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Chapter 4

Method of Ending Disease and the Future Medical System

4.1 Systems and Precision Medicine, the Shortcut for Ending Disease

The characteristics of disease changed with the arrival of the age of chronic diseases. Now, we observe a spectrum of diverse diseases that cannot be properly managed with a simple strategy developed in the age of infectious diseases. Because our living environment changes so quickly, the response of the human body, such as the genes or epigenetic program, cannot keep up with it if we continue the current strategy. We need to find a way to enable adaptation of the human body program to change. Medical education should also be changed to focus on the harmony and balance of complexly entangled systems. Addressing such a need for changes, “systems medicine” is a new approach to achieving breakthroughs in disease prevention and treatment by obtaining and using fairly comprehensive information, such as molecular-, gene-, and cell-level information, as well as lifestyle, clinical, physiological, and environmental information.

From disease-centered strategy to comprehensive health management!

Looking back at the history of medicine, it was not far in the past that the treatment of disease based on accurate diagnosis emerged as the pivotal part of medical practice. Humankind was able to enjoy the fruits of scientific achievements in earnest beginning in the 19th century, with the discovery of pathogens, the understanding of cells and tissues, and the invention of medical devices such as sphygmomanometers, microscopes, and radiographic devices, which prompted innovations in diagnosis. Antibiotics for infectious diseases and therapies for the treatment of chronic diseases were developed in the 20th century. Therefore, it was not until the 20th century that the scientific way of diagnosis and treatment of diseases was firmly established as an essential part of medicine.

The characteristics of disease changed as well with the arrival of the age of chronic diseases after the age of infectious diseases. Today, we observe a spectrum of diverse diseases that cannot be properly managed with a simple strategy developed in the age of infectious diseases. In fact, it is common for a disease to appear along a continuous spectrum of clinical manifestation
even if it is classified as belonging to a specific disease. For example, elevated blood pressure is usually diagnosed as hypertension when the systolic blood pressure is greater than 140 mm Hg and the diastolic blood pressure is greater than 90 mm Hg. If the systolic blood pressure is 130 mm Hg, however, and the diastolic blood pressure is 85 mm Hg, it is difficult to consider it a nonhypertensive state because it has been shown that people with a blood pressure of 130/85 mm Hg are more likely to have a shorter lifespan and are exposed to higher chances of suffering from various other chronic diseases, such as heart disease or stroke, than those with a blood pressure of 120/80 mm Hg, which is deemed the normal systolic/diastolic blood pressure. Therefore, the dichotomous strategy used to diagnose disease or consider treatment options may be just one way of efficiently managing disease but is not necessarily a sufficient strategy to properly manage a person’s health. In that respect, it is not enough to just dichotomously divide a person’s medical condition into hypertension and nonhypertension; rather, one has to understand the person’s lifestyle, environmental factors, and genetic factors affecting blood pressure along a continuous spectrum and to eliminate all the factors that may raise the person’s blood pressure.

It was only in the 19th century that diagnostic names of disease like “hypertension,” “diabetes mellitus,” and “heart disease” began to be used in earnest. Before that time, medical terms based on phenomena or symptoms that can be observed only with the eyes, such as diarrhea, weakness, fever, and edema, had been used extensively. In fact, the use of modern diagnostic names like “hypertension” was aimed at ensuring efficiency in disease treatment by classifying diseases with the same pattern or clinical findings as belonging to the same disease group. In other words, the aim of this approach was to improve the efficiency of treatment by applying a standard treatment to the same group of patients. This efficiency, however, does not necessarily improve the level of medical care for individual patients because it is very common for patients with the same category of disease to demonstrate different disease expression.

Contracting multiple diseases at the same time is also common. A deeper look at the disease called “hypertension” shows that it is often accompanied by diabetes mellitus and heart disease. In particular, as the elderly population increases, the number of people with multiple chronic diseases is increasing as well, making it impractical to cope with patients’ problems using single-disease–centered strategies alone, which focus on specific body systems, such as circulatory or nervous system, or body organs, such as the heart and kidneys. In addition, patients do not just want treatments that help relieve them of the various symptoms stemming from their multiple diseases; they also want to be treated conveniently and effectively. Therefore, diagnosis of patient disease should be made by reviewing the individual situation of the patient in a comprehensive manner rather than concentrating only on the disease manifestation, while “comprehensive health management,” including methods for overcoming physical, psychological, and social dysfunction, should be performed as well.
Therefore, it is necessary to comprehensively identify and manage various lifestyle habits and environmental factors that cause disease or exert an influence on the disease progress. In other words, disease diagnosis and treatment, which are at the heart of today’s clinical practice, should be seen just as a part of comprehensive health care. Probably, future health care will include the management of higher-level or more complicated issues, such as determination of longevity, surgery and prescription for maintenance or enhancement of human function levels, and management of the death process, as well as the conventional preventive medical services, such as lifestyle recommendations, regular health checkups, nutritional prescriptions, and genetic testing. With these technological advances and the changes in health care, humankind will greet an age of disease control and longevity determination with practices very different from those in the past.

The human body program must adapt to the changing environment

Because our living environment changes so quickly, the response of the human body, such as the genes or epigenetic program, cannot keep up with it if we continue the current strategy. The few available options left to us are to slow down the speed of environmental change or to enable adaptation of the human body program to the change. Evolutionary history has shown that the individual organisms or the species that succeed in adapting to the changes will thrive while enjoying the changed environment, but those that fail to adapt to the changes will become extinct. In Lewis Carroll’s novel *Alice Through The Looking Glass*, the Red Queen advises Alice, “You must run as fast as you can, just to stay in place.” As everything is changing constantly, we cannot stay in place because we will lag behind the others if we try to stay in the same place because human beings are not independent beings but are just parts of the whole system. As the whole system changes over time, staying in the same place without corresponding effort to change means that it will not be able to play a given role within the system and will soon disappear.

A chronic illness occurs when the environment surrounding humans and their body program fails to maintain the balance between them, impeding the normal functioning of the human body program. Ever since the advent of civilization, especially since the Industrial Revolution, the pace of environmental change has been so fast that the human body program pegged on genes was not able to adapt to the rapidly changing environment, prompting the occurrence of chronic illnesses. If such changes continuously occur at a rapid rate in the future while the human body programs have yet to adapt well to such a changing environment, the chronic disease resulting from genetic and environmental incompatibility will never be overcome. In this case, humanity will continue to suffer, bound by the inescapable shackles of disease. At present, the only way out of this trap is by adapting to the changing environment, which means that the human body programs must be changed accordingly. Considering the current advancement of science and technology, humankind ultimately may end up succeeding in changing the human body program to escape chronic diseases. Otherwise, humans will
continue to suffer from chronic illnesses because of the failure to adapt to the change. Therefore, humanity must find a way to make the human body program, including the genes, adapt to the changing environment to end chronic diseases.

The method, however, is not so simple. Basically, there are two methods: (1) correction of the human body program itself by using medicines, surgery, or genetic manipulation and (2) continuously changing each person’s life and behavioral style to suit the changed environment, using the various pieces of information being churned out relentlessly. The method of making the human body programs adapt to the environment, however, will have difficulty to succeed if we take a simple concept that correction of specific factor is the solution for a given problem. For instance, attempting to prevent or treat Alzheimer disease by genetically manipulating the mutated part of the ApoE gene, which is related to the development of Alzheimer disease, turning it into a normal gene, does not necessarily mean that Alzheimer disease can be cured, the reasons being that each of the systems affecting the Alzheimer disease consists of very complex programs beyond the ApoE gene mutation and that complex systems are again linked with one another in a parallel or hierarchical manner, interacting with each other and affecting overall health status. Therefore, for the complex system to operate normally in harmony and balance, there should be in place a more comprehensive and sustainable environmental adaptation program.

The first step for making the program successfully in motion is to provide customized information individually to every member of society. In other words, it is necessary to provide information individually about the complex disease factors and the ways to manage them precisely. However, it is not uncommon today to find cases where the information about the living environment that affects people’s health is not adequately handled, sometimes causing confusion, and is not leading to meaningful behavioral changes that can effectively prevent disease and promote health. For instance, let’s look at the information about cancer. Information on many food, such as broccoli, tomatoes, green vegetables, and yogurt, and lifestyle habits that are known to prevent cancer is delivered to the public almost daily via the mass media, along with the information on numerous carcinogenic factors, including cigarette smoking, alcohol drinking, chemicals, and ultraviolet light. A variety of information on cancer treatment is also being poured out without being screened. It is hard to say, however, that such information is actually used to prevent disease and promote health, since many of the factors are entangled with each other and may affect each person differently. Therefore, this information, to be truly effective, should now be tailored to individual health conditions.

Need for urgent changes in medical education

If we listen closely to the argument of the American physicist and historian Thomas Kuhn that the scientific paradigm is open to competition with different ideas and rationales, it is evident that scientific methods and thoughts do not
exist as undisputable and absolute truths but as chains of processes in which multiple ideas compete with one another before one that best fits the given social context or historical environment is selected.\textsuperscript{85} Now, medical education should also come out of the framework of classic biomedical models based on the simple causation theory that a specific factor causes a specific disease and the pathologic locus theory of diseases, in which a specific disease appears in a specific organ. Medical education itself has to change in line with the paradigm shift to “systems medicine,” which focuses on the harmony and balance of complexly entangled systems, where various factors are networked with one another and affect various diseases.

After the publication of the Flexner Report in 1910, which emphasized that “medicine” should be considered a science rather than a mere clinical therapeutic discipline, medical education has been implemented in a form that combined basic medical science, which explores the root causes of diseases, and clinical practice, which treats diseases in the hospital, in the vast majority of developed countries in North America and Europe.\textsuperscript{86} This system has continued to this day, exerting a profound impact on the current medical education. In fact, it cannot be denied that biomedical model and the medical education based on the Flexner Report have made a significant contribution to the development of modern medicine. In particular, it has had remarkable achievements in containing infectious diseases, thereby ending the age of infectious disease epidemics. In addition, the development of numerous drugs and medical technologies has provided a background for considerable success in the management of noninfectious diseases, such as chronic diseases. Due to this achievement, the incidence of infectious diseases has declined since the mid-20th century, but such development has not yet prevented a dramatic increase in the incidence of chronic diseases like diabetes mellitus, heart disease, and cancer. In other words, humanity has not reached the goal of preventing the occurrence of chronic diseases or controlling them completely to help restore patients to a disease-free and healthy condition. Therefore, acknowledging the limitation inherent in the current model of disease causation and medical education, we need to switch it from the medical education based on the biomedical model to one based on the systems medicine concepts.

Today, medical students learn myocardial infarction by understanding the chest pain and related symptoms accompanying myocardial infarction as well as the other symptoms that they need to distinguish from it. They are also taught diagnostic methods such as electrocardiography, ultrasonography, and cardiovascular imaging, as well as drugs and vascular stenting. They are not likely taught, however, about the factors affecting the cardiovascular status, such as the environmental factors; the constitution of and changes in the genes, epigenetic programs, and metabolic profiles; inflammation and toxic metabolism; mitochondria and energy metabolism; and the relationship of the cardiovascular status with other diseases. Moreover, education on the psychological and social problems experienced by patients suffering from myocardial infarction and the
role of the physician as a patient-care, not just as a disease-treating, specialist is hard to find. Of course, if we take this approach, the volume of education is too vast to be realized for each and every disease. In fact, the notion that everything corresponding to a specific disease should be taught is no longer valid because diseases are not completely independent of one another and many things shared by different diseases will be unnecessarily repeated in their teaching. Therefore, the future medical education should be made different from current one so that students will learn each system inside and outside the human body, understand how these systems affect one another from the beginning to the eventual occurrence of illness, and learn the complete management of diseases, from disease prevention to treatment, all centered on the patients, not individual diseases.

In addition to medical education, hospitals must change as well. Since the 19th century, hospitals have become facilities for performing clinical tests and associated treatments based on them, rather than simply taking care of patients. Hospitals have now settled down as institutions where various tools and equipment are used by the professional medical staff to diagnose and treat diseases. Meanwhile, in hospitals, disease-centered care has been widely performed, and the patient is regarded simply as a person with diseases to be treated. While we cannot deny that the disease-centered treatment strategy has achieved considerable success, it has also revealed quite a number of problems. Currently, more than half of the elderly have chronic diseases, with many suffering from two or more chronic diseases at the same time. As a result, people with multiple illnesses have ended up being treated for each of their diseases separately. In this case, the disease-centered treatment of people with multiple illnesses not only is inefficient but also can cause confusion. This inefficiency and confusion will become more prominent during the transition period from the age of chronic diseases to the age of late chronic diseases.

In the end, hospitals should convert their clinical practices to one that focuses on treating patients rather than on individual diseases, and the way to educate and train physicians should be changed accordingly. When physicians do not understand the whole intertwined system but deal only with a specific disease, it is like walking through a new forest looking only at the trees therein to find a way, without seeing the entire picture of the forest. Probably, they are easily lost on the way! The plan to educate them to understand each disease as an independent unit and to train them to become experts in the specific field, as in the current physician training system, may have succeeded in producing disease-specific specialists to a certain extent. However, it cannot be deemed to have been successful in producing well-rounded experts who will greet and treat patients in the age of late chronic diseases because the training program for physicians does not fit the paradigm required by the changes of the times. Future physicians should understand the importance of maintaining the balance and harmony between the internal system and the external environment and the various phenomena that occur when such balance and harmony are broken and should be taught the knowledge and skills that will enable them to adopt an integrated and holistic approach when managing their patients.
Future hospitals and medical systems

There are currently many occurrences of misdiagnosis or inappropriate medical practices being carried out even in the modern hospitals and many patients experience deterioration of illness and even death there. Why are these so common in the field of modern medicine, which introduced medicine as a science and the disease-oriented clinical practice as the core approach? The reason for this is that medical practitioners often do not carefully observe the patient’s symptoms and test results and fail to properly assess the patient’s circumstances. On the other hand, that is also because it is not easy to equip the capacity to enable accurate decisions about patients in a short time period of their training, although the time is relatively longer than the training period for other disciplines. In fact, the amount of information that a physician needs to know is so great that it is almost impossible to have the ability to know it all. It is also extremely difficult to acquire the new information being discovered every day and to use it for diagnosis and treatment properly. On top of this, even well-trained physicians cannot escape from errors that any human being can commit during medical tests, prescriptions, or surgery, which often result in serious damage to the patients.

On account of all these problems, we will soon see the day when computers replace a significant portion of physicians’ medical practices, such as diagnosis, prescription, and surgery. This does not necessarily mean, though, that the role of the physician will be diminished. Although the technical part of the medical practice will be performed by computers and robots, physicians will act as the overall health care providers for the patients. In fact, physicians can diagnose and treat their patients more accurately and effectively by using computers and robots as assistants. Using a program that supports diagnosis and prescription decisions based on precise information about the patients, physicians will be able to treat each patient more appropriately according to his/her characteristics and environment. Watson, a supercomputer-based artificial intelligence (AI) already developed by IBM, has the ability to gather vast amounts of medical data to provide the medical evidence needed for physicians to make a decision, and in some areas, it is capable of providing more accurate diagnosis and treatment decision than veteran physicians specializing in the corresponding field. Therefore, if this kind of physician-assisted program is used well, physicians will be able to spend time more taking care of their patients because it will take much less time for them to obtain information from their patients and to analyze and judge it. In a word, it would be the technical foundation for the transition from disease-centered care to patient-centered care.

If this trend continues, the hospital itself will turn into a huge automation system. Nearly all of the processes for diagnoses and prescriptions will be automated, and computers and robots will perform most of the tests and operations. In addition, various diagnostic devices will be equipped with algorithms that can make a judgment, beyond current role of merely presenting their findings. For example, if a patient undergoes magnetic resonance imaging or an ultrasound scan, the diagnostic
device will help the physician make a diagnosis by presenting diagnostic names, way beyond merely showing pictures or results on the screen. Along with the prescription, various instructions for a desirable daily life will be automatically entered into the patient’s information terminal, and the necessary medications will be automatically transferred to the patient’s home. In the case of surgery, it is not necessary for the surgeon to manipulate the robot, as in today’s robotic surgery; the robot will be so advanced that it will be able to make a judgment by itself and proceed with the operation. In this scenario, the medical staff will play the role of guiding the patient appropriately and managing the entire operation process to ensure that the preoperative treatment, the process of the operation, and the postoperative care are carried out as planned.

The continuity of care can be ensured even when the patient is transferred from a local clinic to a hospital or a general hospital in case his/her illness is difficult to treat in the local clinic. Suppose that a patient who has received continuous monitoring and management by the medical staff in a community clinic needs to be transferred to a higher medical institution because it has become necessary for him/her to go through a complete medical checkup or difficult surgery. In this case, the local medical staff will use the facilities and equipment of the hospital directly or will treat the patient in cooperation with the hospital staffs. The information about patient care is shared by the entire medical staffs through the computer network system, and this information is used to make final decisions, thereby enabling accurate, consistent, and comprehensive treatment for the patient.

As such, comprehensive medical care can be thought of as a system in which the health management continues from home to the hospital. To achieve this, people from different fields of expertise, from home to the school or workplace, and ultimately those who work at the hospital’s intensive care unit, should work together. Therefore, the patient information should be transmitted from home to the hospital, and the information sharing and judgment system should be programmed in such a way that would facilitate cooperation among them to make the appropriate judgment for the patient. This is another technical basis of continuous and comprehensive medical care. Of course, measures to protect the patient’s personal information throughout the course of the treatment will also be secured through technological advances.

Patients should also continuously transmit their health information to the medical staff via a monitoring device implanted in their body or a biomaterial analyzer placed in the toilet, as well as via wearable mobile transmission devices, such as clothes, watches, and glasses. If any abnormal finding is noticed from such information, a readily available medical treatment system will be provided immediately. The health status of each patient will be judged in connection with the health information that has been monitored since the patient was a fetus in the womb, along with the patient’s genetic and living environment information and the personalized health management guidelines. In the future, the data on the patients’ genes, living environment, past diseases, germ types and distributions in their body, and chemical substances they are exposed
to as well as data from the biomaterial analyzer at home will be integrated. The integrated and properly interpreted data will be provided as reference data for medical judgment, thereby eliminating misdiagnosis or inappropriate medical practices. As such, physicians will be able to provide medical services in earnest centered on patients rather than on diseases.

**A shortcut to ending disease: systems medicine**

Chronic or late chronic diseases are caused by complex exposure factors interacting with the genes, which prompt a reaction in the body beyond the normal range of action, thereby negatively affecting the body structure and function. Care based on the principle of systems medicine can be called “personalized medical care” in that disease prevention and treatment are provided to an individual considering all the disease-related factors of the person. In fact, personalized medicine is not entirely new. The blood transfusion process, through which the blood type of the patient is determined and then the blood that matches the identified blood type is transfused to the patient, can be deemed as a form of personalized medical care. If blood type A is given to a person who has blood type B, a severe immune response may cause the death of the patient. Therefore, the patient should be able to receive blood that is appropriate for him/her, instead of receiving any blood. This is a somewhat extreme case, but if you do not know the patient information properly, you will not be able to achieve a desirable therapeutic effect but may end up causing a serious side effect, which again can worsen the patient’s health even further. The same is true for the efforts to prevent disease. If you give standard precautions without knowing the patient’s precise information, you can worsen the person’s health even further in some cases. As many factors affect a person’s health, it could be dangerous to consider only certain factors and provide preventive guidance according to the limited information.

Systems medicine is a new approach to achieving breakthroughs in disease prevention and treatment by obtaining and using fairly comprehensive information, such as molecular-, gene-, and cell-level information, as well as lifestyle, clinical, physiological, and environmental information. This approach considers a comprehensive array of information that can affect each person’s health instead of the approach based on the concept of a simple relationship between specific factors and specific diseases, as outlined in Chapter 2. Therefore, for systems medicine to be realized, the information on genes, metabolites, and biomarkers should be considered together with a wide variety of exposure information, and the information management basis for processing such complex data should be well established. In addition, advanced data processing skills are required because large amounts of data (“big data”), including lifestyle, environmental, biological, microbiological, and clinical data, should be analyzed as combined or merged data.

This approach may deal with information significantly different both quantitatively and qualitatively from the information currently available for medical care. For example, the detailed analysis of blood cell types and their distributions
may be used to measure a person’s immune status instead of simply measuring the number of blood cells. Blood pressure, serum glucose level, and heart rate information may be automatically transmitted through a portable device and then monitored continuously. In addition, it will soon be possible to know what kinds of exposure factors or diseases a specific person is vulnerable to by analyzing his/her genetic and epigenetic profiles. It will also be possible to identify the patient’s potential risk for certain diseases by evaluating the microbial patterns in the patient’s colon through the analysis of his/her feces. Blood analysis can be used to diagnose cancer at a very early time by detecting abnormal gene fragments circulating in the blood. The various clinical tests that are currently being used for health screening will be further expanded and refined to provide personalized information on almost every possible disease of the person on a regular basis. As such, the precise knowledge on individual’s current health status and the detailed information about the person’s exposure will make customized health care realized.

There is a condition, however, that should first be arranged for systems medicine to be properly realized: the information on the determinants of diseases, which can be acquired through detailed evaluation of network of complex systems of the inside and outside of human body. The reason for this is that it is only after sufficient information about the pathogenetic mechanism, from the disease initiation factors to the reactions in the body and to the eventual disease occurrence, has been accumulated that one can determine which part of a person’s body or which lifestyle or environmental factors to be corrected for the prevention or treatment of the disease. Therefore, efforts should be made a priori to obtain proper information for prevention and health management appropriate to individual characteristics through systems medicine research.

To see how the various biological reactions in the human body, especially those stemming from the exposure to the lifestyle and environmental factors, change over time alongside the life stage, we must track large populations with different characteristics over a long period of time and analyze the results. Therefore, large-scale and comprehensive follow-up studies throughout various age groups, from fetuses to elderly people, are required to track and investigate population groups with different racial and cultural backgrounds. The level of prevention and treatment of chronic diseases will be dramatically improved if the information obtained from such studies can be quickly shared and used by medical professionals around the world. The systems medicine based on this global medical information–sharing system, and the precision medical approach based on this system, will enable us to control chronic disease in the near future.

4.2 Global Strategy for the Borderless Disease

Community needs to take a responsibility to secure an environment in which each individual can prevent disease and promote health. As communities interconnected without physical barrier become the foundation of the future society,
medical institutions will also be interconnected each other, thereby forming a comprehensive medical system. It is likely that the city will become a unit of disease management system in the coming world. If cities are tied closely together, however, along with globalization, this can become another risk factor for disease. Just as urbanization provided a hotbed of chronic illnesses, globalization may be a trigger for new epidemics of infectious and environmental diseases. Therefore, the next step is to create a strategy to end the disease on a global scale, based on a strategy of the globalization of health care to reduce the difference of health and disease levels among countries.

**Personal practices and community-level efforts to end disease**

The disease management strategy that is most urgently required now for ending the era of diseases is to have a system in place for appropriately managing chronic or late chronic diseases, which currently bring the greatest distress to people, with their increasing prevalence. The management of these diseases begins with providing all the information that the person needs and helping the person make appropriate decisions and take necessary actions based on such information. To recap, it is necessary to have a system that continuously monitors the physical, chemical, and biological factors of the surrounding environment as well as the internal body of each person and to help him/her make a judgment based on the information and act accordingly.

Let’s imagine a man walking or running in the park. If a system is developed that closely monitors the information on the animals and plants in the park as well as the information on the microorganisms therein, and that analyzes the potential factors that can pose a threat to humans, and if such information will be provided to the man, then he will be able to judge what to do next and act appropriately for his health. The system can also monitor all the chemical substances that people can be exposed to, as well as air pollutants like fine dusts and ozone, before giving a warning when the level of a specific component in the air is high. The system will also tell the person about the expected weather condition, such as snow, rain, temperature, and humidity, as well as the corresponding measures to take to maintain the optimal conditions for his body. Based on such information, the person will decide how long his walk or running will be, which way to go, and when to rest, by taking into account his genes, defense capacity to toxicity, and health conditions.

The continuous reporting of the monitoring results, however, including the information on the environment outside the human body, such as the air pollutants, toxic chemicals, and weather factors, as well as the information inside the body, such as the genes, epigenetic profiles, metabolites, inflammatory status, and oxidative stress, does not guarantee the prevention or management of chronic or late chronic diseases automatically; this will not be possible unless each person puts into practice measures for improving his/her lifestyle and environment factors. In addition, as the number of elderly people is increasing along
with the increasing human lifespan, chronic or late chronic diseases are more likely to occur. Therefore, the incidence of these diseases can be reduced only if people exert more efforts than before. It is, therefore, important to make people understand the living environment factors associated with the occurrence of these diseases and exert efforts to address such factors.

Let’s first look at food. The goal of long-term dietary management should be to reduce the risk of acquiring the chronic or late chronic diseases that the dietary habits of modern humans can cause. Therefore, it is necessary to formulate desirable dietary habits based on a full understanding of humankind’s dietary habits, which changed from the one in the age of hunter-gatherers to a grain-oriented one after the Agricultural Revolution, and to another characterized by a markedly increased intake of animal fat after the Industrial Revolution, which had a considerable effect on disease development. Also, it is necessary to continuously do regular exercise, such as running, brisk walking, and the lifting of proper weights, to maintain a healthy body because our genes require a certain level of physical exercise. In addition, although it is virtually impossible to eliminate stress, which is one of the key factors for the development of chronic or late chronic diseases, it is necessary to manage stress appropriately so as to maintain a normal psychological state: combination of relaxation of tension with intermittent tension.

The living environmental factors that cause chronic or late chronic diseases, however, are not limited to individual lifestyles. Factors like climate change, environmental pollution, and the increase of chemicals in the vicinity of our residential or working place also significantly contribute to disease occurrence. These factors are difficult to address with individual efforts alone. It is therefore necessary for the community to take a responsibility to secure an environment in which each individual can prevent disease and promote health. The environmental chemicals will continue to increase, and some of them may be toxic or carcinogenic or may even interfere with the normal hormonal actions. Moreover, this may affect not only the health of a particular individual but also the health of an entire population in the community. In the end, the community should play a role in reducing chronic diseases by providing a safe environment without necessarily creating inconvenience in daily living, through the stringent management of the production, distribution, and use of environmental chemicals. For this, the community is required to exert considerable efforts to reduce hazards of the chemicals for promoting the health of its members, because, in some ways, the environmental pollution or chemicals created by the community have a greater impact on the community members’ health than individual choice of their lifestyle.

**Urban environment determines our health**

Humankind underwent major changes in the form of community until majority of communities were eventually formed in cities. The Agricultural Revolution that prompted the formation of civilization, and the Industrial Revolution,
which led to modernity beyond the Middle Ages, changed the shape of the human residence twice. The first change was the shift from the life in the age of hunter-gatherers, where people could not settle down in a certain place for a long period, to permanently settled living in a specific area along with the agricultural revolution. The second change was the rapid increase in the urban population as a result of the massive migration of people from the rural areas to the cities along with the Industrial Revolution. As a result of these changes, humankind’s residential style changed dramatically from the family-centered residences in the age of hunter-gatherers, where one or a couple of families lived together, to a village-centered residential style in the wake of the agricultural revolution, and to the urban residential style characterized by a rapid increase in the population per unit area and the clustering of strangers.

Urbanization, which has expanded even more since the 19th century, has had a considerable impact on the health and disease patterns of modern humans. In addition, to the introduction and spreading of new pathogens due to the increasingly close contact among people, the city provided sufficient risk factors conducive for the occurrence of diseases, such as a decrease in physical activity caused by convenience facilities and an increase in air pollution caused by toxic gases and dusts emitted from factories or automobiles, all of which ended up becoming critical factors that decisively increased humankind’s chronic diseases. In fact, the diseases that are epidemic in the modern society, such as diabetes mellitus, hypertension, cardiovascular disease, cancer, allergy, and depression, are not due so much to the changes in individual lifestyles as to the changes in the residential and living environments of the community, such as urbanization.

Nowadays the city has become the central form of community. Probably, it is more reasonable to think that urbanization has not progressed steadily since the beginning of civilization but has progressed rather rapidly of late after stagnation for a long time. Three thousand years ago, there were only four cities in the world, with their respective populations greater than 50,000, and by the year 2000 BC, still only about 40 cities had a population greater than 50,000 people. Population migrations and exchanges exploded during the period from the Age of Exploration until the imperialist era, and many people began to live in cities, but the urban population still remained at only 5% of the world’s population until the beginning of the 19th century. Then urbanization progressed at a rapid speed in the wake of the arrival of the modern society after the 19th century on, and within just 200 years since that time, the urban population has grown remarkably, accounting for greater than 50% of the world population at the moment. Such rapid urbanization is the main reason for the incongruence between the genes and the environment to transpire. Therefore, what is more important than individual efforts to change lifestyles are the efforts to reduce the incongruence between human genes and the modern environment by building healthy community from the early stage of urban planning and community development.
With the progress of urbanization, the sizes of cities have grown enormously, and dozens of large cities, each with a population of greater than 10 million, have appeared all over the world. Although these metropolitan changes seem to be prominent now, however, this trend is “unlikely” to continue for a long time. In fact, the need for a large and physically congregated city is likely to decrease in the future because as even physically distant places are interconnected with one another via computer networks or very fast transportation, there will no longer be any inconvenience in life in such places. The quality of life can be further improved as there will be no restrictions imposed by physical distance in accessing medical services as well as administrative services and education. In the end, the urbanization trend in the future society will gradually shift from urbanization centered on big cities to one centered on small communities interconnected each other.

As communities interconnected without physical barrier become the foundation of the future society, medical institutions like clinics and hospitals will also be established interconnecting each other, thereby forming a continuous and comprehensive medical system responsible for the health of the community members. As hospitals are automated further, computers and robots will perform main works for diagnoses, prescriptions, and surgeries. The physicians working in community clinics will be transformed into those responsible for managing the overall health care, as family physicians. Perhaps the future medical institutions will no longer be the place for patients to visit after judging their own health problems upon the appearance of symptoms, as it is today. Instead, the medical institutions like clinics or hospitals will monitor the environmental factors, lifestyle, and biomarkers of each individual using the community’s computer network system, and if any abnormal signal is detected, it becomes the place where the problem will be solved by guiding the patient even before he/she feels the symptom. In addition, the community environment, such as housing, transportation, food supply, waste treatment, green space, and clean air and water, will be planned and implemented centered on the community members’ health.

This change, however, will not happen by itself. Desirable changes will occur only if planning and implementation efforts is made to construct the network systems where the elements constituting the foundation of the community will be interconnected centering on the community members’ health. In other words, efforts should be made to create an urban community environment with human health as the overriding value, and based on that, a comprehensive medical system connected by a computer network of clinics and hospitals should be created.

A well-organized community network in the future will be based on a dramatic increase in productivity, and the remarkable development of science and technology will lead to new changes in the people’s way of life as well as in the future disease management. It is difficult to predict future changes in detail, but the existing institutions, such as the state, church, and the social status, will collapse or at least lose their power, and a new order will rise to replace them. In fact, it can be
said that the existing order was intended to maintain the production relations corresponding to the productivity level. For example, the concept of the state came about in the modern society because the capitalists wanted to protect their interests through the state. As it is no longer possible to maximize the interest of capital within the framework of the state, however, people pushed for the globalization of capital, and the state is gradually losing its power. This implies that the basis of productivity has been changing from a framework based on the state to an expanded framework beyond the states, and therefore the production relation—i.e., the relationship between capital and labor—is also being globalized.

Therefore, while the presently powerful state framework is getting weaker, the urbanization will progress even further, and the urban community will develop into a more independent form, thereby becoming a basic unit of globalization. In the end, the vast majority of residential areas in the world will be urbanized, and the city will become a unit of disease management system as well as an economic, political, and cultural unit in the coming world. If cities are tied closely together, however, along with globalization, this can become another risk factor for disease.

The danger of globalization: the era of borderless disease

The modern society built on industrialization and urbanization has led to an epidemic of chronic diseases along with the remarkable achievement of a dramatically increased lifespan. The modern society also stepped into the era of globalization, without stopping at industrialization in each country, where the world is bound to one market, production is outsourced to other countries, and sales are made to global consumers. Globalization is the process by which the entire world is interwoven as a single connected community as trade and exchanges grow beyond the level in the past. Just as urbanization provided a hotbed of chronic illnesses, globalization may be a trigger for new epidemics of infectious and environmental diseases.

For example, patients with encephalitis accompanied by severe muscle weakness were reported at about the same time as dead crows were found in New York City in August 1999. The West Nile virus, first discovered west of the Nile River in Africa, entered the Americas when interregional exchanges became active, infecting people through birds. The West Nile virus further expanded its habitat in the Americas before spreading later to Europe as well as to Asia and Australia. The swine influenza that went pandemic in 2009 was the result of an infection that caused flu in humans by a virus that had taken pigs as hosts in the past. When the virus that originally inhabited in pigs were transferred to humans, mutations happened to occur in the virus which makes the mutated virus transmissible among humans, and the frequent travel between countries or regions led to a pandemic spread of the flu.

The West Nile virus and the swine influenza are cases where viruses from animals have caused epidemics in humans. During the 10,000 years of civilization,
humankind has experienced a number of potent infectious diseases, most of which have been transferred from animals to humans when close contacts happened. Therefore, there are many more possibilities of such epidemics in the future because there are some areas that have yet to be developed, and there will be increasing contact with animals; further, human interactions will become more frequent along with globalization. There is also a great potential for new viruses and bacteria in the frozen ground to surface in the wake of global warming due to climate change and infect humans through insects and animals. With the predicted decline of the diversity of the ecosystem and animal species, the conditions of pathogens’ habitats are expected to turn sour, disrupting the balance between pathogens and their hosts, thereby increasing the likelihood of the pathogens switching their hosts from animals to humans. Once humans become hosts of new pathogens, the likelihood of widespread epidemics as new communicable diseases will rise in the globalized contemporary society.

In November 2002, a disease characterized by fever and respiratory symptoms like pneumonia occurred in Guangdong province in China and soon spread to Hong Kong, Singapore, Vietnam, and then Canada. Although the host animal has not been clearly identified, it is presumed that the virus has migrated from a bat or a musk cat before causing the disease in humans. A total of 8000 people were infected, and among them, 800 died. The mortality rate seemed to be so high in the beginning that it was named severe acute respiratory syndrome (SARS). The Middle East respiratory syndrome (MERS), which became prevalent in South Korea in May 2015, was also caused by coronavirus that migrated from camels in the Middle East. It is now obvious that these new infections did not exist in the past, and the epidemic is no longer confined to a few countries. In fact, influenza, whose incidence is almost as frequent as that of the cold, has already become a borderless disease spreading to other areas as soon as it occurs in one area on the planet.

In 2008, a dioxin concentration greater than 100 times higher than the standard level was detected in pigs that were fed grains provided by Irish suppliers. As dioxin can cause cancer or diabetes mellitus, it could have a significant impact on the health of the Irish people. Moreover, Irish pork had already been exported to 23 countries by that time, making the problem spread beyond Ireland. In fact, fish and agricultural products, as well as meat, such as beef, pork, and poultry, are already becoming globalized, beyond the level of production and consumption within the local community or country. In addition, as the livestock feeds production industry supplies its products across borders or regional boundaries, any potentially harmful substance contained in the feeds can affect the meat produced in various regions, triggering a global spread of toxicity.

In April 1986, a nuclear power plant exploded in Chernobyl, Ukraine, a part of the erstwhile Soviet Union, releasing massive amounts of radioactive particles. The radioactive particles flew westward with the wind, polluting not only Belarus but also Russia and Europe. Thirty-one people died on the spot due to the explosion, but the number of cancer cases estimated to have occurred
later due to radiation exposure was greater than 40,000. The accident in the Fukushima Daiichi nuclear power plant in 2011 also showed this problem. The radioactive contamination was not contained in Japan; the contaminated water flowed into the Pacific Ocean, but we do not know what the consequences will be for now. Increasing amounts of air pollutants are also spreading widely across the borders. In South Korea, there have been frequent alarms on fine dusts of late due to the increased air pollution. This happens to a considerable extent because the fine dusts spewed from the neighboring industrial park in China flow eastward along with the westerly wind. These examples illustrate that a global community-level response beyond the boundaries of the region and country is required when it comes to responding to newly emerging diseases in today’s world.

The World Health Organization declared in 1977 that it had eradicated smallpox, a move that was made possible largely by its extensive vaccination program since the mid-20th century. The vaccination program has contributed significantly to reducing the incidence of communicable diseases by preventing many diseases, such as measles, poliomyelitis, diphtheria, and hepatitis B. The use of antibiotics, such as penicillin, along with the success of vaccination, has also achieved great success in the treatment of infectious diseases, including communicable diseases. The rosy hope of ending infectious disease after conquering pathogens with antibiotics, however, turned gloomy again when humankind encountered an unexpected problem in the form of antimicrobial-resistant bacteria. In other words, most of the pathogens die due to the toxic environment created by antibiotics, but some genetic mutations occur in the pathogens with continuous use of antibiotics, resulting in the creation of bacteria that do not die in the toxic environment of antibiotics.

In fact, the antimicrobial-resistant bacteria that were created by genetic mutation can spread rapidly even if the number is small at first, because pathogens produce offspring very quickly. The other reason for the spread of the antimicrobial-resistant bacteria is that antibiotics are widely used in livestock breeding and fish farming, and are sometimes overused in the medical field. Such overuse of antibiotics has created favorable conditions for the bacterial mutations to occur more frequently. In addition, to pathogenic bacteria, pathogens such as viruses and malaria parasites are becoming increasingly resistant to respective antimicrobial drugs. As the past pathogens are reemerging newly armed with antimicrobial resistance, it may be difficult to achieve the goal of overcoming infectious diseases completely at least for the time being. Problems like antimicrobial resistance, however, are not limited to a particular country or region. In today’s globalized world, it cannot be assumed that pathogens with an antimicrobial resistance can be contained within specific regions. Therefore, comprehensive global level strategies, beyond the local-level strategies, for suppressing the development of antimicrobial-resistant microorganisms are required, along with the development of new antibiotics and vaccines to effectively disarm the pathogenic germs.
Ending disease through the globalization of medical care

Disease patterns are basically determined by the development stage of civilization. However, due to the different historical development stages of each region and the different experiences and times of civilization construction and propagation, the patterns of disease may appear differently among various regions. At present, there are still family members or clan-centered societies living a life as hunter-gatherers, such as the Hiwi in South America, who have yet to suffer chronic diseases in earnest. On the other hand, people in developed countries, while enjoying the modern urban living, are experiencing chronic diseases together with the late chronic diseases. These two populations, who are very different in terms of development stage of civilization, coexist. To cope with these different stages of social development and disease, strategies for dealing with diseases tailored for each society must be adopted.

If we look at the civilization of humankind as a whole, however, we can see that it has undergone specific stages of development along with the time. Even though there were some exceptional cases of having returned to hunting and scavenging when the condition was not conducive for farming and herding, such as in unfavorable weather conditions, there was no change in the basic direction of going forward to the modern society after the Agricultural Revolution and then the Industrial Revolution. Therefore, it is desirable to adopt a disease prevention and management strategy that is suitable for each development stage specifically because there is different disease experience at each stage.

A cross-sectional look shows that there are now various stages of disease on the planet, and therefore, it would be appropriate to adopt different strategies for each region according to the stage. It should also be taken into account, however, that the various stages of disease affect one another and that the disease stage changes along a certain direction. For instance, the problems of chronic disease in developed countries and nutritional deficiencies in sub-Saharan Africa coexist at the moment, and they may represent different stages of disease development, but the transition of disease pattern is not fundamentally different from one region to another because the sub-Saharan region will eventually experience an epidemic of chronic diseases soon, as in developed countries.

Therefore, despite the different stages of historical development among various regions, the trend of globalization requires a governance system capable of carrying out various strategies according to each stage in the global scale, and such governance system also requires close coordination between countries and regions. Along with the trend of globalization, the healthcare services that have been planned and performed mostly within the framework of the country need to be changed as well, embracing globalized approach genuinely. Otherwise, the world can be polarized more and end up with deepening inequality. In fact, many countries are now seeking to adopt the developed countries’ advanced medical technologies while still struggling with poor medical access and a poor social environment. This may lead to the polarization of health care within the country, while accelerating the globalization of medical care at the same time.
Now, there is a need for global-scale disease management strategy that addresses these issues of polarization and globalization in earnest. Priority should be given to reducing the disparity in the health and disease levels in each country, leaving no one behind in terms of accessibility to medical care, by applying technologies and tools available to the local community. The next step is to create a strategy to end the disease on a global scale, based on a strategy of the globalization of health care to reduce the difference of health and disease levels among countries. Probably, one of the practical measures to conquer disease is to strengthen the international governance structures, such as the World Health Organization and the World Bank, that establish and enforce a global strategy.

4.3 Epidemic of Mental Illness Comes to Torment Humankind to the Very End

People’s health status and lifestyle habits can be monitored via biosensors, and early measures can be taken to ensure that chronic diseases will not pose a threat anymore in the future. The changes in the coming years, however, will not simply bring about such a rosy future. Above all, the mental workload will grow excessively, although the physical workload will be reduced. This will pose a significant challenge because mental illnesses can increase significantly. As humankind becomes increasingly dependent on the technical development and becomes a part of a huge computerized network, people may feel threatened or anxious because of a loss about value of their existence as independent selves. Such change can lead to an epidemic of mental illnesses at a very alarming level. For this reason, humankind should prepare for mental illness, which will soon emerge as key disease in the hyperlinked society.

Disease management strategy in the wake of the network revolution

In 1981, *Time* did not choose a person of the year. Instead, it chose a machine of the year, signaling that the computer will be playing a central role in the future development of the society. Medicine, medical care, and disease treatments are no exception in that they are affected by this change. If the Industrial Revolution was a historical event that dramatically increased productivity supported by fossil fuels and machinery, the network revolution enabled by computers and the Internet is another major historical event that has brought about changes throughout all over the society. Humankind entered the age of abundance as the Industrial Revolution, which began in the 18th century, triggered a scientific revolution worthy of being called the “Second Industrial Revolution” at the end of the 19th century, but on the other hand, it caused the maladaptation of the human genes to the environment owing to the excessively fast-changing living environment. The decisive role that the maladaptation of the genes to the environment played in ushering in the arrival of the age of chronic diseases
suggests much about the diseases that the network revolution, called the “Fourth Industrial Revolution,” can bring about.

By the turn of the 21st century, the development of information technology had created a great turbulence in the society. With the arrival of the networked age, humanity began entering an era where people are connected with other people and with things and, where things are connected with other things, to enable a more intelligent judgment. Moreover, the speed of change is very fast, unlike in the past. It took 6 million years from the emergence of the hominids to the prehistoric humans to emerge, 10,000 years from the formation of civilization to the Industrial Revolution, and 250 years from the Industrial Revolution to the modern society. It took only about 30 years, however, for humanity to be interconnected with one another through the network revolution. The speed of change will be accelerated even more in the future until each person no longer exists as an individual independent from others but as a constituent of the global network that is one human community.

The characteristic of this age is that humankind manages the physical environment and the cyber environment in a consolidated manner, overcoming the constraints of time and space, and the entire planet is morphing into an organic system. In other words, the boundaries between people, objects, and events will be blurred, and there will emerge an increasingly close interconnection among them. Therefore, people’s individuality will disappear as everything is being integrated organically, while the system for managing this will also evolve from a centralized to a decentralized system of responsibilities. Ultimately, it can be said that humanity and the environmental factors will be linked with each other, transforming the society into a networked one that overcomes the constraints of time and space and creates new values.

In the networked society, all the information, such as how much people walk and exercise in a day, how much calories are consumed, how high the blood pressure is, how fast the heart rate is, and how many hours one sleeps, can be recorded in each person’s smartphone or via IoT (Internet of Things) tools at work and at home. People’s health status and lifestyle habits can also be monitored by detecting physiological or pathological changes via the biosensors installed in clothing, watches, and glasses, as well as via those inserted in the body or installed in the living space at home or at the workplace, and transmitting such information to the computer network. For example, the health condition can be continuously checked by inserting a small device capable of continuously measuring the blood sugar level or metabolites in the skin or by installing an analyzer capable of analyzing the DNA or microorganisms obtained from the urine or feces in the toilet. The monitoring via biosensors can be done automatically and inconspicuously, because it can deeply penetrate people’s daily lives.

The information obtained from the biosensors will be automatically transmitted to the medical care system and analyzed so that if any anomalous signal is generated in the body, the medical staff that is in charge of the patient care
will be provided with immediate information and the appropriate medical measures required for treating the patient. In fact, chronic diseases like hypertension, diabetes mellitus, and hyperlipidemia do not usually develop into serious problems if managed properly while monitoring the disease biomarkers accurately and continuously. Also, life-threatening diseases like cancer can be sufficiently cured if they are found at an early stage. Through such monitoring with biosensors, early measures can be taken to ensure that chronic diseases will not pose a threat to humans anymore in the networked future society.

**Reduced physical activity and increased mental activity**

In the future, the very shape of labor engaged in the production activity will change. The conventional practices, including going to work or attending a meeting, will almost disappear, and people will be connected to computers anytime and anywhere, working in a more efficient environment to gather information and opinions and then to make decisions based on these. The labor force will also change. The traditional way of working as a specialist in a specific field after mastering a certain specialty area will be gone. Instead, the task itself will change in ways that will integrate various fields. Therefore, opportunities for learning will be provided throughout one’s lifelong period, even after the completion of a regular education course and in ways that will enable the acquisition of knowledge not just from one field but from various fields. Moreover, because elderly people will live longer in the future by strengthening their biological functions, age will no longer be a limiting factor to work, thereby gradually eliminating the concept of retirement.

If humankind’s future productivity exceeds the level of human consumption and the community ends up having sufficient social infrastructure, it will be possible to provide all the members of the community with their basic necessities for daily living, including food, education, transportation, communication, and medical care. As the living standard of all the community members improves, the production relation will also undergo a similar transformation. In other words, humankind will be able to realize a community in which monopolization of ownership has been largely resolved. As the production and consumption are elaborately well managed based on sufficient productivity and advanced network system, the monopoly ownership over surplus products will disappear, along with the social class. If such a community is realized in a desirable direction, individuals can achieve self-realization through labor, along with a rediscovery of the true meaning of labor.

Therefore, if humankind successfully achieves such monumental transformation, the problems of slave labor, feudalism, and labor alienation, which have not yet been resolved through capitalism and socialism — i.e., “labor for others rather than for oneself” — can be essentially solved. Individuals can choose to work according to their abilities and aptitudes, and can change their labor activities as necessary. In addition, the work environment, which has been
characterized by intensive labor and dangerous and repetitive work since the Industrial Revolution, will be turned into jobs that are less physical and taxing. With the introduction of remote manipulation and virtual reality (VR) technology, the industrial scene is being transformed into a smart space from a space where workers face machines directly. Thanks to the widespread use of state-of-the-art sensors and the interconnection between objects, plant operators and engineers will work in offices, just like white-collar workers. In addition, the office will no longer be a fixed place in the same company building, as it is today, but will change to flexible concepts like a mobile or home office.

The changes in the working environment, however, will not simply bring about such a rosy future. Above all, the workload itself may not be reduced because the mental workload will even grow in volume. As the amount of information that a person has to deal with is much larger than in the past, and as it is necessary to organize and analyze such information and to make decisions, the mental workload will grow excessively, although the physical workload will be reduced. This type of working environment will be markedly different from the labor condition in the age of hunter-gatherers, which was characterized by a massive amount of physical activity but a limited level of mental labor, which still defines our state of body and mind today.

In fact, it can be said that chronic diseases like obesity, diabetes mellitus, and heart disease are caused by the differences in the physical activity between the people in the age of hunter-gatherers and those after the Industrial Revolution. Likewise, if the physical activity is reduced further in the future while the mental activity grows in volume to an incomparable extent, this will pose a significant challenge to disease management because mental illnesses, which are often attributable to one’s failure to accommodate the changes in the society or the relationship, can increase significantly. Accordingly, just as chronic diseases like hypertension and diabetes mellitus are caused by an imbalance between the energy supply and consumption with the considerable reduction of the amount of physical activity, the greatly increased amount of mental activity will cause an overload of brain activity and a corresponding explosion of mental illnesses like depression and adjustment disorder in the future. Perhaps the chronic disease that will dog humankind to the very end would be mental illness. Therefore, the future medical systems should adopt health management practices that sustain the human body and mind in a biologically optimal state by monitoring both physical and mental activities at the same time.

**Increased mental labor shakes up the age-old physiological equilibrium of the human body**

In the networked society, data and services can be used anytime and anywhere as necessary. As a result, the work efficiency can be significantly increased because the work is carried out without being limited by time and space, but the boundaries between the leisure and work hours can also become fuzzier.
You may have to work in your leisure time, thus tiring yourself with overwork. These increased tasks, however, are usually those that require mental activities instead of physical activities. The more computerization advances, the more the work style changes from physical activity to mental activity. This can shake up the physiological equilibrium of the human body that has evolved to the present form over a long period. That is, the amount of energy used by the brain has greatly increased compared with the past, while the amount of energy consumed by the muscles has dropped to a much lower level.

The muscles are very important in controlling the body temperature in addition, to enabling physical activity. If the external temperature detected in the hypothalamus of the brain (the central nervous system responsible for thermoregulation) is high, the blood vessels under the skin will be expanded to allow an easy escape of heat from the body. Conversely, when the temperature is low, it will shrink the blood vessels and reduce the possibility that the body heat is dissipated. In addition, heat is generated to maintain the body temperature by contraction of muscles thanks to the energy generated when the ATP is converted to ADP in the muscle. Therefore, shaking of the body in the cold is due to muscle contraction to generate heat. As such, the muscles play a very important role in controlling the body temperature. If the amount of muscle mass decreases along with falling energy consumption by muscle, the body temperature control function will deteriorate as well. As body temperature regulation is essential to maintaining the proper metabolism of the body and to facilitating key functions like the brain function, people will be increasingly dependent on external-temperature control devices like air conditioners, heaters, and clothes for controlling the body temperature. Of course, the devices for maintaining the appropriate body temperature can be further advanced as well. For instance, a sophisticated indoor environment controller or clothes capable of automatically adjusting the body temperature will be developed. This, in turn, means even more dependence on machines and tools for basic life-sustaining activities. Eventually, humankind will find it quite difficult to survive without machines or tools.

On the other hand, there is a limit to the information-processing capacity of the brain because brain size and the number of neurons cannot be increased. Therefore, the amount of workload that the brain has to carry out cannot continue to increase for good, suggesting that the amount of mental labor needed in the future societies will someday reach a point where the biological brain can no longer afford to handle it. In other words, there will come a day when a certain system capable of boosting the brain function will be needed. In addition, given the current pace of technological development, the brain’s biological capabilities, such as memory, perception, and analysis, can no longer match the performance of AI. Therefore, we may wish to boost the biological capability of humans by using AI devices connected with the brain cells via interfaces. Perhaps it takes a considerable amount of time for AI to be equipped with deeper underlying biological capabilities such as emotions and moods to communicate
with humans through such interfaces. Feelings and moods, however, are also derived from the interaction between the environment and individual humans as well as from the response patterns learned through biological reactions and experiences. Accordingly, AI will attain a certain level of capability someday that is good enough for it to understand and express emotions or moods.

Dependence on AI lowers one’s self-esteem

When the intelligence of our hominid ancestors and that of the modern humans are compared, a big difference will probably be seen, if not as great as the one between the apes and modern humans. The constant improvement of the intelligence is due to the pressure of natural selection, and the changes to further improve the intelligence will continue as long as there is competition for survival. Since the 1980s, the computer-enabled revolutionary changes have had a profound impact on everyday life as well as on the society as a whole, and a variety of attempts have been made to overcome the limitations of current biological intelligence. A look at our daily lives will show that we get information easily from our smartphones, store information on mobile media, and use the information stored in various media at any time, as necessary. People are now consciously or subconsciously exerting efforts to improve their intelligence so that they will not have to rely solely on their biological intelligence. These efforts are expected to accelerate further. In the end, it will reach the point at which AI will be used beyond the intelligence capabilities of biological humans.

In addition, studies to overcome the limits of life may lead to technological breakthroughs, such as that the brain cells will not die and will continue to function. If AI devices are connected with the brain via an interface, or are sufficiently miniaturized to enable them to be inserted in the brain, along with the use of technology to regenerate brain cells or to extend their lifespan, the human intelligence will be improved to a much higher level. If AI is combined with the human brain, the AI connected to the computer network will push the human intelligence to advance far beyond its biological bounds of individuals, and will further evolve to become the collective intelligence of humankind. This collective intelligence can create a new civilization residing in a world with completely different shape from the current civilization.

The aforementioned change may happen not in the distant future but in the present century. This, however, will not necessarily bring positive results only. Perhaps humankind will be biologically strengthened in the future, but at the same time, humankind will become more technology dependent and less different from machines. Also, as humankind becomes increasingly dependent on the technical sophistication and productivity of the community than on the individual’s ability, the individual personality or independent self can lose its strength. For example, if the memory and intelligence will be strengthened by the AI devices implanted in the brain, the intelligence will be enhanced, but the independent self will not necessarily be strengthened. Rather, one’s reliance on
computers or machines can lower one’s self-esteem and can make humans more of a component of the overall system because it will be difficult to play a social role without a computer, and the computer itself is not made by the independent individual but is a technical achievement of the community. Therefore, although the unity of the community grows, the awareness of the independent self, which has seen itself as a completed entity, will inevitably be reduced. In the end, people may hand over their individual independence to community as a whole and live just as components that make up the whole.

Just as a cell does not exist as an independent entity but only as a constituent of an individual organism where the cells unite with one another, an individual human also can be regarded to exist only as a social member and not as an independent individual. This is because each individual can have a sense of existence as a human being only when he/she establishes a relationship and plays his/her given role as a member of a family, as a close acquaintance with somebody, or as a part of a community. When a cell does not play its given role in the tissue, and has independence from the governing framework formed among the cells, it can become a cancerous cell that destroys the tissue, or it may turn into a diseased cell incapable of functioning normally, and then cause a disease or induce apoptosis at best, thereby killing itself. If a person does not play his/her given role in the community and crosses the boundary of cultural and social norms, he/she may harm the community or develop a mental disorder, such as an adjustment disorder, anxiety, and depression, or may even end up killing himself/herself.

In the end, for an individual to function properly between the two extremes of complete dependence and the rebellious independence, he/she should have a healthy level of self-esteem as an individual entity, and the relationships with others should be formed well harmoniously within the community at the same time. Therefore, the quality of life of the future humans can be determined by how much the individual freedoms are preserved and realized under the framework of the community or the networked society. It is not desirable for a society that individual freedoms are uninhibited or allowed to expand infinitely, but neither is it desirable for an individual to act only as a component of the community that loses its identity. Ultimately, maintaining an appropriate balance between human freedom and community control will turn out to be a key challenge in securing individual mental health and creating healthy communities in the future society. This may as well depend on how humankind manages AI, which will then have established itself as an important axis moving the community.

**Existential anxiety triggers an explosion of mental illness**

In 1950, Alan Turing proposed the Turing test as a criterion for judging whether a machine is truly intelligent. A machine that passes this test is considered to have an independent intelligence. After that, AI has continued to evolve with the development of computers. In 1997, IBM’s chess-playing computer Deep Blue
defeated Russian chess world champion Gary Kasparov with two wins, three draws, and one loss. In 2016, Google’s Alpha Go defeated Korean Go champion Se-dol Lee in a historic match by winning in four of five games. As AI today is capable of performing complicated tasks that require a higher level of skills, AI machines will soon carry out a great deal of professional tasks that are currently being performed by humans.

The superconnected society that will materialize in the near future is a society where people act as nodes of a huge network, connected with countless objects and robots. In this society, the meaning of existence as an individual human with an independent personality may become obscure, and the ability to live harmoniously with the superconnected system may be valued more highly. As humans have succeeded in building societies and creating complex relationships since the advent of civilization, they are expected to succeed as well in forming more complex relationships in the future, but moving toward a machine-connected relationship will pose a serious challenge to humanity. If you become a part of a huge network instead of existing as an independent human being and you feel threatened or anxious because of such a loss about value of your existence as independent self, it can lead to an epidemic of mental illnesses at a very alarming level.

The traditional powers appear to have gradually handed over their dominance on people to the networked systems. For instance, we can often see today that the social media like Facebook influences people more than a government power. It is not easy, however, to recognize such transition of powers, because it looks as though each individual seems to have taken on an independent position with free will. This is, however, in fact a shift from a subordination relationship to traditional power to dependence on the network system. The network can be regarded as a convergence of people from all over the world into one immense system. The main reason that traditional relationships like the state–citizens, employers–employees, and teachers–students have broken down and new relationships among people based on the networks have emerged is that we all have become subordinated to the complex connection of computerized networks. If an individual fails to secure his/her position in the network connection and loses his/her self-esteem amid the daunting feeling associated with the huge network of the superconnected society, he/she can suffer from an existential crisis, which easily turns into anxiety or depression.

In the hyperconnected society, an individual person does not make his or her own decisions about most issues, as the individual people today do; AI takes over it instead, making the vast majority of decisions, with the roles of humans being limited to the approval or understanding of such decisions. Humans can fall from the subjective position of thinking and acting to a passive and dependent position in biological and social terms. In short, humans with absolute and independent rationality (certainly it is a very hypothetical idea, but we have presumed as such!) may no longer exist, and there may only be passive and dependent entities subordinate to the gigantic network system. This threat will
be different from any other threat that humanity has ever faced, such as hunger, germs, and chronic diseases, in the past.

Just as the changes in the period of 250 years since the Industrial Revolution have prompted a widespread epidemic of chronic diseases, the transition to a superconnecting society taking place in a very short period could bring a new disease epidemic in a large scale. That is, the insecure position of human existence can trigger an explosive outbreak of an epidemic of mental illnesses. Furthermore, based on the history of humankind, where collective psychiatric conditions often manifest themselves as serious political madness (see the Nazis and World War II), the widely prevalent mental illnesses in the future societies could have some catastrophic results. For this reason, humankind should prepare for mental illness, which will soon emerge as key disease in the hyperlinked society. Therefore, the future medical care should advance to the stage of managing the physical, mental, and social functions to fit the networked society, away from the present medical care limited to diagnosis and treatment of infectious or chronic diseases.

4.4 Economic and Social Inequities Lead to Biological Inequalities

If the rate of change in human society is too fast, it can cause serious problems leading to the crisis of human sustainability, way beyond health problems. If we address them successfully, we will be able to carve out an ideal future. For instance, humans can survive well harmoniously beyond the limits of their biological lifetimes. However, unless special efforts are exerted, there is little chance that the future will evolve as such. The more likely scenario, in fact, is that the productivity will improve further while worsening the overall social and biological inequality. The inequality may manifest as the difference between the biologically strengthened new human beings and the Homo sapiens without such strengthening. If we want to avoid such tragedy, we must turn the direction of change towards ensuring the sustainability of humankind.

Uncertainty of the future leads to humanity’s crisis

With the exponential advances in science and technology, it is increasingly possible to treat chronic and late chronic diseases successfully and to overcome the limitations of life expectancy. Disease will not be terminated, however, and a happy future will not come so easily, even if the disease treatment technology will be improved to a level that can cure most of the chronic or late chronic diseases. The reason for this is that if the present economic inequality, the unbalanced development of science and technology, and the difference in medical accessibility are sustained or accelerated, there will certainly be population groups that cannot enjoy the benefits of the medical technology development. Although humankind has evolved into a global community, the conflicts
between countries, religions, or races are intensifying at the moment. In fact, the existing economic inequality among population groups has not been resolved and is becoming rather worse. In other words, we are living in an age of uncertainty, where risk and opportunity coexist, because of the growing inequality.

Such uncertainty may be a harbinger of the coming revolutionary changes that will have a profound impact on the entire human race. Therefore, unless humankind exerts efforts to control or adjust to the rapid changes, along with efforts for the mitigation of the existing contradictions, the current crisis can bring humanity to an entirely uncontrollable contradictory society. Humanity, in fact, is presently standing at the crossroads of its destiny. If the control of change and the resolution of inequality are pursued in a desirable direction, human beings will be able to create an ideal community supported by the development of science and technology. If the conflicts and inequalities further deepen, however, without controlling the rapid changes, science and technology cannot be used in a desirable direction but will be used only to deepen the conflicts of interest among countries, religions, and races.

Industrialization and urbanization, which are the main characteristics of the modern society, are also bringing about rapid changes in ecosystems. Climate change and the destruction of ecosystems can cause civilization-level havoc when the global environment reaches a tipping point, where its resilience is lost. Civilization began 10,000 years ago along with the shift of the cold climate to a warm climate after the atmospheric temperatures near the earth’s surface increased by 5–6 degrees as the Ice Age retreated. Therefore, if current climate change occurs rapidly to an uncontrollable level, along with a rapid change in the ecosystem, humankind will be forced to face a crisis of having to survive in an entirely different global environment. The crisis at that time can be a civilization-level change whose size and content are difficult to predict now. The civilization-level havoc signifies that the human adaptation process needs to be required not only simply to the environment change but also to the political, economic, social, and cultural changes, which will be quite different from the current ones.

Humankind is already destroying ecosystems by abusing the earth’s limited resources and raising the earth’s surface temperature, causing uncertainty about the sustainability of the global environment itself. These global-scale changes may bring about catastrophic results unless we address them properly. Therefore, even if we will not be able to stop the change itself, we should at least be able to control the pace of change for our adjustment. As argued previously, the most important reason for the occurrence of chronic illnesses in the contemporary humans is that the adaptation process of the genes cannot keep up with the rate of lifestyle and living environmental change. If the rate of change is continuously fast or even accelerating, however, it can cause much serious problems leading to the crisis of human sustainability, way beyond health problems like the failure of chronic disease management and the epidemic of new diseases.
Can humankind greet a utopia where disease has been terminated?

Productivity refers to the amount of products or services produced when a unit of work is used, usually measured as the amount of output per work hour. The higher the productivity, the more the products are produced and the more easily the product becomes available. On the other hand, in a society with low productivity, products are so valuable that it is difficult for many people to obtain and use them easily. Until 10,000 years ago, our ancestors hunted and gathered food by using tools made of stone and wood, and because they had to rely on the plants or animals that are available in nature for their products, they formed small groups at best, living with such a low productivity. As the productivity increased with farming and herding since the beginning of civilization, humanity has been able to settle in certain areas, and expand their community as well. Further, with the Industrial Revolution, humankind made a dramatic advancement in boosting productivity. With the development of science and technology, the means of production were mechanized and automated to a considerable extent, while the nitrogen-based fertilizer increased the agricultural productivity, making it possible for common people to use products and obtain foods relatively easily and abundantly.

Therefore, human history can be interpreted as the history of ever-increasing productivity. If we solve our current conflicts and contradictions on the basis of productivity enhancement, we will be able to carve out an ideal future that is much better than the present. As the means of production become more automated in the future, the ability to produce more than the amount can be consumed by the entire human race will be realized soon. In addition, as the production volume becomes sufficient, the problem of distribution can be also solved, ushering in an age where everyone can use products freely anywhere. Of course, it is unlikely that a society running on the utopian principle of “production according to the ability and distribution according to the needs” as envisioned by many socialists, including Karl Marx, will come spontaneously any time soon. Despite the conflicts among many nations, ethnic groups, religions, and ideologies, however, the issue of production and distribution, which was the root cause of the conflict, can be controlled and managed appropriately before long.

If the time comes when the productivity is greatly improved and an appropriate level of production and distribution becomes technically feasible thanks to the development of science and technology, the community will be able to build a well-organized economic system that engages in production and distribution as necessary while ditching the legacy production relationship, where a few elites govern the majority. These production relations may again exert an influence on politics and the society, leading to the birth of a genuinely equal society, which will be formed via a union of free and independent individuals, which humankind has long dreamed of. In this imagined society, the safety and health of the members of the society will emerge as the most important social
values, and the social security and medical system designed to protect them will become a fundamental social structure.

Aside from the aforementioned distribution of products according to individual necessity, in the utopian era, education will be provided according to people’s talents and needs, free medical care will be provided for the treatment of all diseases, and conclusively, people will be able to do what they want. Moreover, as regional barriers among communities almost disappear, the boundary between states will likewise disappear, and the political system can be transformed into a form of direct democracy, in which free individuals participate directly in the political decision-making process. The foundation of production may no longer be commoditized or enslaved labor but will be the labor aimed at realizing oneself, which signifies a transition to a community in which the monopolization of ownership will finally be dissolved. Labor can no longer be an act in the consciousness of labor for living, but an act of free will. Just as labor was not enslaved or commoditized but was a critical part of daily life in the age of hunter-gathers, labor will no longer exist for others but for oneself in the utopian era.

The productivity, mode of production, and structure of distribution are fundamental determinants of the political system, social structure, and cultural characteristics of the society. It can be said that the development of civilization in the past was largely determined or constrained by these factors. Therefore, if the production capacity exceeds the consumption and the dilemma of distribution is resolved, humankind will witness an era that is much advanced than the past politically, socially, and culturally. In particular, as the progress of science and medical technology leads to the eradication of disease, humans can survive well past the limits of their biological lifetimes, or they are able to control their lifespan in the future. In the end, humans will be able to welcome the utopian era they have been dreaming of for a long time.

**Biological inequalities can lead to dystopia**

Can humanity, however, greet such a utopian era in earnest? It may not be easy, even under the best scenario, for humankind to overcome the conflict and crisis that people are currently experiencing and to succeed in controlling and adjusting to change nicely, because even if we succeed in solving the many problems that humanity has experienced so far, new problems will certainly emerge in the society. The problems that will arise following the resolution of our current problems will be entirely new problems that we have never experienced before; further, they are the problems that may not be easy to solve, such as the aging of the population, the choice between life and death, and a stagnant society that has lost the vibrant energy for further development. In fact, unless special efforts are exerted, there is little chance that the future will evolve as we have imagined in the best scenario.

Now, the indicators of human conflict and crisis, such as income disparity, the unequal development of the society, and the differences in medical accessibility,
are not decreasing but are even increasing. Therefore, the more likely scenario is that the productivity will improve without resolving contradiction in the production–distribution structure while science and medical technology continue to develop, thereby worsening the overall social and biological inequality. If only a limited number of groups will enjoy the achievements attainable through the advancement of science and medical technology, then only a subset of the people will acquire superior capabilities through enhanced biological functions, resulting in biological inequalities depending on social class. If such a scenario is ever realized, the future of humankind is likely to be a dystopia, not a utopia. Especially if such biological inequalities are realized, the future society will have crossed the point of no return because the dominance–subordination structure can be perpetuated, pushing humankind into irreconcilable conflicts.

Inequality is a major factor in the political, religious, and class conflicts faced by the humans living in the contemporary era. Looking back on the history of humankind, we can say that the people in the age of hunter-gatherers, which did not have any noticeable accumulation of wealth or class differentiation, belonged to an equal society. As civilization came into existence, however, communities like villages, towns, and cities were formed and then developed into nation-states before undergoing a series of changes to become unequal societies. As the power structure was created to manage and maintain the community, class division and wealth accumulation were realized, resulting in inequality among the members of the community. The class structure had been transformed from master–slave to citizen–noncitizen, nobility–commoner, and capitalist–worker according to the times. Fundamentally, however, we can say that the members of the society were divided into those who manage labor and own the surplus and those who barely own products to an extent that allow them to work and regenerate themselves.

Inequality occurs within communities like cities and countries, but it fundamentally arises from the differences in technology or productivity between communities. Even though various communities on the planet already showed considerable differences in their respective technological levels, the communities with superior technologies are becoming increasingly different in terms of application of science and technology from the other communities with comparably less advanced technologies. In a word, the inequality between communities is worsening in the future. In addition, if we keep the current trends, communities with advanced technologies can soon evolve to a point where they can apply their superior technology directly to the human body. Particularly if this inequality continues and extends to the point of the genetic manipulation of the embryonic cells, and the superior ability of only a few groups is transmitted to their future generations, the age of evolution by natural selection may come to an end, and a new kind of human species that is superior to the current H. sapiens may be born.

No matter how large are the inequalities that are currently observed among countries, races, and groups, the differences are still limited to the opportunities
The Changing Era of Diseases

for consumption and the cultural life, education, and healthcare access. The differences in physical and mental capacity, however, that may appear in the future societies may not be limited to the issue of mere opportunities. This difference will manifest as the difference between the new human beings that have been biologically strengthened through the enhancement of human abilities and the *H. sapiens* without such strengthening. Perhaps this difference may be greater than the difference between our ancestors who lived in the age of hunter-gatherers and the modern human who achieved civilization through the agricultural and industrial revolutions. It could be an absolute difference in capability between species, such as chimpanzees versus humans or, to a lesser extent, Neanderthals versus the *H. sapiens*.

**Enhanced human abilities, another potential tool for domination**

On the bright side, we will soon be able to fully understand the complex phenomena that cause and progress diseases on the basis of the power of the rapidly developing science. Based on such understanding, we will have a new future where the infectious and chronic diseases are rarely seen and the lifespan is greatly increased. Probably, the future over the next decades will be recorded as the time when the changes in the disease pattern happened most dramatically, and the increase of the human biological lifespan was the greatest in all ages. The change that will take place in the future, however, may be too fast and extensive to allow us to cope with, using the philosophical, ethical, and social concepts that humanity has established in the past, slowly over thousands of years. Therefore, it will be challenging for us to prepare for the future changes. Nevertheless, we, the present generation, cannot avoid our responsibility for the future, because the future society depends on us now, and it can give future humankind a more serious challenge if we do not prepare well now.

Since the age of hunter-gatherers, technological advances have transformed the tools that humans use, and newly emerged tools have led to the establishment and development of civilization. We are now entering an age where technological changes are transforming humankind itself. Just as it was difficult to imagine how civilization would evolve in the age of hunter-gatherers, however, it will be as difficult to anticipate the future with the view of present civilization. Just guessing, we may be able to find the key to unlocking age-old challenges like chronic illness and aging in the future, but it may also be the key to opening the door stepping into entirely new challenges at the same time.

Above all, as the share of the elderly population will be increasing in the future society, we will try to overcome the problems of aging by slowing down the aging process and maintaining our youth, or by strengthening human capability. For example, an elderly person with weakened muscles or who has difficulty walking can wear a human capability-strengthening device, such as a musculoskeletal assistant device, which will enable him/her to perform activities comparable to or more than those being performed by young people in their
daily lives. Devices that enhance the biological ability to recognize and respond to things through memory or intelligence enhancement, and genetic engineering or gene expression control, as well as physical activity-boosting devices, will be developed and used in daily life widely.

Technology for strengthening the human body functions will be developed competitively and will first be applied to patients and the elderly population, but it can later be used to enhance human ability far beyond the average physical and mental capacity of the contemporary humans. For example, in some communities or groups, ordinary people, such as students, soldiers, and workers, other than patients or elderly people, may seek to gain superior status to people in the other communities or groups by using human capability enhancement technology. If we allow elderly people with weak muscles to live a healthy life with the use of a human capacity-boosting device, we will recognize such device as good one for helping weak and sick people. If a young and healthy person, however, enhances his/her human ability by using the device and defeats others in competitions, the device can be recognized as a tool for competition and domination.

As the group armed with the advanced weapons in the past conquered, enslaved, or extirpated groups armed with less advanced weapons, so too will the future group. Those who will have acquired stronger, faster, and healthier bodily capability as well as excellent mental capability in terms of memory or intelligence with the use of artificial intelligence devices try to dominate those without access to such strength-boosting devices. In the areas of learning, occupation, sports, and entertainment, people with enhanced physical and mental functions will dominate, and, in a severe case, a new relationship of dominance and subordination — the new master–slave relationship — can appear.

Unlike the natural selection process, however, in which superior genes are selected over a long period of time, the human body enhancement is a process of creating excellent physical and mental abilities artificially in a short period of time, suggesting that there is insufficient time for a variety of excellences to be verified extensively in terms of safety for humanity. Accordingly, such human capability enhancement process cannot be said to have been verified for securing our presence, nor it can be known what influence it would have on the sustainability of humankind. It is at this moment that the fate of humanity as H. sapiens becomes uncertain.

**Stopping the tragedy of H. sapiens becoming slaves**

Humanity ended up as the dominant species on earth not because it was able to use tools but because the cultural information produced by humanity was passed down and then accumulated. For instance, chimpanzees can use tools and can convey such use to the next generation in the form of behavior mimicry, but it is only humankind who can accumulate this information and transmit it in the form of thought. The accumulation and transmission of ideas by tools, such
as language and script, were not only very efficient but also enabled the construction of a culture on which new ideas could be continuously added. It cannot be said, however, that the ability to create a culture has been equipped from the beginning of our hominid ancestors. As our ancestors began to eat meat and fish through hunting instead of simply eating plants and vegetables, humankind became omnivorous, thereby laying the foundation on which the brain could grow. The cerebral cortex has been developed more through the fierce pressure of natural selection for survival. Only after having their brains progressively advanced over a long period of time did the human race gradually develop the ability to produce culture.

In the past, the accumulation of information and the development of culture were based mainly on such ability of the neurons of the human brain, but now, far more information is stored in computers or information storage media than the amount that humans can accumulate in their brain. Now, humans and AI cannot be compared at all in terms of their storage capacity and information processing capability, suggesting that AI, not humans, will play a more important role in the creation and transmission of culture in the future. Until now, humans have played the role of the creator of culture because of their outstanding ability to see, touch, feel, think, and judge. The time will soon come, however, when AI takes over these senses and thinking and judging capabilities, or when people’s abilities are enhanced far beyond the current human abilities with the help of AI.

As the framework of the community changes constantly and the roles of the computer keep growing, humanity will gradually depart from the cultural framework built on regional, racial, and religious foundations. Computer networks will provide a basis for new life so that people can meet and do virtually according to their common interests and tastes, without spatial constraints, and so that people will hardly feel the barriers of physical reality. The physical and mental functions that deteriorate with aging will also be supplemented or even strengthened by human enhancement tools and AI, which will again reduce the differences in cultural life according to the varying age. Furthermore, the traditional role of sex will be diminished as humans will have a stronger ability to control their sexual desire or cool alternatives to satisfy it. These changes will eventually transform today’s family-centered society into a society based on new human relationships.

The signs of this unprecedented change are already envisaged today, and the wind of change will blow even stronger. If we have any choice at all amid such changes, the only available option for securing our future is that of controlling the speed and target subjects of the change. Thus, humanity’s fate will depend on how fast we are going to change and how much control we can have on our target subjects. If the pace of change is very fast, the beneficiaries will soon turn out to be only the rich and powerful, and if the poor and the subordinates cannot have the opportunity for the change and will stay behind, the current inequality structure will further deepen. Depressingly, such a dark scenario is likely to be realized in the future. The rich and powerful people and groups will
not only consolidate their current dominance but will also be able to strengthen themselves further and become excellent beings thanks to the advancements in science and medicine.

Perhaps the strengthening of the human capacities based on the desire to live forever can end up wiping out the civilization of the *H. sapiens* because new human species or superhominids can be born through the enhancement of human capacity. If we want to avoid the fate where the new human species become the ruling class and the *H. sapiens* become slaves, we must turn the direction of change toward ensuring the sustainability of humankind. This is also closely linked with ensuring harmony and balance among humanity, the ecosystem, and the global environment as well. It is because humankind’s sustainability is only possible when the whole of humankind can keep pace with other life forms and the physicochemical constituents of our planet for the harmoniously changing world.