biopharming.

Biopharming involves using transgenic plants or animals to produce pharmaceutical products for therapeutic use. This involves the insertion of target genes into hosts (crops or animals) that would not normally express those genes. The desired compound can potentially be expressed in a form that is routinely harvested (e.g. milk, eggs, fruits, etc.), There are several established examples of biopharming, including:Transgenic sheep that produce human α-1-antitrypsin in their milk (individuals deficient in this enzyme develop emphysema)

This technology, called “biopharming,” involves the insertion into plant cells of foreign genes coding for medically important proteins, such as therapeutic proteins, monoclonal antibodies, and vaccines. To date, however, the FDA has yet to approve a single drug made by this method. One approach to biopharming is to insert the gene for a desired protein into the DNA of chloroplasts, membrane-bound organelles containing chlorophyll. Chloroplasts have their own circular set of genes that is distinct from the main genome in the cell nucleus. In the leaves of higher plants, each cell has as many as 100 chloroplasts, each of which contains up to 100 copies of the genome. Thus, by inserting a transgene into the chloroplast genome, one can greatly amplify the gene and produce large amounts of the corresponding protein.

Production of biopharmaceuticals in transgenic plants may offer a cost-effective alternative to using engineered bacteria or mammalian cell culture. One advantage of biopharming is that plant cells possess the biochemical machinery needed to fold complex proteins and to perform the post-translational modifications (such as glycosylation, the addition of sugar molecules) required for full biological activity. Moreover, unlike mammalian cells, plants do not contain retroviruses and other infectious agents (such as prions) that cause disease in humans

* Animal Biopharming

 Considerably less attention, both public and scholarly, has been paid to biopharm animals than to transgenic animals intended for food or as organ donators to humans (xenotransplantation). Many biopharm animals are currently created through cloning, with implantation into another animal for gestation. Most cloned embryos fail to develop to term, and of live births, many suffer from crippling or fatal abnormalities, the causes of which are not understood. Gestating animals also suffer health problems: for example, bovine gestators of cloned animals are much more than normally prone to dystocia due to oversized calves (“large calf syndrome”) and to hydroallantois, caused by a defective placenta; both of these cause pain and suffering and can be fatal. Cloned animals are more prone to musculoskeletal abnormalities and, perhaps particularly significant for biopharming, compromised immune systems. Abnormalities may not reveal themselves before the animal enters a production system, while some epigenetic aberrations may not show themselves in any obvious phenotypical way (Laible and Wells 2007). Cloned animals can also pass on pathological abnormalities to their offspring. Aberrant transgene integration and its effects are poorly understood. Further, according to Rehbinder and colleagues (2009), “[s]tudies of welfare issues arising from making transgenic animals are still in their infancy” (p. 196). These and other unpredicted and undesirable results highlight for some the degree to which intervention outpaces understanding and for others the riskiness of the endeavor: How can nonobvious, unanticipated, and deleterious changes be identified in transgenic animals (or plants) if one does not know what to look for? And how can the risk of such outcomes be evaluated when understanding is so limited? While these problems are associated with cloned transgenic animals in general, particular to biopharming is the problem of the effect on the animals of the bioactive pharmaceutical substance their cells have been engineered to produce in high concentrations. This would vary depending on the nature of the pharmaceutical substance and appears to be both a potential animal-welfare hazard and a limitation of animal biopharming (i.e., certain kinds of substances may not be producible in animals because of their deleterious effects on the animals producing them). When it comes to assessing the acceptability of using animals in this way, the harms to the animals are often weighed against the potential benefits to humans of the drugs produced. However, it is also necessary to ask: are there alternatives? While it is sometimes claimed that animals could potentially be used to produce drugs whose particular characteristics make them difficult or impossible to produce in other ways, this is not the case for the uses to which biopharm animals are currently being put. The same drugs can be, and are being, produced through conventional biopharmaceutical production and/or through biopharm plants or plant cells. Whether or not one views the harms suffered by biopharm animals to be justified may depend, at least if one takes a utilitarian or consequentialist approach, on how much faith one places in these claims to future indispensability. There are fewer concerns about keeping biopharm products out of the food supply than in the case of plant biopharming, due to the fact that the relevant animals are easier to monitor than pollen or seeds. However, there has already been at least one case of possible inadvertent contamination of the food supply by animal biopharming. Between 2001 and 2003, the University of Illinois released 356 pigs, which were part of their transgenic biopharming experiments to produce certain proteins in the milk of sows, to livestock dealers. The university argued that the pigs did not contain the transgenes of their parent stock nor were they old enough to be lactating; however, investigations by the FDA found that records were inadequately kept and they were unable to verify this (FDA 2003). As this incident suggests, biopharming operations will have an incentive to derive some value from animals or animal materials produced by the operation but not utilizable for biopharming – for example, offspring who do not exhibit the desired traits or are surplus to requirements. It is not unlikely, therefore, that biopharm operators will seek approval for excess animals to be permitted human food or animal feed (U.S. National Research Council 2002). This would create pathways for potential contamination of the food supply through animal biopharming. Risks of contamination of the environment and adverse impacts on other organisms appear to be lower than with biopharm plants because biopharm animals are easier to contain than, e.g., pollen from biopharm crops. However, outdoor animal biopharming (or careless management of indoor biopharming) could potentially impact on organisms in the environment such as soil microorganisms, animals and plants that feed on animal waste, and blood-sucking insects. Through horizontal gene transfer, biopharm animals producing antibiotic substances (or therapeutics with antimicrobial properties, a common trait of pharmaceutical substances not intended to be used as antibiotics) could potentially aggravate the problem of antibiotic-resistant bacteria by encouraging resistance in populations of soil bacteria or bacteria that are the animal’s natural commensals. The degree to which this may be a problem will depend, inter alia, on the substances produced and the scale and location of the biopharming operation. A recognized concern is the possibility of passing on zoonotic diseases (diseases that can be transmitted from animals to humans) through drugs from biopharmed animals. These include prion diseases, that is, transmissible spongiform encephalopathies, including bovine spongiform encephalopathy (BSE), variant Creutzfeldt-Jakob disease (vCJD), and scrapie. The company producing ATryn sourced its original (non-GM) goats from New Zealand because that country has been declared scrapie-free. There is also a risk that the animals will contract zoonotic diseases through exposure to infected organisms in their environment. It is likely for this reason, rather than to prevent contamination of the environment, that the goats producing ATryn are kept in an indoor facility. Keeping animals in indoor facilities may, however, raise other animal-welfare issues, depending on the animals and conditions in which they are kept. While these conditions will almost certainly be more hygienic than those characterizing many food-animal operations, they may still, through confinement, prevent the animals from expressing their natural behaviors.

* Plant Biopharming

Biopharming, also known as plant molecular farming, refers to the use of genetically modified plants to produce a wide range of pharmaceuticals and industrial products. Plants such as tobacco, for example, can be genetically engineered to produce therapeutic proteins, monoclonal antibodies and vaccines to treat cancer, inflammatory diseases and other life-threatening or debilitating conditions. These products are termed plant-made pharmaceuticals. They belong to a class of pharmaceuticals known more generally as “biologics” or “biopharmaceuticals,” as they are derived from living organisms.Crops that express attenuated antigenic fragments for specific pathogenic diseases. Plant biopharming is argued to pose fewer risks to the recipient of the biopharmed drug than animal pharming, because plant diseases are generally not seen as a threat to human health. While plantbiopharmed drugs cannot pass on zoonotic diseases, they potentially pose greater allergenicity and immunogenicity problems, due, in simple terms, to differences between plants and animals in protein production processes (i.e., in the “posttranslational modifications” that occur after the RNA has been translated into protein). Much research in this field aims at making the therapeutic proteins produced by biopharm plants more human-friendly. All biopharmaceuticals require extraction and purification. While a challenge for animal biopharming is the detection and removal of zoonotic disease, for outdoor plant biopharming, the purification process must be able to remove assorted environmental contaminants in and on the plant material, such as pesticide residues (including from pesticide drift), insect parts, bird feces, etc. This would presumably warrant changes to existing purification processes and protocols. A major concern associated with plant biopharming is the possibility of the unintentional contamination of food with bioactive pharmaceutical substances. Some developers are focusing on nonfood plants, such as tobacco, or on plant cell cultures, algae, or duckweed, but a large variety of food plants continue to be used as bioreactors, including major food crops, such as rice, maize, and potatoes. Those who use food plants, especially major food crops, argue that this is justified the fact that more is known about their physiology, agricultural needs, and protein-expression mechanisms (Sparrow et al. 2007). Contamination can occur through a number of pathways, including cross-pollination with non-biopharm crops, seed dispersal, the germination of residual seed, postharvest mishandling (e.g., commingling in storage), the use of agricultural and transport machinery on both biopharm and non-biopharm crops, and the inappropriate disposal of biopharm crop waste. The risk of contamination is obviously increased when food crops (or nonfood crops used in processed foods, such as cotton) are used as bioreactors and open-air production methods are used. While a number of technical measures and production protocols have been proposed for these situations, it is acknowledged that even with these measures in place, the risk of contamination cannot be eliminated entirely. Open-air plant biopharming also appears to pose, at least potentially, significant risks to other organisms in its environment. Birds, insects, rodents, and other animals may feed on parts of the plant producing the pharmaceutical substance. In addition, farmworkers (and close neighbors) may be adversely impacted through inhalation of pollen containing pharmaceutical substances. Soil microorganisms will also come into contact with biopharm plants. As with biopharm animals, biopharm plants producing antibiotic substances (or therapeutics with antimicrobial properties) may exacerbate problems of antibiotic resistance

Number 2

Production of transgenic animals with increased disease resistance.

Genetic modification of livestock will enhance animal welfare by producing healthier animals. Animal welfare is a high priority for anyone involved in the production of livestock. The application of transgenic methodology should provide opportunities to genetically engineer livestock with superior disease resistance. One application of this technology is to treat mastitis, an inflammation of the mammary gland, typically caused by infectious pathogen(s). Mastitis causes decreased milk production. Transgenic dairy cows that secrete lysostaphin into their milk have higher resistance to mastitis due to the protection provided by lysostaphin, which kills the bacteria *Staphylococcus aureus*, in a dose-dependent manner (Donovan*et al.* 2005). Lysostaphin is an antimicrobial peptide that protects the mammary gland against this major mastitis-causing pathogen.

Recent progress has produced prion-free (Richt*et al.* 2007) and suppressed prion livestock (Golding*et al.* 2006). Prions are the causative agents in bovine spongiform encephalopathy (BSE) or ‘mad cow disease' in cattle and in Creutzfeldt-Jacob disease (CJD) in humans. This is only a partial list of organisms or genetic diseases that decrease production efficiency and may also be targets for manipulation via transgenic methodologies. Phenotype-driven traditional animal breeding and marker-assisted selection based on quantitative trait loci (QTLs) have been successfully used for the genetic improvement of many agricultural production traits such as body weight, carcass composition, or milk yield. However, these genetic selection strategies have not yet resulted in a significant increase in the resistance of farm animals to disease.

Currently, genomic sequences are available for several livestock species, and as a by-product of the sequencing, a huge number of single nucleotide polymorphisms (SNPs) were discovered. The large panels of available SNPs were used in genome-wide association (GWA) studies for mapping and identifying genes. GWA studies have already been successful in identifying causal genes and mutations for monogenic traits, but not for complex or quantitative traits such as resistance or susceptibility to disease.

Furthermore, traditional strategies in combating devastating infectious diseases of livestock, such as vaccination, antibiotic treatment, or even culling, have, to date, been unsuccessful.

Parasites evolved to resist chemical or vaccine control measures and bacteria developed resistance to many antibiotics. So far, a single infectious viral disease in livestock, rinderpest (cattle plague), could be eliminated through large-scale vaccination.

As an alternative to the traditional approaches, genetic engineering of livestock species may assist in the fight against infectious diseases.

The oldest and probably the most robust technique to produce transgenic farm animals is the injection of DNA sequences into the pronucleus of recently fertilized zygotes. Pronuclear microinjection was successfully used to generate the most important livestock species, mainly for production of highly valuable human therapeutics. A more recent method for generating transgenic animals is the nuclear transfer technology, that is, “cloning”, which, together with a gene-targeting strategy, allows the generation of specific gene-targeted animals. Recently, lentiviral vector-based strategies have been established which results in highly efficient production of transgenic livestock. This method in combination with the RNA technology may lead to the generation of disease-resistant transgenic livestock in the near future.

In the following section, the authors present an overview of the various transgenic methods used for the genetic enhancement of animal resistance to infectious diseases. Many studies were initially done using transgenic mouse models as this model often provides useful preliminary results prior to initiation of livestock studies.

Disease-Resistant Transgenic Animals

Reducing farm animal susceptibilty to infectious diseases via genetic engineering has been an ambitious goal since the first transgenic livestock was generated more than 20 years ago. Various transgenic strategies for improving animal health are described elsewhere. In general, disease-resistant transgenic farm animals can be generated by two approaches: (1) introduction of resistance genes into the genome of the host (gain-of-function strategy) and (2) specific targeting of endogenous or exogenous susceptibility genes (loss-of-function or exchange-of-function strategy).

Improving Animal Health Through Gain-of-Function Gene Transfer

In most cases, susceptibility to pathogens originates from the interplay of numerous genes, meaning susceptibility to pathogens is polygenic in nature. The murine *Mx* gene is one of the few examples of a single genetic (monogenic) locus encoding a disease-resistance trait. Mice and mouse fibroblast cell lines carrying the autosomal dominant *Mx1* allele are resistant to influenza virus infection. The transfer of the *Mx1* gene was able to restore virus resistance in mice lacking the *Mx1* allele and inhibited influenza virus replication in avian cells. However, the introduction of the murine *Mx1* gene into swine via pronuclear microinjection failed to produce influenza-resistant pig. The constitutive *Mx1* expression seemed to be detrimental to the pigs, whereas the expression from an inducible promoter was too low to produce detectable levels of *Mx1* protein. In the meantime, *Mx* genes of different farm animals have been identified, but their importance for disease susceptibility is not yet clear. However, the ongoing detailed deciphering of the genomes of different farm animals, the improved techniques in generating transgenic animals, and the new tools for controlling transgene expression levels might allow the idea of generating influenza-resistant livestock by transferring a disease-resistance gene to be addressed once more.

Antimicrobial peptides (AMPs) are an important component of the innate defense of most living organisms, and there is a growing body of evidence to show that their role in defense against microbes is as important to the host as antibodies and innate and adaptive immune cells. AMPs are usually composed of 12–50 amino acids and synthesized by microorganisms as well as multicellular organisms, including plants and animals. They can have broad-spectrum antibacterial, antifungal, antiviral, antiprotozoan, and antisepsis properties. In addition to the wide range of these naturally occurring AMPs, many new ones have also been synthesized .Based on three-dimensional structural studies, the peptides are broadly classified into five major groups, namely, (1) peptides that form alpha-helical structures; (2) peptides that form beta-sheets; (3) peptides rich in cysteine residues; (4) peptides rich in regular amino acids, namely, histatin, arginine, and proline; and (5) peptides composed of rare and modified amino acids .They can induce complete lysis of the organism by disrupting the membrane or by perturbing the membrane lipid bilayer, which allows for leakage of specific cellular components as well as dissipating the electrical potential of the membrane.

In initial engineering studies, the endogenous production of antimicrobial compounds in transgenic animals was shown to enhance disease resistance. Recombinant bovine tracheal antimicrobial peptide (bTAP) isolated from milk from transgenic mice showed antimicrobial activity against *Escherichia coli*, without any deleterious side effects in suckling pups .The antimicrobial activity of the synthetic alpha-helical peptide *Shiva 1a* was confirmed in transgenic mice, challenged with *Brucellaabortus* . The expression of the recombinant peptide significantly reduced both the bacterial colonization and the associated pathological changes in the genetically engineered mice.

Mastitis which is caused by bacterial infection of the mammary gland is reported to be the most costly disease in animal agriculture. It seriously affects animal well-being and is the most common reason for antibiotic use in dairy cattle and the most frequent cause of antibiotic residues in milk .The major contagious mastitis pathogen, *Staphylococcus aureus*, is sensitive to lysostaphin, an antibacterial peptide naturally produced by a related bacterium, *Staphylococcus simulans* .Kerr and colleagues showed that mammary gland expression of a bioactive variant of lysostaphin conferred protection against *S. aureus* infection in mice. The staphylolytic activity in the milk of transgenic mice appeared to be fivefold to tenfold less active than bacterially derived lysostaphin but was sufficient to confer substantial resistance to staphylococcal mastitis. Transgene production appeared to have no apparent effect on the physiology of the animal, the integrity of the mammary gland, or the milk it produces. Using nuclear transfer techniques, this approach was successfully extended to cattle, recently. Transgenic dairy cows secreting lysostaphin constitutively in their milk were more resistant to *S. aureus* infections than nontransgenic animals. Lysostaphin concentrations in the milk of transgenic animals remained fairly constant during lactation. The recombinant lysostaphin was approximately 15 % as active as bacterially derived protein. Challenge studies with *S. aureus* clearly demonstrated a direct correlation between the extent of protection against *S. aureus* infection with lysostaphin levels in the milk. Transgenic cows have been previously generated, primarily as bioreactors for large-scale production of pharmaceuticals and nutraceuticals. Thus, lysostaphin-transgenic cattle are the first example for enhancing disease resistance and animal welfare in livestock and may allow substantial reductions in antibiotic use. This in turn will help to control the spread of antibiotic-resistant bacteria and to reduce bacterial and antibiotic contamination of milk and milk products.

The antibacterial effect of lysostaphin is restricted to *S. aureus* only and transgenic cows are not protected against other mastitis-causing pathogens. The additional expression of secondary antibacterial compounds in the milk might be necessary for further enhancing mastitis resistance.

Human lysozyme (hLZ), a bacteriostatic milk protein that is known to attack the peptidoglycan component of bacterial cell walls, was expressed in the mammary gland of transgenic mice and transgenic dairy goats. Milk from the transgenic animals showed significant bacteriostatic activity and slowed the growth of several bacteria responsible for causing mastitis and the cold-spoilage of milk. The somatic cell count (SCC) is applied as a measure for udder health and milk quality, and a high SCC in milk is directly correlated with mastitis and an impairment of milk quality. Analyzing the SCC in milk samples of transgenic dairy goats revealed a significant lower SCC compared to milk samples from control animals suggesting an improved udder health in the transgenic animals]. Lysozyme plays a role in the defense against gastrointestinal pathogens and reduces gastrointestinal illness in breastfed infants. Feeding trials were conducted in pigs to evaluate putative health-promoting functions of hLZ-transgenic milk. Pigs are monogastric animals with a digestive system similar to humans and therefore are commonly used to study human health. Brundige and colleagues demonstrated that the consumption of pasteurized milk from hLZ-transgenic goats improved the gastrointestinal health of young piglets and was beneficial against a gastrointestinal infection with enteropathogenic *E. coli*.

A Chinese group enabled synthesis and secretion of bioactive bovine lactoferrin and bovine tracheal antibacterial peptides in goat mammary cells by use of plasmid-mediated gene transfer techniques, and the milk samples collected from these animals exhibited bacteriostatic effects against different mastitis-causing pathogens.

The authors summarize that genetic engineering for secretion of a broad range of AMPs in the mammary gland of dairy goats and cows reduces susceptibility to various microbial pathogens and is therefore a realistic approach to combat mastitis. Enhanced mastitis resistance will not only improve animal health and well-being but also reduce bacterial contamination of milk and milk products in addition to reducing the costs incurred during disease prevention and cure.

Transgenic mice, expressing and processing a human enteric alpha-defensin peptide exclusively in specialized epithelia of the small intestinal crypt, were generated and were immune to an oral challenge with virulent *Salmonella typhimurium*

Number 3

Transgenic technologies for food production.

Biotechnology is the application of scientific techniques to modify plants, animals, and microorganisms to improve their value. Since time immemorial, man has been using green biotechnology to improve the quality, quantity and production outcomes of nutrients. The use of this green biotechnology can offer several potential advantages for food security, which include increase of food production, reduction of agricultural water use, decrease of greenhouse gas emission, decrease of insecticide and herbicide use, improvement of nutritional value, enhancing crop adaptation and reduction of soil physical damage.  Through cross breeding techniques, man used to change and improve the quality of food products of the selected plants and animals that harbor the most desirable traits for food production and breeding for next generation. These traits should present a high yield, be easy to harvest and be non-toxic.  The most recent application of green biotechnology is genetic modification (GM), also referred to as gene technology, genetic engineering, genetic manipulation or recombinant DNA technology. This technology involves the insertion of a gene from a foreign source such as yeasts, viruses, bacteria, animals or plants into typically unrelated species. The plants and animals, in which the genes of interest are added to their genomic DNA, are described as genetically modified organisms (GMO). The plants and animals start to express the proteins of the inserted genes while they grow and develop, which leads to several changes in the organism; such as structure of molecules, anatomy, biochemistry, physiology and morphology thus resulting in the creation of a new living entity not found in nature. The world population has increased at a slow, steady pace which demands increasing the supply of food to meet future needs. This will require increasing crop yields and cropping intensity. It is therefore imperative to invest in agricultural research to increase the yield potentials of specific food crops as well as fish and livestock production, which has forced farmers from different countries, such as; Argentine, Mexico, USA, Canada and China to directly adopt the new genetically modified (GM) crop varieties as they become available. The application of GM technology showed several benefits in different domain like agriculture and food industries. The GM technology increases farming productivity and reduces chemical use (e.g. using pesticide-inherent crops and herbicide-tolerant crops), and lower the production cost which subsequently reduces price. Therefore, adoption of GM technology could be regarded as a pro-poor strategy.  The 2013 report has estimated that 18 million farmers from 27 different countries planted 175.2 million hectares of transgenic crops. Herein study, we addressed the vital role of transgenic food to the hungry world, the most commonly used methods for the creation of GM food, the labeling regulations and detection methods for GM food and products, and the safety issue of GM food and products.

 Various applications of transgenic crops have been envisaged and are under investigation for the future, the main transgene targets were pest resistance and herbicide tolerance, but also resistances to abiotic stress and improvement of the nutritional value were investigated. Furthermore, possible applications that are under development are the production of medically valuable proteins or chemicals in plants (pharma plants) e.g. transgene rice which can produce human serum albumin, or the production of edible plants containing vaccines, the production of bioplastics, phytoremediation, i.e. removal of metal pollutant Nowadays with climate change and global warming genetic engineering has been used to develop transgenic plants which are able to tolerate heat stress conditions

The production of transgenic organisms has been a major technological advance in the study of biology. Transgenic animals have provided new perceptions into the study of the mechanisms of gene regulation and developmental biology. Subsequently, this technology has allowed significant advances in other branches of biomedical sciences including a) the implication of some genes in the development cancer (oncogenes) and oncogenic viruses; b) the mechanisms of regulation and cell interaction in the immune system; c) models for human genetic diseases; d) the mechanisms and control of growth; e) production of biopharmaceuticals, myelin basic proteins from mice, monoclonal antibodies from goats, vaccines and insulin from chicken and eggs, human hemoglobin from pigs, protein C from cow, human erythropoietin from rabbit, human factors VII and IX from sheep and other compounds and f) the basic mechanisms of biology and geneticsFurthermore, transgenic technology is used in production of dragline silk (BioSteel). BioSteel is one of the sp.iders silk which is a protein fiber spun by spider. BioSteel is known to possess outstanding physical and mechanical properties, toughness, elasticity, strength and is weight by weight five times stronger than steel and three times stronger than Kevlar and absolutely biodegradable and biocompatible; these properties are exploited to make medical devices like surgical fiber from BioSteel. Nowadays transgenic goat duly can produce dragline silk in milk as water-soluble silk proteins. Transgenic technology is also employed to generate a novel variety of ornamental fish, transgenic zebrafish, which exhibits vital applications in various domain including biomedicine. Transgenic zebrafish is used as a genetic model to comprehend the human tissue regeneration defects and encourage the progress of regeneration medicine, where zebrafish helps in developing infection disease model (e.g. tuberculosis), screening chemical genetic, emerging cancer pathogenesis model (e.g. melanoma, leukemia), understanding toxicological process (e.g. copper homeostasis). Zebrafish is transparent and under a suitable organ/tissue specific promoter, it can express fluorescent proteins which helps in visualizing the phenotype of the organ.There are various potential applications of transgenic technology to develop new or altered strains of agriculturally important livestock. Practical applications of transgenesis in livestock production include improving the desirable traits such as high milk production and composition, improved meat production, rapid growth rate, feed usage, carcass composition, resistance to diseases, enhanced reproductive performance and prolificacy.