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GENERAL THEORY OF RELATIVITY

See RELATIVITY, GENERAL THEORY OF

GENESIS

The importance of the Old Testament book of Genesis in the history of science stems largely from the fact that the narrative begins with an account of creation. A wide variety of theological cosmologies were based on differing interpretations of these few verses. Most of these views hinged on two major issues of interpretation: the nature of the "beginning" and the primordial materials described in Genesis 1:1–2; and the six "days" described in Genesis 1:4–2:3.

Interpretations of Genesis 1: 1–2 varied with the version of the Bible that was used. The Hebrew version begins with a relative clause: "In the beginning when God created the heavens and the earth, the earth was a formless void . . . ." (New Revised Standard Version), much like the parallel Hebrew construction in Genesis 2:4. So the Hebrew version of Genesis began with the primordial materials of formless earth, water, and darkness (Genesis 1:2). Various interpretations of this "beginning" were possible. Some rabbis accepted the inference that God began with a pre-existent chaos and then created an ordered cosmos (Genesis Rabbah 1:5). Others brought in texts like Proverbs 8:22–24 to demonstrate that God had created the water and the darkness and that the "beginning" of Genesis 1:1 was God's own wisdom as encoded in the Torah (Jubilees 2:2–3; Genesis Rabbah 1:1, 9). Still others argued that God must have created worlds before this one (Genesis Rabbah 3:7; 9:2).

Most Diaspora Jews and early Christians, however, used the Greek translation of the Old Testament, known as the *Septuagint*. This text begins with the absolute statement: "In the beginning God created the heavens and the earth," which implied an absolute beginning for this universe. It also implied that the unformed earth and water were included in the initial act of creation. This reading was followed by pioneering theologians like Basil of Caesarea (c. 329–379) and Augustine of Hippo (354–430) and became the standard interpretation for Christians.

The meaning of the six days of Genesis 1 was also debated. Some exegetes thought there was a temporal sequence of days without specifying their exact length (Jubilees 2:2; Genesis Rabbah 1:3). For those who accepted the idea of an absolute beginning, this implied that God created the cosmos in two stages: God made the building materials (unformed earth, water, etc.) at the beginning of the first day; then God illuminated and formed those materials as described in the narrative (Wisdom of Solomon 11:17; 4 Ezra 6:38–40; Justin Martyr).

Others exegetes saw inconsistencies in the idea of a temporal sequence of days. For example, the first "day" that is described is assigned a cardinal number ("one day" rather than "first day," Genesis 1:5) in both the Hebrew and Greek versions (Genesis Rabbah 2:3; 3:9; Basil); the sun, moon, and stars appear in the narrative three days after the first evening and morning. Some Rabbis saw a nontemporal parallelism between the first three and the second three days (Genesis Rabbah 12:5). Others suggested that the ten utterances ("God said") of the narrative were patterned after the Ten Commandments or the construction of the Tabernacle (Pirqei Avot 5:1; Midrash Tanhuma). Other scholars argued that divine creation required no effort (Genesis Rabbah 12:10) and that it all might have taken place in a single instant (Philo; Midrash Tanhuma). This idea of a simultaneous creation of

all things was followed by early Christian theologians like Origen (c. 185–254), Athanasius (c. 293–373), Basil, and Augustine.

See also COSMOLOGY, RELIGIOUS AND PHILOSOPHICAL ASPECTS; CREATIO EX NIHILO; LIFE, ORIGINS OF

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GENE THERAPY

Gene therapy refers to the repairing or replacing of malfunctioning genes that cause a deleterious illness or condition. There are two forms of gene therapy: *somatic* and *germline.*

Somatic and germline therapies

Somatic therapies are used to replace or repair malfunctioning genes that are expressed in such conditions as cystic fibrosis or sickle cell disease. Since these therapies attempt to remedy the causes rather than alleviate the effects of disease, they presumably will provide more effective and beneficial medical treatments. Although initial attempts to develop somatic gene therapies proved largely unsuccessful, experimental treatments since the mid 1990s of severe combined immunodeficiency disease (SCID) and sickle cell disease have renewed public optimism regarding its potential efficacy.

Like somatic therapies, germline therapies attempt to repair or replace malfunctioning genes. The principal difference is that the corrected gene, rather than the deleterious one, is passed-on to subsequent generations. Consequently, the potential benefits or effects of germline therapies could be much more widespread than those of somatic therapies. As of 2002, no experimental procedures employing human germline techniques had been undertaken.

Ethical and moral objections

In principle, somatic gene therapy has raised few ethical objections. Because these therapies treat the underlying causes of disease at the molecular level rather than concentrating on affected organs or compromised biological processes, somatic therapies have been largely perceived as more sophisticated and potentially more effective extensions of established medical procedures. So long as these therapies are safe, there is nothing inherently wrong in deploying them. The issue of safety, however, came to the forefront with the death in 1999 of a patient undergoing an experimental genetic treatment for ornithine transcarbamylase (OTC) deficiency, an incident that prompted calls for greater public oversight or regulation.

The prospect of germline therapy has proven much more controversial. The primary objection is that humans should not attempt to construct the genetic inheritance of future generations. This objection usually takes one of two forms. First, since so little is known about the complex relationship between genes and larger environmental factors, it would be imprudent to introduce genetic alterations that would be inherited by future generations. Although the goal would be to eliminate a severely debilitating disease or condition, there might be unintended or unforeseen consequences that would adversely affect subsequent generations. Individuals carrying a recessive deleterious gene, for example, might in the future incur certain survival advantages in response to changing environmental factors. Since the effects of germline therapy are so much more widespread than those of somatic therapies, large populations could be potentially devastated. The seemingly harmless or even beneficial intervention into the human germline could wreak havoc down the road.

The second form of this objection invokes a more sweeping moral imperative. Humans do not have a right to shape the genetic endowment of their descendants, and correspondingly, individuals have the right to be born with unaltered genomes. People must simply resist the temptation to play God in shaping the destiny of humans, both as individuals and as a species.