The Gene: Life as Information #1

There are 8 billion people on the planet and all of us are wonderfully unique. We have different eye color, ________, shape of mouth and nose, and _____________ different way of thinking. But, at the same time, _______ ______ characteristics that we all ________. Wherever you go, you will find people who walk, _________ and ________ food the same way. Where do these diversity and _____________ _________ ________? Human body is a _________ of 30 to 40 ________ cells. Each of these cells contains a nucleus, and inside each nucleus is your ________, your DNA that _______ your genetic information. Most of the cell's structures and operational systems are made _________ a __________ of ________. DNA is an ________ ____________, digital information on how to build ________. This genetic code is _________ by the cell and ______ ______ ___________. It __________ both the __________ we all ________ and the _________ _____________ that make us different to _______ __________. In other words, _________ is the software that codes for "you." It's your hair color, a significant ______ _____ your personality, and even ____________ to specific diseases.

There are 8 billion people on the planet and all of us are wonderfully unique. We have different eye color, height, shape of mouth and nose, and dramatically different way of thinking. But, at the same time, there are characteristics that we all share. Wherever you go, you will find people who walk, breathe and digest* food the same way. Where do these diversity and similarity* come from? Human body is a collection of 30 to 40 trillion cells*. Each of these cells contains a nucleus, and inside each nucleus is your genome*, your DNA that carries your genetic information. Most of the cell's structures and operational systems are made from a variety of proteins. DNA is an encoded* instruction, digital information on how to build proteins. This genetic code is read by the cell and put into practice. It specifies* both the features we all share and the inherited* characteristics that make us different to one another. In other words, genome is the software that codes for "you." It's your hair color, a significant part of your personality, and even susceptibility* to specific diseases.

digest	消化する / break down (food) in the alimentary canal into substances that can be absorbed and used by the body
similarity	類似性、類似点 / a similar feature or aspect
cell	細胞 / the smallest structural and functional unit of an organism
nucleus	細胞核、原子核 / the central and most important part of an object forming the basis for its activity and growth
genome	ゲノム。生物のもつ遺伝子（遺伝情報）の全体を指す言葉
encode	暗号化する / convert into a coded form / [Biochemistry] (of a gene) be responsible for producing a substance or behavior
specify	〜を明細に述べる、細かく指定する / state a fact or requirement clearly and precisely
inherit	遺産・遺伝的特徴などを引き継ぐ / derive a characteristic genetically from one's parents or ancestors
susceptibility	感じやすい、影響を受けやすいこと / the state or fact of being likely or liable to be influenced or harmed by a particular thing

The Gene#2

Think about how your computers and smartphones work. Any form of digital information is essentially __ _______ __ 2 letters: 0 and 1. Your devices _____ _____ _______ _____ of information and _____ ___ _____ a picture, a video, a spreadsheet or whatever and show it on the screen. Similarly, our DNA _________ ___ 4 types of letters—Adenine, Thymine, Guanine and Cytosine, or A, T, G, C ____ ______ . The cell reads this ___________ _____ to build a protein, and the protein realizes ____ _____ ___ _________ of the organism.

Genome has 3.2 billion letters of DNA. If it _____ __ _____ _____ a standard-size font, it would have 1.5 million pages _____ ___ just four letters, 60 times the size of an ordinary _____________ . These 3.2 billion letters are divided and _________ into 23 pairs of chromosomes in a _______ ______ _____.

But the _____ majority has nothing to do with your genetic information. Only about 2 percent of DNA encodes proteins, which we call " ______ ." Human genome contains about 22,000 genes in total—only 1,800 more than worms and 25,000 fewer than rice or _______. There is nothing particularly special about human genome.

Think about how your computers and smartphones work. Any form of digital information is essentially a series of 2 letters: 0 and 1. Your devices read this binary code of information and turns it into a picture, a video, a spreadsheet or whatever and show it on the screen. Similarly, our DNA consists of 4 types of letters—Adenine, Thymine, Guanine and Cytosine, or A, T, G, C for short. The cell reads this quaternary code to build a protein, and the protein realizes the form or function of the organism.

Genome has 3.2 billion letters of DNA. If it were a book with a standard-size font, it would have 1.5 million pages full of just four letters, 60 times the size of an ordinary encyclopedia. These 3.2 billion letters are divided and packaged into 23 pairs of chromosomes in a double helix form.

But the vast majority has nothing to do with your genetic information. Only about 2 percent of DNA encodes proteins, which we call "genes." Human genome contains about 22,000 genes in total—only 1,800 more than worms and 25,000 fewer than rice or wheat. There is nothing particularly special about human genome.

binary	2進法		encyclopedia	百科事典
for short	省略すると		divide	分割する
quaternary	4進法		helix	螺旋、ねじれ
realize	実現する、気づく		wheat	小麦

The Gene #3

Another _________ function of DNA is ___ ________ to _____ _______ very ___________ . Most of the genetic code for the various _________ ___________ are the same in ___ __________ from plants to animals, tiny bacteria to Home sapiens. That means the ______ information in those ______ has been ___________ for probably three billion years. DNA can ____________ and ___________ itself with very ____ ________ .

Then how does ________________ make it possible? DNA contains two chains. Each chain is a long _________ ___ four bases—Adenine, Thymine, Guanine and Cytosine, or A, T, G, C. The bases can only _____ ____in a single, ________ way. A can only pair with T, and G can only pair with C. One chain is a ____________ of the other. This means that if you know ____ _______ ___ _______ _______ one chain of DNA, you immediately know the order of the other. If you break the _______ ______ ______ _____ two separate chains, each chain can ____ ___ __ __________ to recreate a perfect _____ ___ ____ original partner chain. This is the way that _____ __________ takes place ________ almost no copy errors.

Another critical function of DNA is its ability to copy itself very precisely. Most of the genetic code for the various cellular components are the same in all organisms from plants to animals, tiny bacteria to Home sapiens. That means the core information in those genes has been preserved for probably three billion years. DNA can replicate and preserve itself with very few errors.

Then how does DNA's structure make it possible? DNA contains two chains. Each chain is a long sequence of four bases—Adenine, Thymine, Guanine and Cytosine, or A, T, G, C. The bases can only pair up in a single, precise way. A can only pair with T, and G can only pair with C. One chain is a reflection of the other. This means that if you know the order of bases along one chain of DNA, you immediately know the order of the other. If you break the double helix apart into two separate chains, each chain can act as a template to recreate a perfect copy of its original partner chain. This is the way that cell division takes place without almost no copy errors.

precise	正確な、精細な		reflection	反射、影響
cellular	細胞の		separate	分け隔てられた
component	構成要素		recreate	再作成する
preserve	保存する、保全する		cell division	細胞分裂
replicate	複製する		take place	起きる、発生する
sequence	配列、順序、配列を決める			

The Gene #4

If DNA is ___ ________ __________ of the cell and the whole human body, how does each cell __________ these ___________ messages to ______ proteins?
Let's go back to ____ _________ of DNA and digital devices and see what happens when you ______ your friend "Hi." One letter on computers is _________ _____ _________ binary code. For example, capital H is ____________ ___ 01001000. When you ______ your friend "Hi," what you're actually sending is just a 16 digits of 0 and 1(Hi=01001000 01101001).
Genetic code __________ quite ___________. DNA _______ ___ 4 bases—A, T, G, C. And three bases come together to carry one piece of information. But why does it have to be three-letter code?
A protein is created from twenty simple chemicals _______ amino acids. A ___________ ____ of single digit would only represent four amino acids. A two-digit would code for 16. A ______ digit of quaternary code can represent 64 messages, _______ ___ express 20 kinds of amino acids and how to control them. For example, ACT __________ the amino acid Threonine, and ATG is the _____ ___ _______ the building of a protein.
By the end of the 20th century, _______ _________ could be ___________ . This was the goal of the Human Genome Project, a $100 million ten-year _______ . Since then, _______, the price has ___________. Today, ___________ a human genome takes a few days and costs less than $1000. It was __ ______ ______ _______ for biology and for medicine. When you understand your genome, you will _______ the _________ ___ _______ you're most ____________ , and, more ____________, how to prevent and _____ them.

If DNA is an encoded blueprint of the cell and the whole human body, how does each cell decipher these encrypted messages to build proteins?
Let's go back to the analogy of DNA and digital devices and see what happens when you text your friend "Hi." One letter on computers is encoded into 8-digit binary code. For example, capital H is represented as 01001000. When you text your friend "Hi," what you're actually sending is just a 16 digits of 0 and 1(Hi=01001000 01101001).
Genetic code functions quite similarly. DNA consists of 4 bases—A, T, G, C. And three bases come together to carry one piece of information. But why does it have to be three-letter code?
A protein is created from twenty simple chemicals named amino acids. A quaternary code of single digit would only represent four amino acids. A two-digit would code for 16. A triple digit of quaternary code can represent 64 messages, enough to express 20 kinds of amino acids and how to control them. For example, ACT specifies the amino acid Threonine, and ATG is the code to start the building of a protein.
By the end of the 20th century, entire genomes could be sequenced. This was the goal of the Human Genome Project, a $100 million ten-year effort. Since then, though, the price has plummeted. Today, sequencing a human genome takes a few days and costs less than $1000. It was a major step forward for biology and for medicine. When you understand your genome, you will learn the diseases to which you're most susceptible, and, more importantly, how to prevent and cure them.

Vocabulary List: No. 29~35

The Gene#5

The genome contains the memory to build every cell in every _______ in every organism. All the cells in your body _____ _____ _____ ____________ ___ 3.2 billion DNA letters. The next question is; what _______________ a brain cell from a ______ cell, a skin cell from a bone marrow cell, even though they have the exact same ____ ___ DNA?
When the cell reads ____ genetic information, DNA code is _______________ ____ a messenger RNA code. The RNA ______ _____ ______ from the nucleus to the cytosol, ________ ____ ___________ ____ ________ to build a protein. But the transcription to RNA is _____ _____________ ; not all DNA is _______ ____ RNA.
The key to understand this mechanism is _____ ____________ , the ______ ____ chemical reactions which ______ _____ ___ ______ ______ ’on’ and ‘off’. For example, the cells in your _______ , skin and brain all contain the same ______ set of 22,000 genes. Gene regulation means the genes _____ ___ ______ __ _______ were turned ‘on’ in embryonic kidney cells, and those _____ _________ specifically to create skin or brain _____ _______ ’____ ’, and _____ _______.
Once ____ _________ _______ instructs cells to be kidney cells, they remember that information and _______ _______ ______ ________. Once a cell is __________ to be a kidney cell, it will remain part of the kidney by turning off unnecessary information.
This mechanism of turning genes ___ ____ _____ ___ ________ “epigenetics.” It does not change the DNA sequence of the genes themselves; instead, it works ___ ________ chemical ‘tags’ to the DNA. These tags tell which genes should be on and off. Only parts of genes _____ ____ “___” are selectively transcribed into messenger RNA to build proteins.

The genome contains the memory to build every cell in every tissue in every organism. All the cells in your body have the same collection of 3.2 billion DNA letters. The next question is; what distinguishes a brain cell from a liver cell, a skin cell from a bone marrow cell, even though they have the exact same set of DNA?
When the cell reads its genetic information, DNA code is transcribed into a messenger RNA code. The RNA copy then moves from the nucleus to the cytosol, where its messages are decoded to build a protein. But the transcription to RNA is done selectively; not all DNA is copied into RNA.
The key to understand this mechanism is gene regulation, the set of chemical reactions which cells use to turn genes ‘on’ and ‘off’. For example, the cells in your kidney, skin and brain all contain the same total set of 22,000 genes. Gene regulation means the genes needed to make a kidney were turned ‘on’ in embryonic kidney cells, and those that function specifically to create skin or brain were turned ‘off’, and vice versa.
Once the growing embryo instructs cells to be kidney cells, they remember that information and rarely change their identity. Once a cell is determined to be a kidney cell, it will remain part of the kidney by turning off unnecessary information.
This mechanism of turning genes on and off is called “epigenetics.” It does not change the DNA sequence of the genes themselves; instead, it works by adding chemical ‘tags’ to the DNA. These tags tell which genes should be on and off. Only parts of genes that are “on” are selectively transcribed into messenger RNA to build proteins.

Vocabulary List: No. 36~40