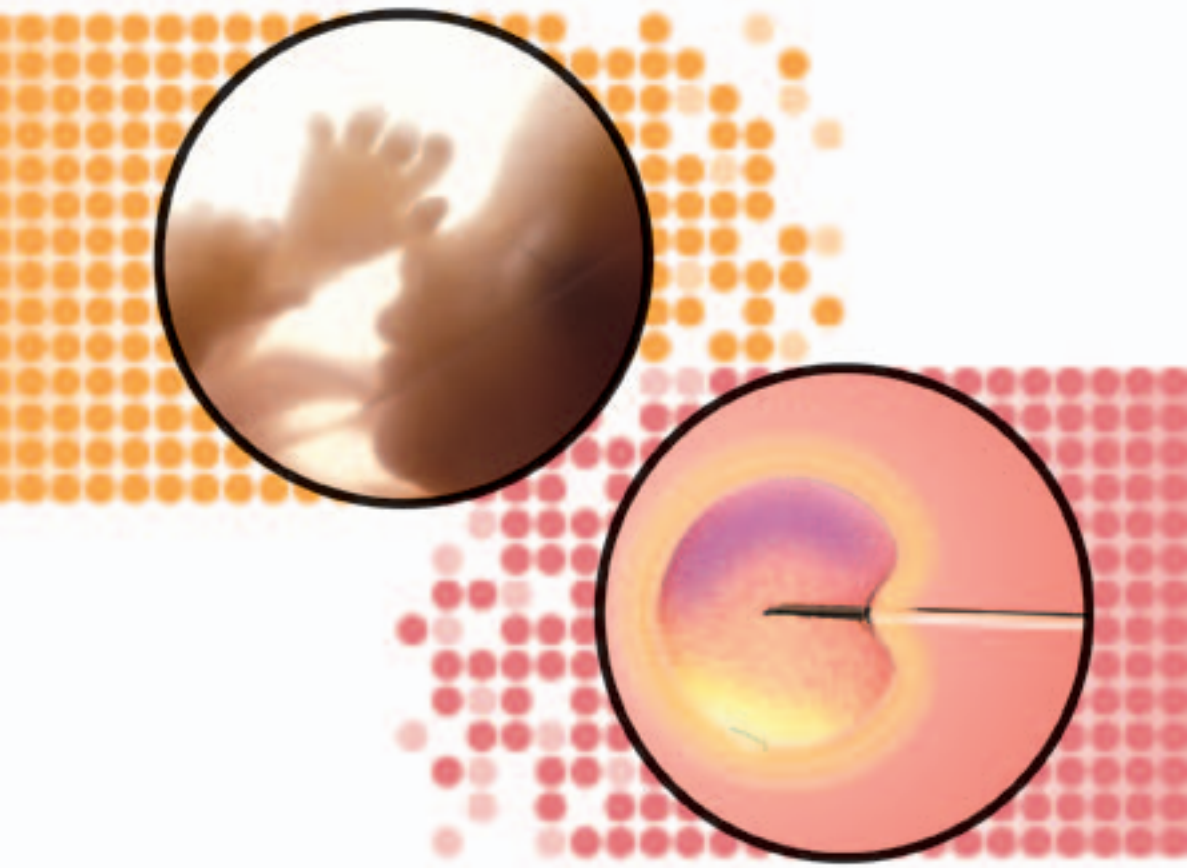
CONTEMPORARY ISSUES in SCIENCE

BEGINNING LIFE



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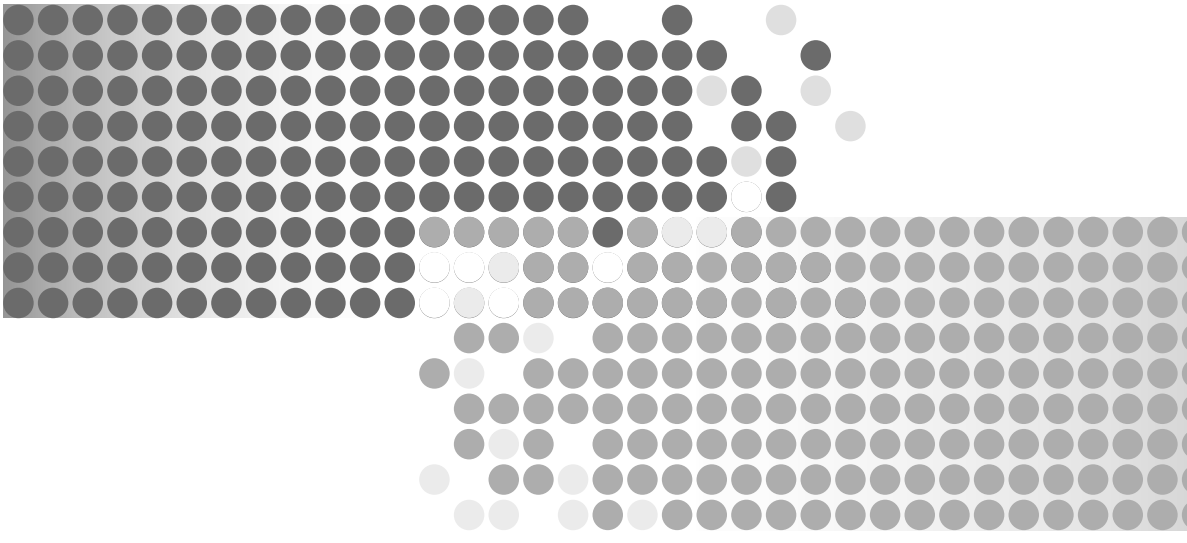

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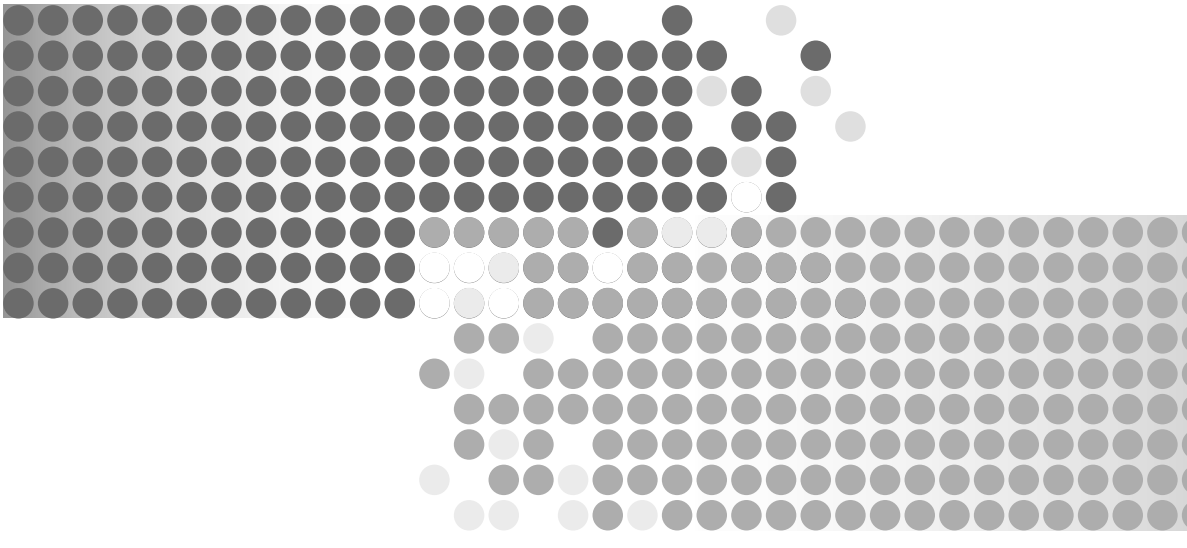

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CONTENTS

Preface viii
Acknowledgments xiii
Introduction xiv

1. ETHICAL PRINCIPLES IN GENETIC AND REPRODUCTIVE RESEARCH 1
Louise Brown: The First Test-Tube Baby 2
The Belmont Report: Ethical Principles in Medical Research 6
The Problem of Scope 7
Patenting Life: The Commercial Ownership of Genes and Organisms 10
In Vitro Fertilization Today 13
Summary 20

2. CONTROVERSIES IN ASSISTED REPRODUCTION 21
ART and Multiple Births: The McCaughey Septuplets 21
Maternal and Infant Health Risks of Multiple Births 24
Surrogate Motherhood 28
Selective Reduction: When Surrogates and Intended Parents Disagree 32
Surrogacy Across National Borders 36
Summary 39

3. EUGENICS, GENETIC TESTING, AND DESIGNER BABIES 40
Genetic Knowledge, Genetic Control 41

Eugenics as Social Policy: The Carrie Buck Story 46
Contemporary Liberal Eugenics 49
Infant Screening for Treatable Conditions 54
Genetic Discrimination and Privacy 57
Screening Children and Adults for Incurable Diseases 58
Summary 61

4. GENE THERAPY AND ENHANCEMENT 63
What Is Gene Therapy? 63
The Death of Jesse Gelsinger 67
Status of Gene Therapy Research 69
Technical Limitations and Ethical Concerns 71
The Transhumanist Movement 79
Summary 81

5. STEM CELLS AND THERAPEUTIC CLONING 82
Types of Stem Cells 83
Turning Adult Cells "Embryonic" 92
Patchwork Policies on Stem Cell Research 96
Celebrities Speak Out on Both Sides of the Debate 98
Embryonic Stem Cells: A Cure for Age-Related Blindness? 101
Summary 102

6. ABORTION AND EMERGENCY CONTRACEPTION 104
Before Abortion Was Legal: The Sherri Finkbine Story 105
Perspectives on Abortion 106
Human-Animal Hybrids and the Right to Life 108
Emergency Contraception 112
When Abortion Became Legal: *Roe v. Wade* 114

The Partial-Birth Abortion Ban Upheld:
Gonzales v. Carhart 117
Summary 118

7. REPRODUCTIVE CLONING AND ECTOGENESIS 119
Dolly: The First Animal Cloned from an Adult 120
Animal Cloning 123
Cloning Humans? 125
Ectogenesis: Growing Babies Outside the Womb 127
Ectogenesis and the Abortion Debate 129
Summary 131

8. INFANTS 132
Baby Doe and the Treatment of Impaired Infants 133
Extreme Prematurity 137
Baby Messenger and Aggressive
Treatment of Premature Newborns 140
Denmark's Required Minimum Gestational Age 142
Summary 144

Chronology 145
Glossary 152
Further Resources 165
Index 183

PREFACE

"Whenever the people are well-informed, they can be trusted with their own government. Whenever things get so far wrong as to attract their notice, they may be relied on to set them to rights."

—Thomas Jefferson

In today's high-speed, high-pressure world, keeping up with the latest scientific and technological discoveries can seem an overwhelming, even impossible task. Each new day brings a fresh batch of information about how the world works; how human bodies and minds work; how human civilization can "work" the world by applying its collective knowledge. Switch on a television news program or the Internet at this very moment—pick up any newspaper or current interest magazine—and stories about health and the environment, worries about national security and violent crime, or advertisements for the latest communication and entertainment gadgets will abound.

Given the nonstop flow of information and commercial pressures, it may seem that a surface understanding of scientific and technological issues is the only realistic goal. The Contemporary Issues in Science set is designed to dispel the myth that a deeper understanding of new findings in science and technology—and therefore considerable power to influence their use—is out of reach of nonspecialists and should be "left to the experts." The set reviews current topics of universal relevance like global warming, conservation, weapons of mass destruction, genetic engineering, medical research ethics, and life extension, and explores—through the lens of real people's stories—how recent discoveries have changed daily life and are likely to alter it in the future.

Stories featured in the set have received attention in the popular press—often provoking heated controversy at a local, national, and sometimes international level—because beneath the headlines lie sticky questions about how new knowledge should, or should not, be applied, as illustrated by the following examples:

- *Genetic engineering.* The pace of discovery about the human genome and the genomes of other animal and plant species has been breathless since the year 1953, when James Watson and Francis Crick first described the double helix structure of deoxyribonucleic acid (DNA), the chemical substance that acts as a blueprint for building, running, and maintaining all living organisms. In April 2003—a mere 50 years later—sequencing of the human genome was complete. This impressive surge in knowledge about our genes has been accompanied by intense hopes—and intense fears—about newfound technical powers to manipulate the production of life. The tragic death of 18-year-old Jesse Gelsinger in a 1999 gene therapy trial begged obvious questions: Can medical investigators ever obtain truly informed consent from a volunteer when the risks of an experimental procedure are largely unknown? Are the potential benefits of gene therapy worth the unknown public-health risks of altering the human genome using viral vectors? What are the environmental risks of creating transgenic plant and animal species?
- *End-of-life care.* Bold medical innovations like mechanical ventilation, organ transplantation, and tube feeding have saved and improved the lives of millions of patients since the 1950s. A state of profound unconsciousness known as "irreversible coma" first occurred with the ventilator; before its availability, patients without working respiratory systems died from lack of oxygen. Now the bodies of severely brain-damaged and brain-dead people can be maintained indefinitely

with a steady supply of oxygen to their living tissues. Theresa Schiavo's case—and other controversial end-of-life cases—shows how loved ones and medical professionals try to grapple with agonizing questions like: When are medical interventions extending meaningful life, and when are they inappropriately prolonging death? If a patient's wishes cannot be known with certainty, who should decide her fate?

- *Consumer choice.* Using cheap and plentiful energy; selecting personal transportation modes; building and occupying homes; consuming . . . well, just about anything: These options are all realized through technological innovation. Consumer choice is credited for dramatically improving quality of life in North America over the past century, but it has also created a suite of forbidding problems: global climate change, pollution, urban sprawl, and resource depletion. Can modern consumers—especially the rapidly increasing Chinese and Indian "middle-classes"—enjoy the same choices, or the same quality of life, as North Americans of the last half of the 20th century? Will purely technological solutions for problems arise (e.g., will a form of cheap and reliable carbon sequestration be developed to store carbon dioxide, allowing coal to be used to produce cleaner electricity)? Or will technology provide the means for a dramatic change in how people live and work (e.g., will ubiquitous broadband and wireless access lead to the delocalized office—employees always at work, so there is no need to "go to work," no matter where they are)?
- *Water.* With "peak water" (the maximum amount of clean, usable water available globally) predicted to occur sometime in the next 25 years, this vital natural resource is certain to be the source of national and regional conflicts. Water plays an essential role not only in living processes but in industrial-scale heating and cooling and in new alternative energy technologies such as coal gasification, hydrogen production,

and biofuels conversion. Water also figures highly in global climate change, acting both as a greenhouse gas and as a dynamic heat reservoir. For humankind's clean water requirements, is technological advancement the problem or is it the solution? Will gigantic energy-efficient desalination plants turn countries with ocean coastlines into the new "wet" OPEC, with "clear gold" (water) replacing "black gold" (petroleum) as the preeminent wealth-generating natural resource? Can technological innovation lessen the terrible toll that floods and droughts take on property and human lives?

- *Privacy.* Today, all bits and pieces of personal information—financial, medical, political, religious, identity-by-association, consumer preference, and lifestyle—are being collected, parsed, amalgamated, mined, and analyzed at a rate, and to an extent, unimaginable a decade ago. An individual's personal information can be collected, shared, exchanged, sold, disseminated, and broadcast without notice given to, or permission received from, the individual—and all perfectly legally. Identity theft is a widespread and growing problem—a phenomenon both created and addressed by modern electronic and software technologies. The use of e-mail to acquire personal financial information under false pretences, known as "phishing," was estimated to have cost U.S. citizens over $2.8 billion in 2006. Can the benefits of instantaneous and remote transactions—financial, consumer-based, social, and educational—ever outweigh the loss of privacy or the risk of being victimized? Who really owns a person's digital identity—the individual, banks, insurance companies, or government agencies?
- *Weapons.* On August 6, 1945, the city of Hiroshima, Japan, was annihilated by an atomic bomb that killed an estimated 70,000 civilians instantly. Radio Tokyo described the extent of the devastation in a broadcast intercepted by Allied forces: "Practically all living

things, human and animal, were literally seared to death." Three days later, a second nuclear bomb was detonated—this time over the southern port city of Nagasaki—killing another 40,000 to 75,000 people. Nuclear weapons have not been used since, but many countries have sought and achieved the technology to deploy them. What is the real threat of nuclear warfare in the early 21st century? What other potentially devastating weapons are being developed today, and how can human civilization avoid its own violent destruction?

Whether readers are students considering a career in a scientific or technical field, science or social studies teachers or librarians, or inquisitive people of any age with personal, professional, or political interests in how new knowledge is applied, the Contemporary Issues in Science set places fresh research findings in the context of real-life stories, clarifying the technical and ethical subtleties behind the headlines and supporting an engaged, informed citizenry.