In the Bible, the book of Genesis _____ that God created plants, animals, and humans. Traditionally, the ability to design and _____ _____ has been considered to be _____ power. Besides the Bible, there are _____ _____ of mythological fictions around the world about the origin of creatures. Today, however, Homo sapiens are _____ this _____ ability. ____ ____ been _____ billion years since the first organisms _____ ____ _____, and all of life has evolved following the principle of _____ _____. But for the first time in the history of biology, we are going to _____ a new _____ to the game of life. _____ the _____ progress of gene editing technologies in recent years, including CRISPR/Cas9, humanity is becoming able to modify the _____ of life. This technology has the potential to _____ genetic _____, increase agricultural production, and even _____ human capabilities. What kind of future _____ _____ _____ ____ genome editing?

In the Bible, the book of Genesis states that God created plants, animals, and humans. Traditionally, the ability to design and produce creatures has been considered to be divine power. Besides the Bible, there are multiple versions of mythological fictions around the world about the origin of creatures. Today, however, Homo sapiens are acquiring this divine ability. It has been 3.8 billion years since the first organisms appeared on earth, and all of life has evolved following the principle of natural selection. But for the first time in the history of biology, we are going to add a new rule to the game of life. With the exponential progress of gene editing technologies in recent years, including CRISPR/Cas9, humanity is becoming able to modify the blueprint of life. This technology has the potential to eliminate genetic ailments, increase agricultural production, and even upgrade human capabilities. What kind of future will be brought by genome editing?

the book of Genesis	創世記		exponential	指数関数的、加速度的な
divine	神の、神聖な		modify	修正する、変更する
mythological	神話の		blueprint	青写真、設計図
organism	生物		eliminate	削除する
principle	原理、法則		ailment	病気

Genome Editing: The In-Vitro Creation #2

Geneticists _____ _____ _____ for decades for a technology to precisely target and edit specific genomic sequences. In 2012, a paper on the defense system of _____ called “CRISPR/Cas9” was published in *Science* magazine. It immediately sparked the imagination of biologists around the world. Some bacterial species _____ _____ a system to _____ _____ the genomes of invading viruses to kill them. The system recognizes the _____ viruses by their DNA sequence. The _____ are not _____ ____ _____ places, _____ ____ _____ _____ _____ in the virus’s DNA. Researchers found that this defense system consists of two _____ _____; “seeker” and “cutter.” The seeker is an RNA _____ in the bacterial genome that looks for the DNA sequence that matches itself in the viruses’ genome. The cutter is a _____ named Cas9. Once the seeker recognizes the virus ____ _____ _____, Cas9 is deployed to cut off the DNA at the _____ _____ by the seeker. _____ _____ ____ _____, the seeker finds the target spot and _____ the cutter to the spot, and the cutter _____ the targeted DNA. Researchers discovered that we can edit genes _____ _____ _____ by introducing two manipulations in this mechanism. First, we can _____ the target DNA sequence by replacing the seeker. Second, we can _____ in the recovery process of DNA. When DNA is cut open, it tries to recover the _____ _____, usually _____ the other copy of the _____ in the cell. But if a cell is _____ with foreign DNA, _____ the gene accidentally copies the information _____ _____ _____ DNA, rather than from its _____. This works more easily, precisely, and efficiently than any other gene-editing methods ever existed.

Geneticists had been longing for decades for a technology to precisely target and edit specific genomic sequences. In 2012, a paper on the defense system of microbes called “CRISPR/Cas9” was published in *Science* magazine. It immediately sparked the imagination of biologists around the world. Some bacterial species have evolved a system to cut off the genomes of invading viruses to kill them. The system recognizes the offender viruses by their DNA sequence. The cuts are not delivered at random places, but at specific targeted sites in the virus’s DNA. Researchers found that this defense system consists of two critical components; “seeker” and “cutter.” The seeker is an RNA encoded in the bacterial genome that looks for the DNA sequence that matches itself in the viruses’ genome. The cutter is a protein named Cas9. Once the seeker recognizes the virus as an enemy, Cas9 is deployed to cut off the DNA at the spot specified by the seeker. To put it simply, the seeker finds the target spot and brings the cutter to the spot, and the cutter snips the targeted DNA. Researchers discovered that we can edit genes with pinpoint accuracy by introducing two manipulations in this mechanism. First, we can change the target DNA sequence by replacing the seeker. Second, we can interfere in the recovery process of DNA. When DNA is cut open, it tries to recover the lost part, usually from the other copy of the gene in the cell. But if a cell is flooded with foreign DNA, then the gene accidentally copies the information from this external DNA, rather than from its backup. This works more easily, precisely, and efficiently than any other gene-editing methods ever existed.

sequence	順序、配列		deploy	配備する、駆動する
paper	論文		snip	チョキチョキ切る
microbe	微生物、細菌		accuracy	正確さ
spark	刺激する、引き起こす		manipulation	操作、処置、改ざん

Genome Editing: The In-Vitro Creation #3

_____ _____ _____ of CRISPR technologies, we can edit genes precisely and efficiently with a lower cost. In principle, a _____ _____ of human DNA can be _____ to another letter, leaving the 3.2 billion other _____ of the genome largely untouched. The cost and efficiency are also important as research funds and time are _____ limited. Since this new genome editing technology was _____ in 2012, its various potential applications have been suggested. One _____ application is _____ improvement. For instance, _____ like high-_____ rice, non-_____ potatoes, and less _____ tomatoes _____ _____ _____ created using CRISPR/Cas9. Given the climate change and food shortages caused by overpopulation, genome editing for crop enhancement is going to be _____. Also, genome editing can _____ the problem of food allergies. Most allergens are specific proteins. We can _____ allergens in food by removing genes associated with the _____ of allergenic proteins. There are already ongoing studies on genome editing in _____ animals, such as chickens that _____ eggs with less allergen. Another application of genome editing is, of course, in _____. Genetic disorders like hemophilia and muscular dystrophy are caused by mutations in specific genes. Hemophilia, for instance, is a condition _____ _____ cells can't _____ blood clotting factors _____ and _____ bleeding can’t easily stop. By employing CRISPR technology, we can cut off the malfunctioning genes in liver cells and _____ the _____ DNA sequence. There are various technical challenges that need to be _____, including _____-target _____, in which the tool falsely targets wrong sites and _____ _____ _____. We are not _____ _____, but _____ _____, we will gain the ability to _____ thousands of diseases from our lives.

With the appearance of CRISPR technologies, we can edit genes precisely and efficiently with a lower cost. In principle, a single letter of human DNA can be mutated to another letter, leaving the 3.2 billion other bases of the genome largely untouched. The cost and efficiency are also important as research funds and time are obviously limited. Since this new genome editing technology was unveiled in 2012, its various potential applications have been suggested. One notable application is crop improvement. For instance, crops like high-yield rice, non-toxic potatoes, and less perishable tomatoes have already been created using CRISPR/Cas9.

Given the climate change and food shortages caused by overpopulation, genome editing for crop enhancement is going to be essential. Also, genome editing can solve the problem of food allergies. Most allergens are specific proteins. We can reduce allergens in food by removing genes associated with the production of allergenic proteins. There are already ongoing studies on genome editing in livestock animals, such as chickens that lay eggs with less allergen. Another application of genome editing is, of course, in medicine. Genetic disorders like hemophilia and muscular dystrophy are caused by mutations in specific genes. Hemophilia, for instance, is a condition where liver cells can't produce blood clotting factors properly and thus bleeding can’t easily stop. By employing CRISPR technology, we can cut off the malfunctioning genes in liver cells and insert the correct DNA sequence. There are various technical challenges that need to be solved, including off-target effects, in which the tool falsely targets wrong sites and delivers unintended modifications. We are not there yet, but before long, we will gain the ability to purge thousands of diseases from our lives.

mutate	変異させる、変化させる		muscular dystrophy	筋委縮症
toxic	有毒の		clot	凝固させる
perishable	腐りやすい		liver	肝臓
hemophilia	血友病		purge	追放する、除去する

Genome Editing: The In-Vitro Creation #4

_____ genome editing offers numerous potential benefits, ____ _____ particularly significant _____ challenges. One of the biggest _____ is that this technology could be used not only to _____ disease but also to _____ human capabilities. There is no _____ _____ _____ _____ _____ _____ enhancing. In most cases, medicine is first developed and _____ to save people from _____ _____ _____ ____ considered ____ _____ _____ _____. However, the same tools can _____ be used to _____ the standard. For example, plastic surgery was first developed _____ the First World War to _____ _____ _____ faces got _____ ____ battles. When the war was over, surgeons realized that the same treatments could also turn healthy individuals more beautiful. Today, plastic or cosmetic surgeons _____ millions by upgrading the wealthy, and we _____ ____ _____ _____. Genome editing might follow the same _____. It will begin with parents who hope to _____ fatal genetic _____ _____ their babies. But _____ _____ becomes possible to edit human DNA to replace deadly genes, we might start using the same mechanism to fix less fatal genes, such as ones responsible for autism and _____. Who _____ _____ their child to _____ from any of these? Furthermore, if you _____ _____ ____ provide your child such treatments, wouldn't you want to give them a little more _____ by enhancing their memory, athletic ability, or _____ system? Even if you are personally _____ such upgradings, _____ ____ the neighbors are doing it for their children? Would you _____ to _____ _____ _____ _____ behind them? Any upgradings are initially justified as healing. But once ____ ____ _____, it may _____ ____ being unstoppable by _____ discussions.

While genome editing offers numerous potential benefits, it presents particularly significant ethical challenges. One of the biggest concerns is that this technology could be used not only to cure disease but also to enhance human capabilities. There is no clear line that separates healing from enhancing. In most cases, medicine is first developed and approved to save people from falling below what is considered to be the standard. However, the same tools can then be used to surpass the standard. For example, plastic surgery was first developed during the First World War to treat soldiers whose faces got injured in battles. When the war was over, surgeons realized that the same treatments could also turn healthy individuals more beautiful. Today, plastic or cosmetic surgeons earn millions by upgrading the wealthy, and we take it for granted. Genome editing might follow the same path. It will begin with parents who hope to eliminate fatal genetic ailments from their babies. But once it becomes possible to edit human DNA to replace deadly genes, we might start using the same mechanism to fix less fatal genes, such as ones responsible for autism and obesity. Who would like their child to suffer from any of these? Furthermore, if you are about to provide your child such treatments, wouldn't you want to give them a little more push by enhancing their memory, athletic ability, or immune system? Even if you are personally against such upgradings, what if the neighbors are doing it for their children? Would you dare to have your child lag behind them? Any upgradings are initially justified as healing. But once it is approved, it may end up being unstoppable by moral discussions.

numerous	多数の		autism	自閉症
surpass	優る、上回る		obesity	肥満
plastic surgery	整形外科、整形手術		immune	免疫の

Genome Editing: The In-Vitro Creation #5

The caste system in _____ has divided people into four groups based on the family they were born into. They believe that individuals in higher caste groups were _____ _____, but this was _____ _____. There is no _____ difference between Brahmins and Shudras, Kshatriyas and Vaishyas. Brahmins insisted that they were naturally smarter than everyone else, but _____ _____ _____ _____ of their DNA, we can never find any _____ _____ to Brahmins. Historically, social and economic _____ _____ _____ _____ _____ genetic differences. Rather, they have been the result of cultural and environmental factors which have been justified and _____ by fictions. However, _____ the advancement of genome editing, the nature of inequality may fundamentally change. Once it becomes possible to upgrade Homo sapiens through genome editing, we will see real gaps in physical and _____ abilities between an enhanced upper class and the rest of society. These upgraded superhumans will _____ _____ health, abilities, and creativity, which will further _____ inequalities. After _____ all of these, your reaction might be to hope that somebody will ____ the _____ to stop it. But we may not be able to _____ its progress. In November 2018, a Chinese scientist _____ _____ _____ _____ created the world's first genome-edited babies. He used the CRISPR/Cas9 technology to modify the DNA of twin girls, making _____ _____ to HIV _____. Many scientists and organizations criticized the experiment _____ ____ potential impacts and violation of _____ guidelines. However, different nations have different _____ _____. If some countries use genome editing to _____ geniuses that far _____ other citizens _____ country forbids genetic engineering, _____ _____ _____ keep hitting the _____?

The caste system in Hinduism has divided people into four groups based on the family they were born into. They believe that individuals in higher caste groups were intrinsically superior, but this was pure fiction. There is no biological difference between Brahmins and Shudras, Kshatriyas and Vaishyas. Brahmins insisted that they were naturally smarter than everyone else, but even after thorough examination of their DNA, we can never find any sequence unique to Brahmins. Historically, social and economic disparities have not arisen from genetic differences. Rather, they have been the result of cultural and environmental factors which have been justified and amplified by fictions. However, with the advancement of genome editing, the nature of inequality may fundamentally change. Once it becomes possible to upgrade Homo sapiens through genome editing, we will see real gaps in physical and cognitive abilities between an enhanced upper class and the rest of society. These upgraded superhumans will enjoy unprecedented health, abilities, and creativity, which will further accelerate inequalities. After hearing all of these, your reaction might be to hope that somebody will hit the brakes to stop it. But we may not be able to halt its progress. In November 2018, a Chinese scientist had claimed to have created the world's first genome-edited babies. He used the CRISPR/Cas9 technology to modify the DNA of twin girls, making them resistant to HIV infection. Many scientists and organizations criticized the experiment for its potential impacts and violation of ethical guidelines. However, different nations have different moral codes. If some countries use genome editing to produce geniuses that far outperform other citizens whose country forbids genetic engineering, can we still keep hitting the brakes?

caste	カースト制度		unprecendented	未曾有の、空前の
intirinsically	本質的に、本来的に		halt	歯止めをかける
disparity	差異、不均衡		resistant	耐性のある
amplify	増幅する		outperform	しのぐ、性能で上回る