

## Session #26: New Genetics/Genetic Engineering (Session Outline)

*"Then God said, 'Let the land produce vegetation: seed-bearing plants and trees on the land that bear fruit with seed in it, according to their various kinds.' And it was so. The land produced vegetation: plants bearing seed according to their kinds and trees bearing fruit with seed in it according to their kinds. And God saw that it was good." (Gen 1:11-12)*

*"And God said, 'Let the land produce living creatures according to their kinds: livestock, creatures that move along the ground, and wild animals according to its kind.' And it was so. God made the wild animals according to their kinds, the livestock according to their kinds, and all the creatures that move along the ground according to their kinds. And God saw that it was good. Then God said, 'Let us make man in our image, in our likeness, and let them rule over the fish of the sea and the birds of the air, over the livestock, over all the earth, and over all the creatures that move along the ground.' So God created man in his own image, in the image of God he created him; male and female he created them" (Gen 1: 24-25)*

1. Introduction: Genetic Engineering (GE'ing) is already occurring, with the most profound impacts still ahead
  - o Recombinant DNA research promises major improvements in foods; medications; elimination of genetic disorders; extending life; and eventually "designer" babies
  - o The Bible is the only authoritative source to address the looming moral and ethical issues (Rom 15:4; 2 Tim 3:16-17)
2. Though genetic screening has been practiced for thousands of years (Gen 30:31-43), the creation and manipulation of fundamental life is recent - and exponentially expanding
  - o 1953 - Discovery of the double helix structure of DNA
  - o 1980 - First patent awarded by US Patent Office on a living organism (GE'd bacterium to eat oil)
  - o 1982 - GE'd bacterium produces human insulin (rDNA techniques placed human gene into bacteria)
  - o 1988 - US patent on OncoMouse - a cancer prone lab mouse useful in cancer research
  - o 1988 - Beginning of the Human Genome Project (sequence entire human DNA; complete by 2003)
  - o 1994 - Not one acre of commercial GE'd crops; 1999 over 70 million acres of GE'd crops planted
  - o Today - 75% of all processed foods contain some GE'd food products
3. Tactics to justify continued research and development based upon evolutionary foundation (logical extension of selective breeding), economics (better, cheaper) and belief that it is safe (extensive testing) - all false!
4. Biblical principles must be examined to provide a foundation to approach this area
  - o Man is created in God's image and has unique dignity, characteristics, and relationship to God (Gen 1:26-27) compared to the animals
    - o Man is of infinite value to God since He gave His Son (of infinite worth) for us
    - o GE'ing of plant or animal genes into humans degrades the created order and dignity of man
    - o Experimentation on human embryos destroys life and should be stopped
  - o Biblical pattern is for life to reproduce after its own "kind" (Gen 1:11-12; 21:24-25)
    - o Man made "species" definitions not consistent with Biblical separation (reproduce after their own kind in the wild according to natural propensity and viability)
    - o What God created separate, man is to maintain separate (no genetic cross breeding)
    - o Mixing of genetic sequences from animals identical to human sequences may not constitute mixing "kinds" since "parts" are the same. Larger gene sequence have unique attributes
  - o Sexual prohibitions imply separation principle (sex with animals (Ex 22:19; Lev 20:15-16); incest (Lev 18:1-29); prostitute become "one flesh" (1 Cor 6:15-17))
  - o GE'ing progressing towards the development ultimately of a superior man
    - o Man is to be conformed to the image of Jesus as his highest goal (Rom 8:29; 2 Cor 3:18)
    - o Technology will never overcome the sinful heart (Jer 17:9)
    - o Any technology can be used for good or for evil (Prov 14:12)
    - o The pridefulness of man convinces him he can improve upon what God has created
    - o Our future hope is in Christ and the new heavens and earth, not a GE'd man

- o Is there a possibility of destruction of all (or much) of mankind through GE'ing bacterium or a totally new life form? (Rev 6:8; 8:8,10; 9:3-11; 17-19)
  - o Man cannot anticipate the ultimate consequences of GE'ing in a fallen, sinful world (Eccl 3:11)
  - o Biblical approach is to investigate benefits, tradeoffs, and implications, and whether the result will bring glory to God (Prov 25:2; Eccl 7:27; 1 Cor 10:31)
5. Bottom line: "The secret things belong to the Lord our God, but the things revealed belong to us and to our children forever, that we may follow all the words of this law" (Deut 29:29)
- o Christians (and Biblical truths) are not observably engaged in this area
  - o To think that man is capable of understanding the consequences of this technology is ultimate arrogance
  - o The dignity of life must be preserved, especially human life from conception
  - o Man is to be a good steward of animals, respecting and protecting animal life, not willfully destroying, harming or genetically 'mixing' 'kinds'
  - o The sanctity and uniqueness of God created "kinds" in plant and animal life must be preserved
  - o Ultimate goal of GE'ing is to create the perfect man - the modern form of "eugenics" (physically and intellectually superior human beings)
    - o The perfect human being "...created in our own image" according to our own design!
    - o This may be the ultimate deception and exercise of pride and arrogance
6. What can Christians do?
- o Be informed by monitoring the developments and decisions in this area
  - o Encourage Christian leadership to investigate the issues, research the Biblical principles involved and inform the Body of Christ
  - o Develop a sound Biblical moral and ethical approach to the issues involved
  - o Demand clear definition of roles, objectives and controls in all GE'ing efforts
  - o Demand strict accountability from our legislators in their decisions concerning this area
  - o Continue to force politicians (and others) to face the fact that life begins at conception and must be protected

Notes:

- (1) *"The Price of a Perfect Baby;" Bruce L. Anderson; 1984*
- (2) *"Making Biblical Decisions;" Franklin E. Payne, Jr. M.D.; 1989*
- (3) *Charles Frankel, "The Specter of Eugenics," Commentary, March 1974, p. 28*
- (4) *"The Unholy Alliance," Dr. Mae-Wan Ho; article in The Ecologist; Vol 27; No. 4; July/August*
- (5) *The National Health Museum (www.accessexcellence.com)*

## Session #26: New Genetics/Genetic Engineering (Detailed Notes)

*"Then God said, 'Let the land produce vegetation: seed-bearing plants and trees on the land that bear fruit with seed in it, according to their various kinds.' And it was so. The land produced vegetation: plants bearing seed according to their kinds and trees bearing fruit with seed in it according to their kinds. And God saw that it was good." (Gen 1:11-12)*

*"And God said, 'Let the land produce living creatures according to their kinds: livestock, creatures that move along the ground, and wild animals according to its kind.' And it was so. God made the wild animals according to their kinds, the livestock according to their kinds, and all the creatures that move along the ground according to their kinds. And God saw that it was good. Then God said, 'Let us make man in our image, in our likeness, and let them rule over the fish of the sea and the birds of the air, over the livestock, over all the earth, and over all the creatures that move along the ground.' So God created man in his own image, in the image of God he created him; male and female he created them" (Gen 1: 24-25)*

***Purpose of this Session: To wake Christians up to the massive moral and ethical questions sown by Genetic Engineering and call them to engage in a reasoned and Biblical manner***

- o Provide a basic understanding of what has already been accomplished
- o Provide a view to the possibilities and implications of continued research in this area
- o Overview significant Biblical principles that apply to this area
- o Realize much of man's effort (in this area especially) is an attempt to reverse the consequences of the fall
- o Discuss what if anything can and should we do

***1. Introduction: Genetic Engineering (GE'ing) is already occurring, with the most profound impacts still ahead***

- o Preliminary questions:
  - o How many read routinely about the developments in GE'ing?
  - o How many read articles about the ethical or moral implications of GE'ing?
  - o What do you know about cloning? (Molly , or the talk about cloning people)
  - o Do you think you have already been affected by GE'ing?
- o The major developments and impacts of genetic research are still ahead of us
  - o The most profound changes imaginable are technologically feasible
  - o The most challenging ethical questions concerning the nature of life itself are with us now
  - o This area could very well shape the 21<sup>st</sup> century (like Nuclear weapons did last century)
- o Current Recombinant DNA (rDNA) research promises:
  - o New agricultural products (most corn grown in the US is genetically altered already)
  - o Greatly improved productivity in crops (herbicide & insecticide resistance)(From "Green Revolution" to "Gene Revolution")
  - o New means of remedying environmental problems (GE'd bacteria "eats" (digests) oil slicks)
  - o New medications (GE'd bacteria produce human insulin)
  - o Elimination of genetic causes of disease
  - o Creation of "designer" babies
  - o Possibility of extending human life span by a factor of two or three
  - o To eventually change character and personality, and ultimately engineer away all pain
- o The Bible is not a text book on technology or scientific truths, but it does speak authoritatively on issues raised by rDNA or cloning:
  - o Moral and ethical issues (**Rom 15:4; 2 Tim 3:16-17**)
  - o The nature of man, animals and plants!
  - o Biblical truths provide basis to address GE issues since there is no hope of secular (humanistic) wisdom and self interest making the right decisions

## **2. Short History: Though genetic screening has been practiced for thousands of years, the creation and manipulation of fundamental life is recent - and exponentially expanding**

- o Genetic inheritance screening is as old as the O.T. (Animal husbandry (**Jacob; Gen 30:31-43**); the command for the Israelites not to marry from the pagan nations)
- o 1818 - Frankenstein by Mary Shelley: Creating life has been a fascination for many years; the tampering with forbidden areas
- o 1859 - Charles Darwin: "The Origin of Species" dealt with variations in inherited characteristics
- o 1865 - Gregor Mendel (monk); noticed certain characteristics of peas could be produced by selecting certain peas and cross breeding
- o 1883 - "**Eugenics**" coined to apply to the theory that the human race could be improved by selective breeding (smarter and more capable allowed to breed, those that were "inferior" not allowed)
- o WWII - Selective breeding ultimately applied under Nazi rule (exterminations; selected breeding partners; superior race)
- o 1953 - Drs J. D. Watson and F. H. Crick; discovered the double helix structure of DNA; since then the genetic makeup of DNA, it's chemical constituents, and ordering has been detailed
- o 1980 first patent awarded by the US Patent Office on a living organism: for a genetically engineered bacterium for cleaning up oil spills; ruling by US Supreme Court; "anything under the sun that is made by man" may be patented (*note (10)*)
- o 1982 Eli Lilly & Co. Successfully introduced the first commercial product of genetic engineering: human insulin made by bacteria given a copy of the human gene for insulin
- o 1987 the "polyploid oyster" was patented; followed by patents on mice, rats, sheep, worms, birds, fish and pigs (*note (9)*)
- o 1988; the US awarded a patent on the OncoMouse, a cancer-prone lab mouse useful in cancer research
- o 1988 the Human Genome Project begun (recently privatized) - sequencing the Human genetic code:
  - o Expected to be completed as early as 2003
  - o Lays groundwork for advanced genetic testing (causal and susceptibility relationships)
    - o Detecting single gene mutations that relate to disorders that are causally necessary and sufficient for a disease to manifest itself (Huntington disease))
    - o Detecting single gene mutations that relate in some way to multiple disease disorders
    - o Detecting multiple gene mutations that relate causally to a single disorder
    - o Determine environmental triggers to genetic mutation: *Xeroderma Pigmentosum*, genetic condition - if a person exposed to ultraviolet light, will develop *Melanoma*
    - o Diagnose in advance all diseases an individual will be prone to during their lifetime
    - o Diagnose susceptibility *in vitro*
    - o Opens door for genetically manipulating genes to create a "better" individual
- o 1994 FDA gave St. Louis based Monsanto Co. authority to sell milk from cows treated with genetically engineered hormones (rBST)
- o 1994 not one acre of commercially grown genetically altered plants were grown
- o 1999 there are over 70 million acres of soybean, corn, cotton, potatoes planted (*note (11)*)
- o 1999, Sept; Gallup Poll: 80% of Americans were confident that food from groceries is safe to eat; 51% said they supported use of biotechnology in food products; 41% said they opposed it (*note (6)*)
- o Bottom line: Genetic Engineering is already with us:
  - o Genetic screening already occurs with the unborn (amniocentesis testing for Down's Syndrome and major deformities)(also: in Ashkanazi Jewish community a high prevalence of Tay-Sach's Disease; (three others also) the community is being asked to voluntarily be tested if they are thinking about dating someone to see if both the man and woman are heterozygous carriers - if so, stop pursuing the relationship or don't have children; very small community in New York with a high percentage of Hasidic Jews)(Brea Walker - newscaster in L.A.)
  - o Sperm banks holding only Nobel prize winners and known geniuses is an example of Eugenics: selective breeding. Genetic engineering will allow this in a more overt and precise way!
  - o There is an increasing number of new food products coming to market that are GE'd
    - o Improved: rapeseed oil; soybean; maize; sugar beet; squash; cucumber; Roundup Ready Corn, Lecithin (also cotton)
    - o BST-milk from cows fed GE bovine growth hormone to boost milk yield

- o Tomato GE'd to prolong shelf-life (Calgen's Flavr Savr tomato - first GE'd food)
- o Currently about 50 GE'd food crops have been approved
- o GE'd foods in 75% of all processed foods (most Americans have eaten altered food)(note (8))
- o Future Shock is coming (see also **Handout: Representative Issues Spawned by Genetic Engineering Technology**) - This is only a sampling!
  - o Linus Pauling (Nobel prize winner in Chemistry): Advocated a tattoo on every young person's forehead, showing his or her genetic makeup to aid in selection of a suitable superior mate (note (3))
  - o Sir Francis Crick: "no newborn infant should be declared human until it has passed certain tests regarding its genetic endowment, and...if it fails these tests, it forfeits the right to live." (note (3))
  - o A gene war between nations striving to grow superior race (greater intelligence, longer life, better physical powers)
  - o Create a life that is in a continual state of ecstasy, never suffering pain or disease
  - o Create pathogens that attack and kill selectively (by genetic marker)
  - o The killing of the unborn for virtually any undesirable trait (looks, height, eye color, genetic deformity, male pattern baldness, sex) very early on in the pregnancy; or worse yet the artificial fertilization of eggs *in vitro* with many zygotes, then selecting the "good" one only (prelude to designer babies)

### ***3. Tactics to justify and continue work are based fundamentally upon Evolution (logical extension), Economics (better, cheaper) and that it is Safe (extensive testing)***

- o Evolutionary worldview
  - o Genetic modification touted a logical extension of: bread and wine making, selective breeding, cross breeding, hybridization (tangelo (tangerine-grapefruit) & beefalo (cow-buffalo) hybrids) to genetic modification (only this is more exact and precise)
    - o Lack of requirement to label foods as GE'd prevents consumer from knowing extend it has become available (1992 FDA policy against labeling - rationale: genetic changes don't alter composition or nutritional content)
  - o Extension to performance enhancing drugs; cosmetic surgery vice only for accident victims; Human Growth Factor (HGF) treatment for pituitary dwarfism (used on black market to grow bigger children)
  - o Evolutionary theology generally underlies research and technology development in this area
    - o Belief that science can "improve" upon living organisms (accelerate what would supposedly take under ordinary conditions eons to accomplish)
    - o Man has evolved to where he can improve himself and his surroundings and not wait for time and chance (perfectability)
    - o How could anyone fight the removal of horrible suffering and pain in the world that could be alleviated by GE'ing better humans
    - o Completely ignores the spiritual side of man (essence; life; soul)
- o Economic drivers
  - o Because economy is so strong, little interest in addressing other issues that don't affect us directly and immediately
  - o To layman, advances seem good & beneficial - they produce "better" crops at lower prices
  - o If one objects to development of greater food yields and reduction in use of herbicides and pesticides they will be viewed as not compassionate towards the starving masses or the delicate balance of "nature" (have's verses the have nots)
  - o Large industry (e.g. Monsanto) employs individuals that had high positions within current and previous Presidential administrations (influence; lobbying; access; influence foreign governments) to ensure protection of marketing rights, continuance of research, etc.
- o Safety ensured
  - o Industry wants public to believe extraordinary precautions are taken to protect individuals and environment through extensive testing and government oversight - who are we to question the progress being made
  - o Scientists put on pedestal, scientific "breakthroughs" almost commonplace - expected in

- o medicine, drug, and therapy arenas. Work in GE assumed to be in good, knowledgeable hands
- o Terminology and technology are very sophisticated and difficult to understand, giving the public difficult time to understand implications (counter: nuclear weapons are very sophisticated, yet we understand the consequences of their use!)
- o Awareness of the public in general to the implications has received minimal treatment
  - o Large companies will tend to “marginalize” the potential effects and tout benefits
  - o The public appears so far removed from this technology it doesn’t think it has a say
- o Some counter tactics used
  - o Terminology: “Tampering with Nature” what does this mean or conjure up? “Scrambling genetic code” “genetic pollution” “suspicious DNA” “Genetically Modified Organism (GMO)”, Xeroxing of life
  - o “Frankenfood” (now in dictionary)
  - o Lawsuits, publicity, visions of grotesque creatures that are half man and half beast
  - o In Europe, the burning of test crop sites
  - o In this case, radical environmentalists and conservatives share a common concern - yet for different reasons

#### ***4. There are significant conflicting interests in the secular community - few concerns are based upon Biblical principles***

##### **o Political (government vs citizens vs big industry):**

- o *EPA and FDA to protect consumer; Congress wants to encourage big business*
- o Is some science bad and not worthy of pursuing (leaving more funds for other research)?
- o Should the government be sponsoring technology development that has such a huge impact upon the world without engaging citizens in open and detailed dialogue?
- o Biotechnology is extremely big business, multi-national and trans-national, how should it be controlled or regulated - if at all?
- o What right does government or the public have to regulate or control industry from exploiting these new product lines?
- o Who supervises science - should some science be done only under the supervision of non-scientists who can have a more objective opinion (or are they not qualified)

##### **o Economic (US vs Europe vs consumer vs world hunger):**

- o *Do the economic benefits outweigh any “potential” harmful effects?*
- o Should large corporations be allowed to own new life forms, techniques, etc. and not be regulated or controlled by outside agencies
- o US government does not require labeling of foods that are GE’d, yet European countries and Japan already demand it
- o Does the consumer have a right to know whether their food is the result of GE or not?
- o Is the development of a “terminator” technology in food crops really concerned with protecting intellectual property or ensuring the third world remains dependent upon US production

##### **o Environmentalist (Environmental fragility vs evolutionary quantum leap):**

- o *Protect “nature” and maintain status quo vice improve upon “nature”*
- o Is nature so fragile or delicate that any tinkering could be catastrophic?
- o Could entire organisms be wiped out by accidental release of GE’d organisms, thus upsetting the environment forever?
- o Is this the next logical step in improving in a few years what it took “nature” millions of years to accomplish?

##### **o Humanistic (Exultation of human life vs selective destruction of life):**

- o *Individual rights supreme but destroy or radically affect all follow on generations*
- o Is this the next natural step in the evolutionary process - self improvement?
- o Is this a more humane way to bring about a superior race?

##### **o National Security (National protection interests vs accidental catastrophes)**

- o *Protect this Nation but at same time put it a tremendous risk (escalation; accidents)*
- o If US didn’t pursue certain genetic technology - what prevents rogue states from doing so?
- o Biological weapons for defensive purposes can be used offensively also, no real distinction
- o Does the creation of exotic pathogens with no known cure demand a response by others,

whether they actually exist or not?

o Is it possible to totally prevent accidental release of deadly organisms forever?

**o Theological (Co-creators vs end-of -the-age):**

*o Deify life on the one hand, but destroy it on the other to eventually “improve” it*

o Are we just “Co-creators” with God and this is a natural extension of what God has done and now gives us the ability to do?

o Are we trying to change the “kinds” that God originally created?

o Are we ushering in the end of the world with ghastly creatures of our own making that we will be unable to control? (Book of Revelation?)

o Hindu’s are concerned that the creation of genetically mixed life forms (transgenic) could have major implications on reincarnated life

**5. Biblical moral principles must be examined to provide a foundation to approach this area**

o First, man created in God’s image, has a unique dignity that is not to be despoiled (**Gen 1:26-27**)

o Man is unique of all creation and is intrinsically different from animals and plants

o Unique relationship with God

o Uniquely possesses qualities/characteristics that reflect God (self-conscience; free moral agent (will); can reason (intellect); can appreciate beauty; can create within the bounds of his existence; he is immortal and possesses a soul; can discern good & evil

o Man has a unique dignity and position above the animals

o Man uniquely has dominion over the creation

o Man is of infinite value to God since He gave His Son (of infinite worth) for us

o Man’s form is the perfect representation of God in creation (Jesus Christ took it on)

o The GE of animal or plant genes into the germ of man would degrade the created order and nature of man into another “creature” however close he may still appear to be fully human

o Exception may be a one to one replacement of constituent “part” that is identical (similar to receiving an animal organ transplant - same function)

o This area is so sophisticated that much is still unknown

o Eve formed from Adam’s flesh

o Second miraculous act of creation of a human being (others: Adam and Jesus)

o Interesting that “bone of my bones and flesh of my flesh” description used - implies use of specific genetic material and/or differentiated cells to form another human being - distinct from yet part of the man

o Implies that creation from existing material to form another human being (other than through God ordained propagation by marriage) is of God only and not for man

o The time of entrance of the soul is unknown - cannot be determined with certainty -

o Reasonable approach - accept it occurs at conception, not arbitrary time afterwards

o Fertilized egg contains all the information needed to grow a fully developed human being

o Zygote should be protected from conception on (no experimenting or selection for destruction)

o Biblical pattern is to reproduce only after their kind. Q: what does “kind” mean?(**Gen 1:11-12, 24-25**)

o Is “species” equivalent to “After their own kind?” (**Gen 1:11-12,21,24-25**)

o “Species” - “A particular kind of organism; members possess similar anatomical characteristics and have the ability to interbreed” (*note 7*)

o Biologists also define common species as those that breed in nature & produce viable offspring

o Species structure established by Linnaeus (not a Biblical system) - classifying all things into:

1. Kingdom      2. Phylum      3. Class      4. **Order**  
5. **Family**      6. **Genus**      7. **Species**      8. Variety

o “Kind” = “*min*”; uncertain origin; provides specification or technical enumeration; always occurs in the singular (**Gen 1; 6; 7; Lev 11; Deut 14**)

o Biblical usage cuts across a biologists/zoologists species; genus; family and order classifications in different verses

o Implies animals and plants are to reproduce according to their ability in the “wild” according to their natural propensity and viability, and that cross-kinds are not to occur

- o Principle: cross breeding or genetic engineering across unlike “kinds” is against the structure that God has established. Transgenic would specifically be prohibited
- o What God created separate, man is to maintain as separate
- o Selective breeding (genetic screening?) described in O.T., but still within its “kind” (**Gen 30:31-43**)
- o Mixing of “kinds” prohibited (different kinds of animals; planting different kinds of seed in the same field; wearing clothing woven of two kinds of material)(**Lev 19:19; Deut 22:9-11**)
  - o Instruction applies to holy nation of Israel and its distinctive separation from world - however, for animals the command is consistent with command to multiply only after their own kinds
  - o Limits appear to have been set by God that are not to be violated (**Gen 1; 6; 7**)
  - o Mixing of genetic sequences taken from animals identical to human sequences may not constitute mixing “kinds” since “parts” are the same. True also if an animal sequence is substituted for an abnormal human gene sequence (identical to what a normal gene sequence would be). However, larger gene sequences from an animal have unique animal attributes and would be mixing “kinds” if used in humans (and vice versa)
  - o Organ transplants from animals to humans is mixing of “parts” that have the same function and are not the whole organism
  - o Mixing of a germ cell from a human with an animal germ cell would be mixing “kinds”, creating a whole new “kind”
- o Related sexual prohibitions in the O.T. and N.T.
  - o Having sex with an animal (**Ex 22:19; Lev 20:15-16**)
    - o Violates the created order
    - o Destroys the dignity of man by debasing him in a vile act strongly condemned by God
    - o Implication is that animal husbandry between animals that have an abhorrence towards each other (do not mate in natural conditions) is wrong
    - o If we are not to become “one flesh” with a prostitute (**1 Cor 6:15-17**) how much more are we not to be combined in any fashion with an animal (genetic material mixing)
  - o Incest (besides other sexual relationships strictly prohibited by God)(**Lev 18:1-29**)
    - o Known genetic disorders can result from close family interbreeding
    - o Severe consequences can occur for offspring when God’s commands are ignored
- o Genetic engineering is progressing towards the development of a superior man, first improved upon, then perfected. (Nazi’s tried this in WW II)
  - o Biblically, man is to be conformed to image of Jesus as his highest goal and end state (**Rom 8:29; 2 Cor 3:18**)
  - o Technology will not overcome the sinful heart, the consequences of sin in the world, or ultimately the results of the fall of man - if anything, this will provide opportunity for incredible abuses
  - o Any technology can be used for good or for evil (**Prov 14:12**)
  - o The pridefulness of man convinces him he can improve upon what God has created
  - o Our future hope is in Christ and the new heavens and earth, not a man made (created) one on this planet
- o Is there a possibility of the destruction of all (or much) of mankind through a new GE’d bacterium or totally new living thing?
  - o **Rev 6:8** “I looked, and there before me was a pale horse! It’s rider named Death, and Hades was following close behind him. They were given power over a fourth of the earth to kill by sword, famine and plague, and by the wild beasts of the earth”
  - o **Rev 8:8** “The second angel sounded his trumpet, and something like a huge mountain, all ablaze, was thrown into the sea. A Third of the sea turned into blood, a third of the living creatures in the sea died, and a third of the ships were destroyed”
  - o **Rev 8:10:** “The third angel sounded his trumpet, and a great star, blazing like a torch, fell from the sky on a third of the rivers and on the springs of water - the name of the star is Wormwood. A third of the waters turned bitter, and many people died from the waters that had become bitter.”
  - o **Rev 9:3-11** “And out of the smoke locusts came down upon the earth and were given power like that of scorpions of the earth. They were told not to harm the grass of the earth or any

plant or tree, but only those people who did not have the seal of God on their foreheads. They were not given power to kill them, but only to torture them for five months. And the agony they suffered was like that of the sting of a scorpion when it strikes a man....The locusts looked like horses prepared for battle. On their heads they wore something like crowns of gold, and their faces resembled human faces. Their hair was like women's hair, and their teeth were like lion's teeth. They had breastplates like breastplates of iron, and the sound of their wings was like the thundering of many horses and chariots rushing into battle. They had tails and stings like scorpions, and in their tails they had power to torment people for five months. They had as king over them the angel of the Abyss, whose name in Hebrew is Abaddon, and in Greek, Apollyon."

- o **Rev 9:17-19** "The horses and riders I saw in my vision looked like this: Their breastplates were fiery red, dark blue, and yellow as sulfur. The heads of the horses resembled the heads of lions, and out of their mouths came fire, smoke and sulfur. A third of mankind was killed by the three plagues of fire, smoke and sulfur that came out of their mouths. The power of the horses was in their mouths and in their tails; for their tails were like snakes, having heads with which they inflict injury."
- o The end will not come until the Lord is ready to bring all things to an end! (**2 Peter 3:10**)
- o Man cannot anticipate the ultimate consequences of GE in a fallen, sinful, corrupted world (**Eccl 3:11**)
  - o Would imply great caution needs to be taken in everything that is tried
  - o Research should not be pursued if a clear moral and spiritual implication is destructive to us or offensive to God
  - o We should not be presumptuous upon God's blessing of these technologies
  - o Ultimately, God allows trials and suffering to fulfill His purposes (**Rom 5:3-5; 1 Peter 1:6-8**)
- o A Biblical approach is to investigate benefits, tradeoffs, and implications, and determine how the result will bring glory to God - the Creator!
  - o **Prov 25:2** "It is the glory of God to conceal a matter, to search out a matter is the glory of kings"
  - o **Eccl 7:27** "Adding one thing to another to discover the scheme of things..." (Building blocks)
  - o Should priority be placed on removing those genetic conditions that debilitate people and do not allow them (hinder them) from supporting a family or contributing to the needs of others more fully (*note (2)*)
  - o Improving mankind for purely cosmetic purposes serves only vanity and cannot be justified on a Biblical basis (exception are those that suffer terrible burns and disfiguring accidents). But where do you draw the line? (**1 Sam 15:17; Isa 53:2; 2 Cor 12; 1 Peter 3:3-4**)
- o We should not take lightly the concern that we may be tampering with forbidden areas! **Deut 29:29**

**6. Bottom Line: "The secret things belong to the Lord our God, but the things revealed belong to us and to our children forever, that we may follow all the words of this law" (Deut 29:29)**

- o Christians specifically (and Biblical truths generally) are not obviously engaged but seem to be conspicuously absent from the GE battleground
  - o We have the only sure source of truth to engage the entire area
  - o If not engaged, it will soon overwhelm any opposition or moral inhibitions currently operative
- o Man is incapable of understanding the complete effects and consequences of rDNA. To think he is able is ultimate pride and arrogance. Because of this:
  - o Great caution should be shown in any experimentation
  - o Some experimentation should be absolutely forbidden (human embryo, fetus, etc.)
  - o Very high accountability should be maintained for any work - private or governmental
- o The dignity of unique human life should be preserved
  - o Mankind is created in God's image, and as such his life has a unique dignity that demands it's respect and protection
  - o Because of the lack of definitive knowledge as to the beginning of human life; personhood; and the existence of a soul - all human life must be protected from the earliest point of its existence (conception)
  - o Full legal status must be given to human life from the point of conception
- o Man is commanded to provide good stewardship of animals, therefore animal life must be respected and

protected and not willfully:

- o Destroyed
- o Harmed
- o Created in potentially grotesque ways
- o Genetically “mixed” with other “kinds”
- o Sanctity & uniqueness of God created “kinds” in plant & animal life must be preserved and not violated
- o Though plant, then animal rDNA splicing is justified on economic & environmental basis, & human rDNA work on humanitarian basis, the ultimate end point of this research is a very sophisticated form of “eugenics” - creating the super man, super race; the desire to fulfill **Gen 3:5** “...you will be like God...” Reversing the fall by creating beings:
  - o Superior physically (without disease or pain)
  - o Superior intellectually (genius, morally superior)
  - o Never die
  - o Perfect human being, created “...in our own image...” according to our own design!
  - o The ultimate deception and exercise of pride & arrogance

### ***7. There is much we can and should do as Christian citizens!***

- o Be informed (several good Christian books on the topic are available - see the notes)
- o Monitor the work going on (various web sites (see notes below), however, few from a Christian perspective or even remotely “religious” in nature)
- o Encourage Christian leadership to investigate the issues, research the Biblical principles that apply, and inform the Body of Christ about them
  - o Encourage active participation with our elected officials
  - o Anticipate moral and ethical issues and publicize widely to help ensure proper accountability
- o Develop a sound Biblical moral and ethical approach to the various issues that are being raised
  - o Address while the technology is being discussed, not after it has been developed
  - o Encourage debate and assessment amongst a large Christian constituency to identify Biblical principles, implications and reasonable safeguards
- o Create a Biblically based web site for information publication; contributions from other writers; ethical issue exploration (comments; chats; etc.); warnings)
- o Demand strict accountability from our legislators (research sponsored; testing; control; exporting; monitoring other nations) and open disclosure of the ethical basis for decisions
- o Demand clear definition of roles, objectives and controls in any GE effort
  - o Most people do not understand the technical details of nuclear fusion, but they do understand the implications of its use as a weapon!
  - o Just because a technology is possible, it does not mean that there is a ethical or moral imperative to develop or use it
- o Continue to force politicians to face the fact that life begins at conception, and that embryos are to be protected and considered as living beings, not as things to be experimented on and discarded.
- o Continue to treat human life with the dignity it should have, and not allow it to be mingled with animal or plant genes which would denigrate it and make it into something less than what God would will

### ***o Misc End Notes:***

- o July 25, 1978; Louise Brown born, first human conceived outside the womb (England)
- o 1983; UCLA perfected the technique of implanting an already-conceived embryo into another woman's womb, where the baby is carried to term
- o One couple in eight has fertility problems, and adoption may take up to seven years (note (1))
- o 1962, Seattle: first hemodialysis machine became available, with many more people with end stage kidney disease than there were machines - resource allocation problem (who pays - currently the U.S. provides Medicare entitlement to dialysis and renal transplantation)
- o Bumper sticker: “Hey you - out of the gene pool!”
- o In Illinois about 40% of soybeans and 25% of corn are mixed together in the grain holding tanks prior to shipping - with no way available to separate it (and no dual system in existence to keep it separated to begin with)
- o 1998 - 600,000 Chinese farmers sowed Monsanto's gene-altered seed products
- o GE'd foods are in 75% of all processed foods (most Americans have eaten altered food)

**Notes:**

- (1) *"The Price of a Perfect Baby;" Bruce L. Anderson; 1984*
- (2) *"Making Biblical Decisions;" Franklin E. Payne, Jr. M.D.; 1989*
- (3) *Charles Frankel, "The Specter of Eugenics," Commentary, March 1974, p. 28*
- (4) *"The Unholy Alliance," Dr. Mae-Wan Ho; article in The Ecologist; Vol 27; No. 4; July/August*
- (5) *Dr. Ernie W. D. Young, lecture notes as posted in "Access Excellence - Activities Exchange: The Genetic Revolution: Ethical Issues", Gene Connection Second Annual Bioethics Symposium and Workshop presented by the San Mateo County Biotechnology Education Partnership*
- (6) *Bill Lambrecht; Post-Dispatch; Washington Bureau; 7 Oct; 1999*
- (7) *"Biology" Third Edition; Neil A. Campbell; 1993*
- (8) *Bill Lambrecht; Post-Dispatch; Washington Bureau; 27 Dec; 1998*
- (9) *"The Lawyers Weekly" June 26, 1998, Vol. 18 No. 8 (pg 11); revised Feb 10 1999*
- (10) *Diamond, Commissioner of Patents v. Chakrabarty (1980), 2066 U.S.P.Q. 193; U.S. Supreme Court decision granting a patent for oil-spill-eating bacteria*
- (11) *Bill Lambrecht; Post-Dispatch; Washington Bureau; 10 Oct; 1999; "Genetic research on plants steams ahead here, despite concerns in Europe"*

# Genetic Engineering: Some Basics

## A Few Facts & Figures

- o A single strand of human DNA contains one billion bits of information (500 pages of double-spaced typewritten pages) (*"The Price of a Perfect Baby;" Bruce L. Anderson; 1984*)
- o Translation of a single strand of DNA into technical language would require 1000 volumes of fine print, single-spaced reports (*"Making Biblical Decisions;" Franklin E. Payne, Jr. M.D.; 1989*)
- o The DNA found in the 23 chromosomes of a single human cell (few thousandths of an inch in diameter) when stretched end to end would measure over a meter in length. (*Charles Frankel, "The Specter of Eugenics," Commentary, March 1974, p. 28*). This is packed into a cell nucleus 0.006 mm in diameter
- o The human body consists of approximately 10 to the 13<sup>th</sup> cells, for a total of about 2x10 to the 13<sup>th</sup> meters of DNA. If stretched end to end, the DNA in one human body would stretch to the sun and back 50 times! (*"An Introduction to Genetic Analysis" Sixth Edition; Griffiths, Miller, Suzuki, Lewontin, Gelbart; 1996*)
- o Representative numbers of nucleotide pairs contained in the Genome of:
  - o E. coli bacterium = 2.0x10 to the 6<sup>th</sup>
  - o Humans = 3.3x10 to the 9<sup>th</sup>
  - o Zea mays (plant) = 5.4x10 to the 9<sup>th</sup>
- o Zygote: A fertilized egg cell before it divides. After division, the individual cells are called blastomeres. These blastomeres (the first divisions of the zygote) have unique characteristics (not confirmed in humans, but observed in other organisms):
  - o One or more blastomeres can be removed from the aggregates and the remaining cells can produce a whole organism (origin of identical twins in humans)
  - o Individual blastomeres can develop into a whole organism
  - o Aggregates produced by combining two or more zygotes can develop into one organism
- o After the eight-celled stage, the embryo cells begin to differentiate and lose their ability to individually produce a whole organism

## DNA ( DeoxyriboNucleic Acid)

- o DNA is made up of four different nucleic acids (Nucleotides) (Adenine; Guanine; Thymine; Cytosine)
- o The four nucleotides are arranged one after another in a specific sequence (...ATGCCCTAGCTAA...)
- o This sequence is double stranded (helical form) and forms a chromosome. Each of the 23 human chromosomes has a homologous pair (46 chromosomes total)
- o A gene is made up of a string of nucleotides (DNA sequence) that are associated with a certain function that is performed (and only for identified functions - as more functions are correlated with specific Nucleotide sequences - more genes are defined)
- o By mutating (changing or damaging) the Nucleotide sequence (all, some, etc.) of lower organisms and allowing them to then mature, the effect on the development can be observed so that the function of that sequence can be determined (thus defining the gene)
- o The "genome" is the combination of all genes and non-gene sequences in all 46 chromosomes
- o The "Human Genome Project" is "sequencing" (identifying the nucleotide ordering) of the entire human DNA (all 46 chromosomes). This sets the foundation for "mapping", that is defining genes and associated function on each chromosome
- o Monogenic traits: Those traits determined primarily (or entirely) by one site (gene) on one chromosome
- o Polygenic traits: Those traits determined by more than one site (possibly on more than one chromosome)

## Recombinant DNA (rDNA) Technology

- o rDNA is gene splicing technology, that adds, replaces, or subtracts specific nucleotides from a sequence. This is not the same as cloning

- o There are three fundamental ways multi-celled organisms can be changed:
  - o Sperm or eggs (germ line) of the adult could theoretically be modified to correct a known genetic problem and eliminate it from the resulting offspring (e.g. try to rid the gene pool of these factors)
  - o Germ cells after fertilization (zygotes) could theoretically be modified to correct a known genetic problem in that person and their resulting offspring
  - o Non-germ (somatic) cells may be engineered without affecting the rest of the organism e.g. introduce the gene that expresses insulin into the pancreas, the cells in turn produce insulin without having to use injections or by inhalation
- o rDNA can make use of nucleotides from other life forms (animals, plants, humans) in different combinations across species or within species using a variety of well developed techniques. Changes in the nucleotide sequence of a gene can cause the function of the whole gene to change (giving it a different function) or making it non-functional

## **Cloning**

- o Every cell in any organism contains all the necessary information to construct the entire organism. However, only reproductive cells have the capacity to activate this total store of information into a whole organism (some exceptions: onion root, nuclei of cells lining the intestines of frogs, etc.)
- o Identical twins can be considered clones, since they have the same DNA sequencing (zygote split into two separate cells before cell differentiation and then developed into complete babies)
- o “Dolly” the cloned sheep resulted from taking the DNA from a mammary cell of a pregnant sheep, implanting this DNA into an egg cell (DNA removed) of this same sheep, taking the resulting cell and “shocking” it electrically to stimulate it to divide, then planting it into a second sheep to carry it to term and be born as Dolly. No sperm cell was used, the DNA was totally the mother’s (perfect replication - therefore must be female)

# Representative Issues Spawned by Genetic Engineering Technology

(29 November, 1999)

- Note:*
- 1. These represent only a fraction of known or potential issues; the actual number is only limited by the imagination and the resources applied*
  - 2. Although virtually all of the following can be considered moral issues (or ethical in nature), the general categories are used to help isolate specific concerns more quickly*
  - 3. With further research, some of the following may be determined to not be feasible or possible to do, however, the current state of knowledge would indicate that most are at least plausible issues*

## Moral Issues:

- o GE'ing a zygote once formed can entail many failures, is this killing a person?
- o Should testing be allowed on embryos before they show qualities of "personhood" so it can be determined whether they should be allowed to continue developing? How is "personhood" defined and who is going to do it? Should research of any kind be allowed to be conducted on human fertilized eggs?
- o Fertilizing an egg outside of the mother can entail many "failures" first; what is done with the left over fertilized eggs that may not appear "quite right"? Is it right to destroy them? What type of tests should be allowed before a determination of whether the fertilized egg should be implanted or not?
- o Should unborn babies be tested, even if far into a pregnancy? If so, for what reason?
  - o To see if they have any genetic disorders, then decide to correct or abort?
  - o What about other non-life threatening problems (nearsightedness; height; proneness to diabetes or breast cancer or any of a number of diseases)?
- o How should "normal" conditions or characteristics be defined in order to judge what should be eventually genetically engineered "out" of a person?
  - o Cosmetic surgery already very commonplace both for treatment of severe injuries and major deformities from birth, where should a person draw the line on GE'd changes for cosmetic purposes?
  - o Should acceptable characteristics be defined for a baby? If it does not "measure up" will it be destroyed (aborted) for any and all reasons since it has no legal status until born anyway?
  - o How much of a "designer" baby technology should be allowed to be developed and used?
- o Should "positive" eugenics be encouraged to:
  - o Add to the human gene pool so-called desirable characteristics (who determines these?)
  - o Enhance beauty, intelligence, or create abnormal characteristics for novelty purposes? What about combinations of these?
  - o Grow individuals to specifically be super athletes or "drone" workers?
  - o Remove genetic disorders by "correcting" genetic markers in germ cells and then creating a zygote in vitro to ensure the disorder is not passed on to the next generation?
- o Testing of children - what if a condition (susceptibility to breast cancer) is known, when should the child be told? Do the benefits outweigh the risks to the person if there is no known treatment. What about late onset *Alzheimer's Disease* (as one example)?
- o Sperm and egg can come from any donor (available now on the Internet - auctions of sperm and eggs from beautiful, intelligent individuals who want the cash) and be grown in any woman
  - o Who should have legal custody?
  - o Should a mother be allowed to have a surrogate mother grow her child, just so that she will not lose her figure
  - o What if someone wanted to grow a child for a novelty (different race, different color of hair)?
  - o Should a person be allowed to sell their sperm or eggs to the highest bidder?
- o Should the growing of spare parts be allowed through cloning of an individual (and suppressing the brain development)?

## Legal Issues:

- o What happens if a "test tube" baby is deformed - who is responsible?
- o Should patents be granted on new life forms? Should they be considered inventions, intellectual property, or something to only be owned and marketed? How much of a change (enhanced or new functions, whether beneficial or not) is needed in order to define a new life form?
- o What are the legal ramifications to false positives and false negatives in genetic testing? (Even though there is a very low incidence, genetic testing is not 100% correct)
- o What constitutes "informed consent" relative to someone who is to undergo gene "therapy" - how can the potential side effects be addressed since so much is unknown and potentially disastrous?
- o Should farm test sites used for genetically engineered crops be made public knowledge as they are in Europe (currently not required in USA)?
- o Should employers be allowed to require genetic screening of prospective employees and be allowed to deny work on the basis of the results?
- o What privacy rights should a person have to their own genetic information; should the government have access to it?
- o Should everyone have their DNA analyzed to allow them to be uniquely identified?
- o Should some couples not be allowed to have children because of a very high risk of genetic abnormality in their children and the resulting cost to them and society for their care? Should their marriage not be allowed if there is certainty of only genetically "impaired" offspring? Who decides what is acceptable and unacceptable?
- o Should full genetic disclosure be made for all babies that are adopted, should this be done before a marriage license is granted so that the fiancée knows what risks and characteristics their children may have?
- o Should genetic information on an individual ever be allowed to be sold to companies that are marketing Products to individuals with specific physical characteristics (man pattern baldness, etc.)?

## Food Issues:

- o Splicing peanut or shellfish genes into other foods (tomatoes; etc.) could potentially yield a fatal reaction in someone who is extremely allergic to peanuts or shellfish
- o Could the creation of transgenic organisms by splicing genes from bacteria or animals into plants and vice versa contain totally new proteins that are toxic, or that cause severe allergies in some people?
- o GE'd food plants could (and are) being made to be resistant to herbicides, diseases, and pest insects, these could become "Super-weeds" if they escape into the environment and overgrow or interbreed with native plant species. In addition, wind blown pollen from GE'd plants could contaminate surrounding plants and change the ecosystem irretrievably
- o Will the use of herbicide resistant food crops result in greater use of herbicides such that the chemical contamination of the environment would be even greater?
- o Should "terminator" technology be allowed to be developed? Patent awarded in March 1998 (seeds from one harvest cannot be saved for the next crop - sterile; protects proprietary biotechnology)
- o We don't know what we don't know relative to the unexpected effects on agriculture and bio-diversity when GE'd plants become even more common. This is particularly true after tens or hundreds of generations later.
- o Should GE'd food be labeled for the consumer with the specific source of genetic material that has been added? What about artificially created "genetic" material that does not originate from another organism?
- o What happens to competing strains if the "perfect" soybean (or any other food stuff for that matter) is created? Will it replace all other varieties of soy and thus do away with genetic variability? What happens if a bacterium with no known anti-bacterium agent then attacks the crop - it is defenseless in it's entirety?

## **Animal Related Issues:**

- o Should animals be GE'd (cancer prone; pain; malformed; etc.) for the sole purpose to further medical research? Is it OK to do this to rats (OncoMouse), what about cats and dogs, horses, gorillas?
- o Should "public morality" be a criteria in allowing or disallowing GE'ing of animals (such as Europe does)? If so, on what is it to be based? Whose morality?
- o Should human genes be allowed to be spliced into animal zygotes in order to create animals with more human characteristics?
- o Should animals be GE'd in order to provide spare organ parts for humans? How about splicing human genes into animal germ cells in order to ensure closer human characteristics of the resulting organs? How much of a human's genes should be allowed to be placed into another organisms germ cells before it is considered "human-like"?

## **Health Insurance/Insurability Issues:**

- o Should genetic screening be used to determine those that are susceptible to certain diseases or medical conditions - thus making those most in need of medical coverage the least able to obtain it
- o Should health insurance be nationalized and available for everyone so that the risk is spread out amongst a large population, specifically to protect those who have genetic disorders?
- o How should the psychological impact upon people be handled when they are tested positive for a genetic disorder that they will develop later in life but there is no cure to arrest the condition?
- o Who should pay for counseling of individuals tested positive for a genetic disorder - insurance company? Bioengineering company that developed the test capability? The government?
- o If we test positive for a gene that shows we are pre-disposed to a genetically linked condition, how much medical or life insurance are we going to be allowed to take out?
- o If we are self insured or part of a small company that must have medical exams given before obtaining insurance - what will our rates be if we can obtain insurance?
- o Would we be insurable at all? Would we be insurable but with exclusions for the known condition? Will the insurance company be able to have an unborn child tested to see if they have genetic conditions that would result in great expenses - thus encouraging abortion or refusing to ensure it because it can be aborted and wasn't?
- o Are we obliged to inform the insurance company of our genetic status whether the condition that can result from it has surfaced yet or not?
- o Should an insurance company have the right to examine an applicant's genes? What about someone's fiancée?

## **Transgenic life form Related Issues:**

- o Is it right to put human or animal DNA into animal or plant DNA at all? How much should be allowed?
- o What should be done to a newly created "species" that is not wanted or does not meet expectations?
- o What will happen when a new "life form" is created and it gets loose in the environment and has no natural predators?
- o Will all new life forms be protected from extermination? Will their creation be irreversible, or will they only be considered property and disposed of as the "creator" desires?
- o What impact will the creation of totally new life forms have upon the life forms around it?
- o Will splicing human genes with food plant genes result in the eating of humans?
- o Should cross breeding of animals and humans, for example to obtain modified pig organs that could then be transplanted into humans (xeno-transplantation) be allowed?
- o Could vegetarians, and those with strong religious dietary restrictions, unwittingly be eating vegetables and fruits containing genetic material from animals or even humans?

## **Environmental Issues:**

- o Once a “perfect” food stuff is generated, it will naturally force all other varieties out of the marketplace as it is cloned and mass produced. Will this end up destroying all other variety/diversity (intrinsic survivability will be substantially diminished)?
- o GE'd biological organisms are inherently more unpredictable than chemical pollutants, since they can reproduce, migrate, and even mutate over time. If accidentally released into the environment it would be virtually impossible to retrieve and could cause devastating damage
- o Genetically altering plants to make them more resistant to viruses can result in the viruses mutating or adapting into more virulent forms that are much more difficult to control, or they could attack other plant species
- o GE'd microorganisms could create hazardous new pathogens that could escape into the environment and have no known medical remedy

## **Cloning Issues:**

- o Should cloning be allowed in order to supply “spare parts” to the originator if the brain were able to be prevented from developing?
- o For human cloning, what should be done with the failed tries (took 277 attempts to produce Dolly; several failed attempts produced profoundly malformed and major birth defect lambs)?
- o Who determines who will be cloned, what characteristics will be looked for?
- o Should homosexuals be allowed to have clone children (males yield males, females yield females) which would truly be their own children (woman carry her own, man will need a host)

## **Military Related Issues:**

- o Should GE'd biological agents be created that can:
  - o Resist all known antibiotics, defeat vaccines and overcome human or plant natural resistance?
  - o Be more virulent bacteria and viruses than presently known, and be able to live much longer and kill faster (more efficiently)?
  - o Disrupt human hormonal balance?
  - o Target specific ethnic groups or those with unique racial characteristics?
- o How would any biological pathogen used in military action be constrained to only enemy forces?

## **Misc Issues:**

- o Should humans be GE'd to live two or three times longer than the present?
  - o What impact will this have on health and life insurance? The economy? Housing?
  - o What will be the mental state of these individuals?
  - o What will happen to the world's population?
  - o What unforeseen sociological and psychological effects will there be?

## Session #26: New Genetics/Genetic Engineering

### *Homework: Discussion questions*

- o “Will a cloned human being have a soul?”*
  
- o “What, if anything, is wrong with splicing animal genes into human germ cells?”*
  
- o “What, if anything, is wrong with splicing human genes into animal germ cells to create animals that are more ‘human-like’?”*
  
- o “With organs suitable for transplants difficult to obtain, why not grow ‘spare parts’ by altering animal germ cells with human genes for specific organs, or better yet, grow our own spare organs from our own genetic material?”*
  
- o “What’s wrong with developing ‘designer’ babies to order? What about with novel characteristics that would make them unique in non-traditional ways?”*
  
- o “Shouldn’t there be full and open disclosure of the genetic characteristics of a fiancée before marrying in order to determine if possible problems may occur with future offspring?”*
  
- o “What would be wrong, if anything, in creating entirely new species or life forms by genetic engineering?”*
  
- o “Since we cannot stop other countries from pursuing genetic engineering to any extent they want, shouldn’t we pursue it as far as possible to protect ourselves?”*
  
- o “Do you have confidence that the Department of Defense could genetically engineer a deadly pathogen with no known cure, and then totally prevent accidental release forever? How about other countries?”*