

Abortion and Stem Cell Debate Background Information

Fetal Development

Terms

- **Syngamy:** fusion of two gametes in fertilization
- **Zygote:** name of the cell resulting from fertilization until it implants in the uterus 3-4 days later
- **Blastocyst:** stage of cell division in which there is an inner and outer group of cells. Inner cells become the embryo.
- **Embryo:** animal organism in the early stages of development—from blastocyst stage until about 8th week
- **Fetus:** animal organism in the later stages of development—from about 8th week until birth
- **Differentiation:** stage of cell development in which cells begin to take on specific functions (most important stage is first trimester)

Fetal Development

- **First Trimester**
 - Conception to 2 Weeks: fertilization, implantation, and beginning of cell differentiation
 - Weeks 4-5: brain, spinal cord, and heart begin developing; tissue that will become bones develops; early eye and ear structures; arm and leg buds visible
 - Weeks 6-8: lungs begin to form; arms, legs grow hands and feet; webbed digits; all essential organs have formed; facial features continue to develop; end of embryonic stage
 - Weeks 9-12: beginning of fetal stage; fetus about 3 inches long; eyelids close and will not reopen until 28th week; tooth buds appear; genitals appear differentiated; red blood cells produced in liver

Fetal Development

- **Second Trimester**

- Weeks 13-16: fetus around 5-6 inches long; fine hair develops on the head (lanugo); bones become harder and muscle and tissue continue development; fetus actively moves; liver and pancreas produce their fluid secretions
- Week 20: fetus about 8 inches long; lanugo covers body; eyebrows and lashes appear; nails appear on fingers, toes; mother can feel fetus move (quickening)
- Week 22-24: fetus about 11 inches and weighs about 26 ounces; foot and finger prints forming; sweat glands develop; external skin turning from transparent to opaque; alveoli (air sacs) form in lungs

Fetal Development

- **Third Trimester**

- Weeks 25-28: fetus about 15 inches and about 43 ounces; rapid brain development; nervous system developed enough to control some body functions; respiratory system immature but some gas exchange is possible; approximately the stage at which fetuses are thought to feel pain
- Weeks 29-32: fetus about 15-17 inches and about 4.5 pounds; rapid increase in body fat; rhythmic breathing movements occur but lungs are still immature; bones developed but soft and pliable
- Week 36: fetus about 16-19 inches and 5.5-7 pounds; lanugo starts to disappear; fingernails reach fingertips; high chance of survival outside the womb with medical assistance
- Weeks 37-40: full-term at 37 weeks; around 20 inches; breast buds on both sexes; lanugo gone except for upper arms and shoulders

Interesting Facts about Fetal Development

- Success rate & Fertilization
- Twinning
- Fusion

Success Rate & Fertilization

- Fertilization, like embryonic and fetal development, is a process taking approximately 1-2 days
 - There's no discrete point at which fertilization occurs
- Approximately 65-75% of all embryos either do not implant, are spontaneously aborted, or undergo twinning or fusion
 - Spontaneous abortions or miscarriages can occur up to 20 weeks into a pregnancy

Twinnings

- Twinning occurs when the embryo splits in two (monozygotic twins)
 - Twinning can occur up to two weeks after fertilization
- Vanishing twins: fetus begins development as a twin but growth of one stops; roughly one out of every eight pregnancies result in vanishing twins

Fusion

- Fusion occurs when separate and genetically distinct embryos fuse to form a single human being (opposite of twinning)
- Tetraparental Mice: a mouse with four parents that has organs made from some cells derived from one pair of parents and some cells derived from the other pair
- Tetragametic Human: humans derived from four different gametes, not just two (some tetragametic humans have all XX sex chromosomes; others have some XX and some XY sex chromosomes)
- In 2004, researchers at Mayo Clinic observed the fusion of human and pig cells in the body that carried genetic information from both species

Chimeras & Mosaics

- Chimera & Mosaics: individuals with two or more cell lines due to early development fusing
 - Mosaics: the genetically different cells types arise from a single zygote
 - Approximately half of the mammals on earth are a type of mosaic
 - Chimeras: the genetically different cell types arise from more than one zygote
 - in mythology, a chimera is a monster composed of a lion's head, goat's body, and a serpent's tail
 - chimeric cattle are common

Abortion

- Abortion is the termination of a pregnancy
 - Some abortions are involuntary, as in spontaneous abortions or miscarriages
 - Other abortions are voluntary, as when one ends a pregnancy by medical intervention, either surgical or drug

Stem Cell Research

Stem Cell Research Background

- Stem cells are unprogrammed cells that have the ability to change into other cells
- Stem cells can turn into bone, muscle, cartilage, nerve cells, and any other type of cell
 - Because of the plasticity of these cells, regenerative medicine is interested in using these cells to treat many diseases or regenerate organs
 - Much research is concerned with the mechanisms involved in the differentiation process, the stage at which unspecialized stem cells give rise to specialized cells

Characteristics of Stem Cells

- Three characteristics of stem cells:
 - i) they are capable of dividing and renewing themselves for long periods;
 - ii) they are unspecialized; and,
 - iii) they can give rise to specialized cell types

Types of Stem Cells

- Embryonic stem cells – stem cells taken from embryos
- Fetal stem cells – stem cells taken from aborted fetuses
- Umbilical stem cells – stem cells taken from umbilical cords
- Adult stem cells – stem cells taken from adult tissues

- Embryonic and fetal stem cells hold more promise than adult stem cells because they have the ability to change into a greater variety of cells
 - ESCs can replicate themselves many times without differentiating themselves, while most adult stem cells cannot

Embryonic Stem Cells

- Embryonic stem cells are derived from embryos that develop from eggs that have been fertilized *in vitro* and then donated for research purposes with informed consent of the donors
- The embryos from which human embryonic stem cells are derived are typically four or five days old and are a hollow microscopic ball of cells called the blastocyst

Conferring Moral Status

When to Confer Moral Status

- How does one establish or determine the moral status of the embryo and/or fetus? When does an entity have (or lose) moral status?
- What features are important for determining the moral status of the fetus?
- How much moral protection is reasonable and fair to confer upon the embryo/fetus?
- If the fetus does have moral status, to what degree does it have moral status?
 - Is the moral status of the fetus the same as the moral status of an adult?
 - What rights of adults might outweigh the rights of a fetus?

When to Confer Moral Status

- Should the conferring of moral status be understood as an objective fact based on some
 - discrete biological state (fertilization) or
 - intrinsic property (sentience, self-awareness, genetically human) of the entity?
- or,
- Should the conferring of moral status be seen as a decision made within a range of possible and competing alternatives?

Genetically Human & Moment of Conception

- What makes humans entities that have moral status?
 - a feature that marks us as distinctively human is that we are genetically human (Genetically-Human Argument)
- When do a bunch of cells become genetically human?
 - At conception (Moment-of-Conception Argument)

Greene's Arguments

- Moment-of-Conception Argument
- Argument Against Moment-of-Conception Argument

Moment of Conception Argument (Greene)

1. A moral individual exists once a discrete biological event occurs and an individual embryo exists.
 2. An individual human embryo exists at the moment of conception.
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3. Therefore, at the moment of conception a genetically human being gains moral status.

Discrete Biological Event

- What are the discrete biological events assumed by the argument?
 - Fertilization:
 1. Moment of contact
 2. Moment sperm enters egg
 3. Syngamy

1. Moment of Contact

- Event: Embryo exists at the moment the sperm contacts the egg
- Problem:
 - egg emits chemical signals that helps attract the sperm
 - Do these signals constitute contact?
- Biological processes do not easily allow for the individuation of discrete events

2. Moment Sperm Enters Egg

- Event: Embryo exists once sperm penetrates egg's outer membrane
- Problem:
 - more than one sperm can penetrate the egg's membrane
 - Is there fertilization only after second penetration ruled out?

3. Syngamy

- Event: Zygote exists when the egg's and sperm's set of chromosomes join together.
 - Appearance of a cell with a new diploid genome.
 - Occurs 18-26 hours after sperm enters egg.
- Problem:
 - Post-fertilization issues of twinning and fusion undermine syngamy as the stage at which an individual human embryo comes into existence

Fertilization as Process

- Fertilization is a process that takes place over 24-48 hours
- There is no discrete "moment" of fertilization which one can unambiguously point to as the moment when an individual moral being comes into existence
- Conferring moral status at fertilization would require a decision about which stage of the fertilization process is pivotal
 - Can one say one stage of the fertilization processes is more important or has some special moral-status-conferring capacity?
 - No.

Post-fertilization and Early Embryo

Early embryo's individual cells (blastomeres) remain totipotent; i.e., each cell is undifferentiated and capable of developing into a complete human being.

Two problems for specifying existence of an individual human being in early embryo:

- Twinning
- Fusion

Early Embryo Problem for Individual Human at Conception

- If biological humanness occurs at syngamy, twins/triplets/quadruplets are evidence against early embryos being an individual human being.
- Early embryos are an indefinite number of beings in one package

Twinning

- Identical twins — a case of the splitting of the early embryo
- Problem: diploid genome occurring at syngamy is not sufficient for discrete, individual biological humanness since early embryo not necessarily one human being.
 - (Cells lose totipotency after about fourteen days of development.)
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- In other words, one cannot argue that at the moment of conception there is a discrete, individual human being since there are potentially many human beings at conception

Fusion—Problem of Individuality

- Occurs when separate and genetically distinct embryos fuse to form a single human being
 - Chimeras: individuals with two or more cell lines due to early development fusing
- Problem: It is difficult to talk about the early embryo being a single biological individual.
 - If the Moment-of-Conception Argument is correct, then what happens to the moral status of the fused embryos? Do the fused embryo have double moral status? Does the moral status of one disappear?

Individuation

- When exactly is embryonic individuality determined?
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- Both twinning and fusion raise questions about when individuation occurs
- Individual moral status does not arise at syngamy since the existence and unique individuality of the embryo is still undetermined

Later Embryo and Mortality Rate

- Some studies suggest that approximately 60-75 percent of all fertilized eggs do not implant in the womb
- This natural embryonic loss occurs during the first few weeks of fertilization in normal, healthy women
- Problem: Should pre-implantation embryos gain moral status when biological processes do not favor the pre-implantation embryo?

Argument Against Moment-of-Conception Argument

1. Either, one can confer moral status by appeal to a discrete biological event or by appeal to the existence of an individual embryo at the moment of conception.
 2. Properties of the fertilization process do not allow one to objectively identify a unique biological state or time as the moment of conception.
 3. Early embryo development does not allow one to identify a unique, individual embryo existing from the moment of conception.
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4. Therefore, one cannot confer moral status to a fertilized egg or early embryo at the moment of conception.

Ramifications for Stem Cell Research

- If it is true that one cannot confer moral status by appeal to a discrete biological event or to the existence of an individual embryo, then it appears embryonic stem cell (ESC) research is permissible. It violates no one's rights or privileges.
- This conclusion does not entail that one should not have an attitude of respect toward ESCs.

Further Ramifications

- If, contrary to the evidence, one picks a stage of fertilization or embryonic development as the morally significant point in the process, the stage at which individuation and moral status arise, then one has made a non-objective decision about which stage in the process is important.
- Such a decision requires that one examine the underlying values, motives, and reasons grounding that decision.
 - What are the costs and ramifications?

Other Biological Stages

One might still grant moral status to a being by appeal to a different stage in the biological process, e.g.,

- Implantation
- Viability
- Birth
- Or one might confer moral status by appeal to features that arise in later stages of biological development, e.g.,
 - Sentience
 - Rationality
 - Member of the social/moral community