KENILWORTH UNION
CHURCH

SERMON

From the Pulpit: July 21, 2024

Sixteenth Sunday in Ordinary Time—Communion

The Reverend Dr. Katie Snipes Lancaster

Genesis 2:7

God After... IX: God after Doudna

Genesis 2:7
Then the Lord God formed a human
from the dust of the ground
and breathed into his nostrils the breath of life,
and the human became a living being.

Some of the scientific discoveries we've covered in this sermon series look back to primordial beginnings, asking where did we come from? Others have looked out at the stars.

This one asks us to think about what it means, at the most fundamental level, to be human, and how we might choose, in some instances, to change some of the inmost parts of ourselves, our DNA.

Abraham Joshua Heschel, Jewish philosopher and theologian offers this prayer, which seems apt:
"Some asked for success.
I asked for wonder.
And You gave it to me."[1]

We must hold this all with wonder. It ultimately takes us back to the beginning when God took the soil, the fertile earth and breathed life into it. And there we were. Living creatures. Marked by the spirit of God, every breath a reminder that we are never far from the Spirit, we are never removed from the Holy One.

Now we hold, with wonder the story of Jennifer Doudna. There are three critical histories that intersect with Jennifer Doudna, all of which deserve at least an hour long lecture as we consider who God is in her wake.
(1) The history of women in science
(2) the history of genetic engineering and
(3) the history of pandemics[2]

We'd also need a looking glass into the future, because Jennifer Doudna is still alive and her impact on our understanding of the self, the other, and God is therefore yet unfolding.

Jennifer Doudna was born in 1964. She grew up in Hawaii, her father a professor at University of Hawaii. And though now she champions curiosity-driven science, it is clear that from the beginning she was a curiosity-driven child.

She and a friend would ride bikes to visit the blind spiders who lived in lava-flow caves, and she would ride her horse to the fields of "sleeping grass" fern-like leaves that curiously fold up when touched.

When her dad left a copy of James Watson's *Double Helix* on her bed in the sixth grade, her life was unmistakably set on a trajectory toward the sciences. It reads like a mystery novel, James Watson's big personality coming through making each scientific scene feel cinematic, but it also gave her a glimpse of the scientist Rosalind Franklin who captured the double helix structure of DNA, but whose story was sidelined by gender discrimination, yet Rosalind Franklin was there nonetheless, leading Doudna to courageously say "yes" to a scientific career despite her own experience of gender discrimination—especially from her high school counselor who said women don't pursue science.[3]

At Harvard Medical School, Doudna decided to follow in the footsteps of a scientist who was moving away from the more popular DNA research to the realm of RNA (DNA's more ancient co-partner in coding life). A decision which put her in the right place at the right time to develop precision gene editing using CRISPR.

In 2020, with microbiologist Emmanuelle Charpentier, Jennifer Doudna won the Nobel Prize in Chemistry, the first time a science Nobel was awarded to an all-female team.

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[1] Heschel, Abraham Joshua. *I Asked for Wonder: A Spiritual Anthology*. Edited by Samuel H. Dresner. New York: Crossroad Publishing Company, 1983.

[2] see my appendix for the multiple intersecting histories.

[3] Isaacson, Walter. *The Code Breaker: Jennifer Doudna, Gene Editing, and the Future of the Human Race*. New York: Simon & Schuster, 2021.

"Some ask for success. I asked for wonder. And you gave it to me," prays Abraham Joshua Heschel.

These are the women who change history. This is groundbreaking science that is still forthcoming.

What is CRISPR? What did Jennifer Doudna discover exactly? Jennifer Doudna developed precision genome editing by harnessing an ancient process used by bacteria for eons to defend themselves from viruses.

CRISPR. Bacteria have these repeated codes, called CRISPR9 (clustered regularly interspersed short palindromic repeats) which are two things:

first a memory bank full of genetic code full of information about viruses that bacteria have encountered in the past,

second using that memory bank as a way for bacteria to detect and destroy those viruses with such precision as had not previously been seen or understood before.

Jennifer Doudna used this ancient, primordial CRISPR technology inside everyday bacteria to create a universal way for scientists to detect, cut, and replace DNA anywhere.

She basically went to the bacterial equivalent of ACE hardware and borrowed a tool that bacteria had been successfully using since possibly before human life began.

"Some ask for success. I asked for wonder. And you gave it to me," prays Abraham Joshua Heschel.

Here's what the technology means: if the human genome fit letter by letter into a book, it would fill the equivalent of 60 encyclopedias of DNA sequencing, those letters ACGT repeating in a unique way for every individual. And the CRISPR technology can find, select, cut, and replace ***just one word***, in that 60 volume encyclopedia, ***just one piece of DNA*** with the same precision editing as a word processor trying to find, copy, and paste a word into a document.[4]

She discovered this technology in 2012 and raced to publish her research.[5] But by 2015, she asked for a scientific moratorium on DNA modification until the scientific community could think through the necessary ethical considerations.

DNA is the source code for life. Was it possible to cut and paste a mistake instead of a cure? What if you messed with the DNA not just of an individual, but of an individual's germ line—their inheritable DNA—changing the DNA of humans for generations to come? There were too many questions to just blindly move forward.

She gathered the scientific community. It seemed reasonable to want the community to consider the implications, and find realistic ways to live into the Hippocratic Oath "do no harm."

At the first summit she summoned, while she was hand wringing about potential bad actors in the scientific community taking this technology in unforeseen sinister directions, a scientist leaned over and whispered: what if the question is not "should we use this technology?" but instead "now that we know this information, will it soon become unethical ***not*** to use it?"

Does "***not*** pursuing gene editing actually do more harm by prolonging unnecessary suffering for potentially CRISPR curable diseases?

With CRISPR gene editing there is potential to diagnose and treat cancer and edit gene mutations that cause cystic fibrosis, muscular dystrophy, Huntington's disease, and hemophilia. It can interrupt childhood asthma. It can edit crop genomes to secure the global food supply.[6] It can help animals adapt to climate change.

Doudna thinks she might be able to curb 90% of agricultural methane emissions using CRISPR.[7] On January 9, 2020 when the entire genetic sequence of the corona virus was posted online by Chinese researchers, Doudna knew what it took to harness the collaborative efforts of a multidisciplinary scientific team, so that by March of 2020 she had transformed her entire lab into a COVID research hub.[8]

No one part of this story can be fully told here. But suffice it to say that Doudna now carries a kind of hope within her, hope that is found every time she comes face to face with the children and parents of impossible everyday genetic disorders that might have real cures in the generation to come.

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[4]Ian Brewer, "Tracking the Rapid Rise of Human Enhancing Biotechnology with Siddhartha Mukherjee," *GZERO World with Ian Brewer* (podcast), December 2, 2023.

[5]Charpentier, Emmanuelle and Jennifer Doudna. "Programmable DNA Scissors Found for Bacterial Immune System." Science 336, no. 6081 (2012).

[6]Heidi Ledford, "CRISPR-edited crops break new ground in Africa: Scientists in the global south use the popular technique to protect local crops against local threats," *Nature*, January 25, 2024, https://www.nature.com/articles/d41586-024-00176-8.

[7]Innovative Genomics Institute. *Annual Impact Report 2022–2023*. https://innovativegenomics.org/wp-content/uploads/2023/12/IGI-Impact-Report-2023.pdf. Accessed July 21, 2024.

[8]Isaacson, Walter. *The Code Breaker: Jennifer Doudna, Gene Editing, and the Future of the Human Race*. New York: Simon & Schuster, 2021.

Jazz Hardrickt has sickle cell disease. When the pain hits, she says it feels like something is stabbing her. She feels like she can't move. You can't make it go away. Sickle cell disease causes your red blood cells to curl up on themselves, folding into the shape of a half circle, a sickle shape.[9] The life expectancy of someone with sickle cell is about 25 years. Scientists admit that there are very limited treatments because of the history of systemic racism as it relates to medicine: 100,000 people in the United States have sickle cell disease, and 90% are African American.

It is children like Jazz Hardrict who Jennifer Doudna has in her sights when she champions the CRISPR technology she discovered barely a decade ago. But you can't read Jazz's story in Doudna's book that she published in 2015, nor in Walter Isaacson's biography about Doudna that he published in 2021.[10]

This is a story that you have to follow in real time. Interviews Doudna gave just weeks ago are unveiling new developments in the CRISPR story, and it was just January of this year that the life-saving CRISPR gene editing tool was approved by the FDA to treat sickle cell disease.[11]

Jennifer Doudan now focuses on two primary ethical concerns: **first is accessibility.** Right now, CRISPR gene editing for sickle cell treatments are 2.2 million dollars per patient. They require months in the hospital, painful bone marrow extraction and preimplantation, and chemotherapy in the meantime. The science is still out about if it is a lasting cure,or just a stop-gap treatment.

Doudna dreams of making CRISPR therapeutics deliverable with a single injection or pill. Something done at your local hospital, or even at the doctor's office. Something fully covered by insurance.

Her second ethical consideration: where to focus the energy of the scientific community. There is a thread of the sickle cell story that is seeking to intentionally pursue treatments of a disease previously impacted by racism.[12] How can the scientific community do the most good for the most people? Where will preciously scarce resources be used to bring about healing and hope for those in deepest need?

How do we understand God after Doudna? Doudna gives us three gifts:
the gift of compassion and justice
the gift of collaboration and cooperation
and the gift of curative care.

In an anxious generation, in a season where all feels uncertain, these gifts lead the way, and feel Gospel-shaped in their own way. "Some asked for success. I asked for wonder. And You gave it to me" —Abraham Joshua Heschel.

George Bernard Shaw says, "Think of the fierce energy concentrated in an acorn. You bury it in the ground
and it explodes into an oak tree." Today, I think of CRISPR, a technology used innately by bacteria for eons, protecting its offspring from viruses. That fierce energy and hope concentrated in the knowledge bank of bacteria all along. It takes me back to that ancient creation story, where we imagine our artist God, gathering up a holy handful of rich fertile top soil and breathing life into it.

From the beginning, some holy spark, uniting us all, humans and living creatures, including the microorganisms we so often overlook, each carrying within a kind of divine wisdom, if only we open our eyes to behold it, if only we let our curiosity, compassion and collaboration carry us to the throne of grace, if only we pay attention.

May we be filled with holy wonder.
May divine curiosity abound.
In the name of the Father,
the Son and the Holy Ghost.
Amen.

ADDENDUM: *Doudna's Three Histories*

DIVERSE PEOPLE OF SCIENCE
Hypatia (355–415) Alexandria, Egypt: one of the first women in recorded history to study and teach mathematics
Maria Sibylla Merian (1647–1717) Frankfurt, Hesse (Germany): Pioneered the study of insects and turned them into fine art
Mary Anning (1799–1847) Lyme Regis, England: Her fossil discoveries helped lay the foundation for modern paleontology
Ada Lovelace (1815–1852) London, England: Gifted mathematician celebrated as the first computer programmer
Marie Curie (1867–1934) Warsaw, Poland: First woman to win a Nobel Prize, and the only person ever to win in two different science fields (discovers radioactivity, discovers polonium and radium)
Michio Tsujimura (1888–1969) Okegawa, Japan: Groundbreaking biochemist known for her research on green tea's nutritional benefits

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[9]"Jazz Journey." UCSF Benioff Children's Hospital. Accessed July 21, 2024. https://give.ucsfbenioffchildrens.org/stories/jazz-journey.

[10]Jazzy as she was called by her Auntie Sarai lost her life long battle with Sickle-cell disease September 5th, 2022 at just 13 years of age.

[11]Sickle Cell Disease Association of America. "SCDAA Statement about Gene Therapy Approval." *Sickle Cell Disease Association of America*. December 8, 2023. https://www.sicklecelldisease.org/2023/12/08/scdaa-statement-about-gene-therapy-approval/. Accessed July 21, 2024.

[12]"Jennifer Doudna: My Life in Science," *UNSW Center for Ideas* (podcast), June 26, 2024.

Isobel Wylie Hutchison (1899–1982) West Lothian, Scotland: The Quiet Explorer who brought new understanding of the Arctic's plant life and Indigenous peoples
Joan Beauchamp Procter (1897–1931) London, England: Devoted herpetologist who changed the way zoos study and house reptiles
Janaki Ammal (1897–1984) Thalassery, Kerala, India: Pioneering botanist and advocate for India's natural diversity
Star Mapping Vatican Nuns (born late 1800s) Lombardy Region: Regina, Concetta, Luigia, and Emilia together mapped the position of nearly half a million stars
Rosalind Franklin (1920–1958) London, England: Captured the double helix structure of DNA
Marie Tharp (1920–2006) Ypsilanti Michigan: Geologist whose maps forever changed our understanding of the ocean floor
Tu Youyou (born 1930) Ningbo, Zhejiang, China: Her anti-malaria medicine has saved millions of lives, but she went unknown for years
Jane Goodall (born 1934) London, England: Made us rethink what it means to be human by studying our closest animal relatives
Sue Hendrickson (born 1949) Chicago IL: Self-taught marine archaeologist and fossil hunter, after whom the Field Museum T-Rex is named
Mae Jemison (born 1956) Decatur, Alabama: First woman of color to go to space, working to change the image of what a scientist looks like
Ozak Esu (born 1991) Kanu Nigeria: Rising international star in engineering and advocate for women in the field[13]

PLAGUE STUDY
1200 BC: Babylonian Flu
429 BC: Plague of Athens killing 100,000
Second Century: Antonine Plague, kills 10 million
Sixth Century: Plague of Justinian, kills 50 million
Fourteenth Century: Black Death, kills 200 million
2020: Covid Pandemic, kills 3 million[14]

GENETIC TIMELINE
5000 BC: Selective breeding of crops and livestock
400 BC: Greek Philosophers and human inheritance
1859: Charles Darwin and Natural Selection
1865: Gregor Mendel and Heredity
1869: Frederick Miescher and DNA Isolation
1879: Walter Flemming and Mitosis Described
1902: Walter Sutton and Chromosome Theory of Inheritance
1909: Wilhelm Johannsen coins the word Gene
1943: William Astbury and DNA's regular periodic structure
1952: Alfred Hershey and Martha Chase show Genes are made of DNA
1953: Francis Crick and James Watson describe DNA double helix
1955: Joe Hin Trio defines 46 human chromosomes
1955: Arthur Kornberg and DNA copying enzymes
1959: Jerome Lejeune and Chromosome Abnormalities
1961: Sydney Brenner and mRNA machinery
1966: Marshall Nuremberg cracks the genetic code
1973: first animal gene cloned
1975: Sanger and Maxim develop DNA Sequencing
1976: First Genetic Engineering Company
1981: Transgenic Mice and Fruit Flies
1983: Huntington's disease found on chromosome 4
1983: PCR invented (to amplify DNA)
1987: First Human Genetic Map
1990: Human Genome Project launched
1994: FDA approves FLAVR SAVR Tomato
1996: ZFNs found to cut DNA
2000: Human Genome Draft Complete
2010: TALENS—programmable DNA editor
2012: Doudna and Charpentier democratize genome editing with CRISPR[15]

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[13]Sinclair, Lindy. Science People: A Celebration of Our Diverse People of Science. Illustrated by David Lee Csicsko. Trope Publishing Co., 2022.

[14]Shapiro, Beth. *Life as We Made It: How 50,000 Years of Human Innovation Refined—and Redefined—Nature*. New York: HarperCollins, 2023.

[15]National Human Genome Research Institute. "Genetic Timeline" https://www.genome.gov/Pages/Education/GeneticTimeline.pdf

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