



Tokyo Tech

Self-Personalized Well-Being for the Elderly Supported by Comprehensive AI Healthcare to Connect the Local Community

*Sustainable futuristic healthy society realized through
AI-assisted proteomics based on practical open innovation*

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Tokyo Institute of Technology *CEWIT2023 Conference*

A "truly" happy, healthy and long-lived society

Everyone knows about themselves (health status, abilities, etc.),

- at any time
- by himself/herself

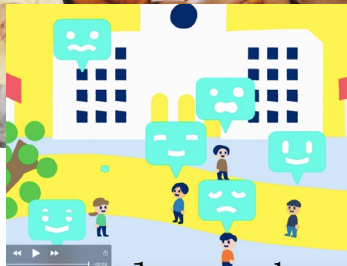


- ✓ Exhibit one's ability and individuality according to TPO
- ✓ Can decide for himself/herself what he/she wants to be
- ✓ Can take care of himself/herself throughout his/her life

AI supports elder's lives by connecting them to their local communities

A "truly" happy, healthy and long-lived society

A society where people can live long and happy lives, where they can exercise their abilities and individuality in accordance with TPO, and where they can make their own decisions and take care of themselves.



AI counselors who work with individuals

Proposals and services for living



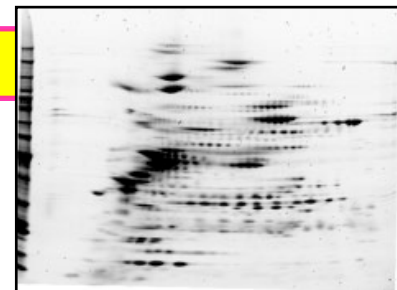
Information and advice



Comprehensive data on health status (Proteomics data image)

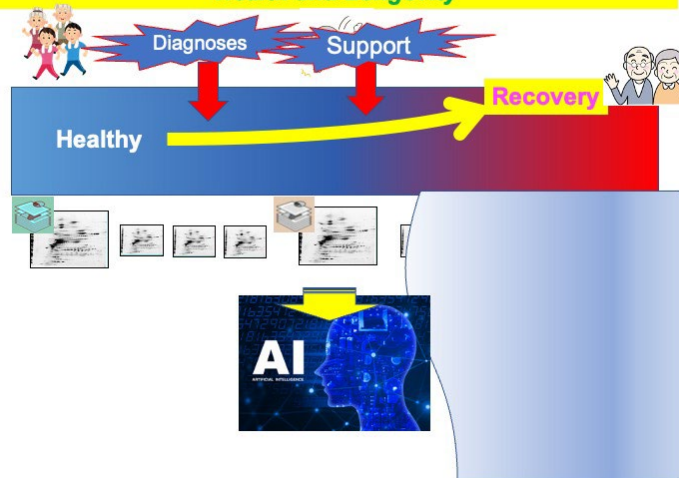


Data acquisition



Data transfer

Toward a Future Health Care Society for High Quality Health and Longevity



Comprehensive health status by AI

<https://www.youtube.com/watch?v=ReWvKzePy7Y>

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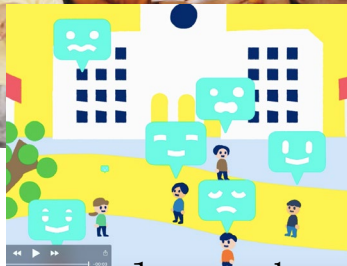
Proposals and services for living



Local Community



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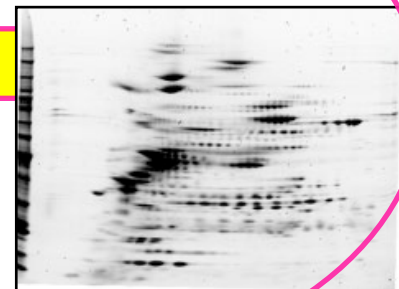


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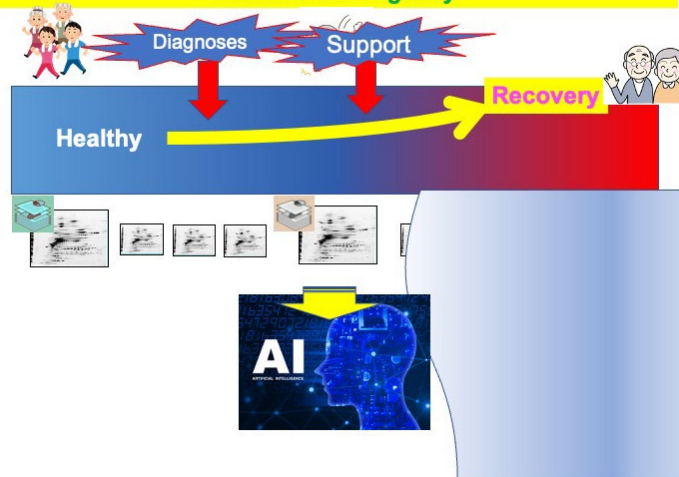


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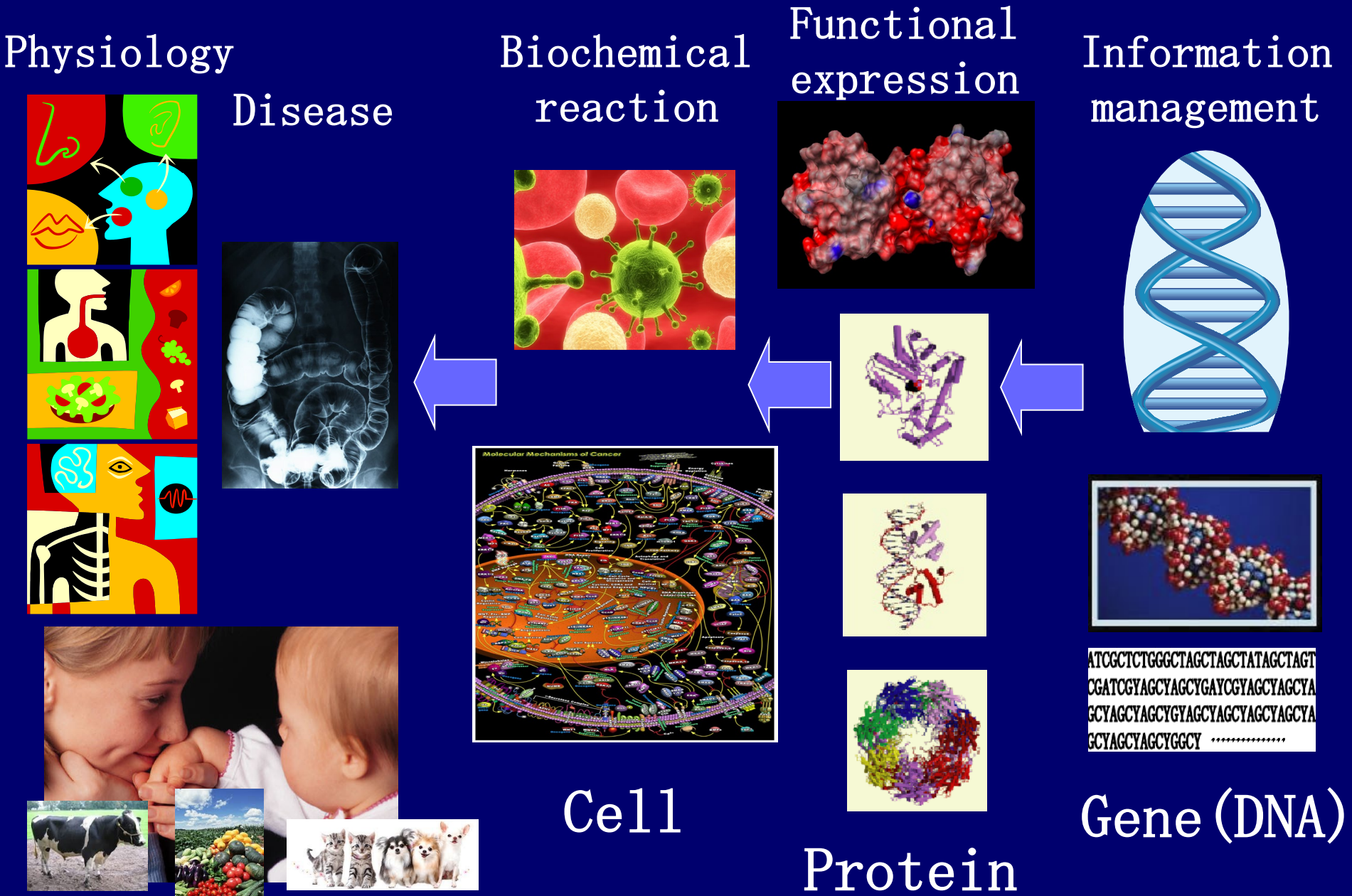
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- Proteins
- Proteomics
- AI Proteomics
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Hierarchy of living body



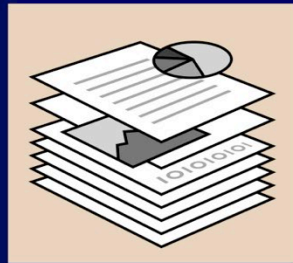
Proteins bear the vital activities

Blueprints

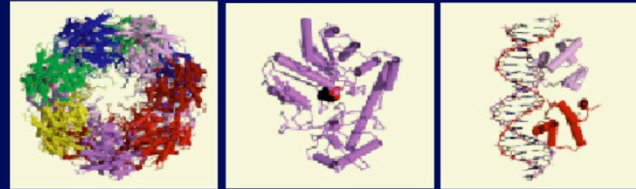


ATCGCTCTGGGCTAGCTAGCTATAGCTAGT
CGATCGYAGCYAGCYGAYCGYAGCYAGCYA
GCTAGCYAGCYGAYAGCYAGCYAGCYAGCYA
GCTAGCYAGCYGGCY

**Gene
(DNA)**

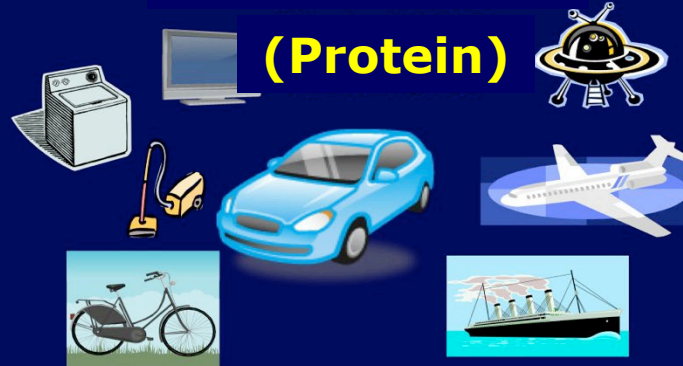


Products



Bio-machine

(Protein)



Possibilities

Permanent
from birth to death

Current states

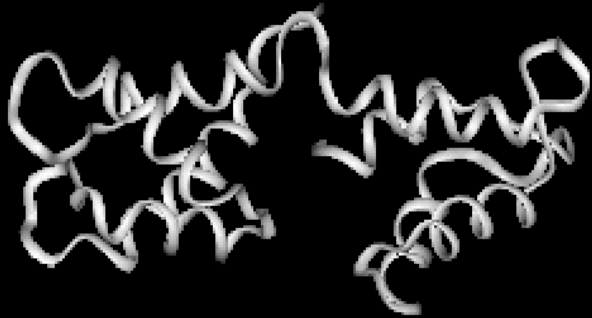
Variable every day

To think

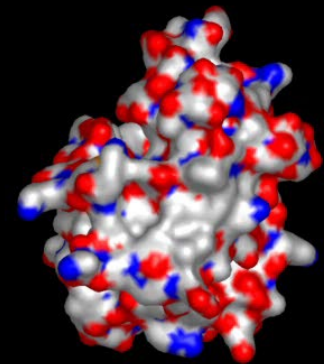
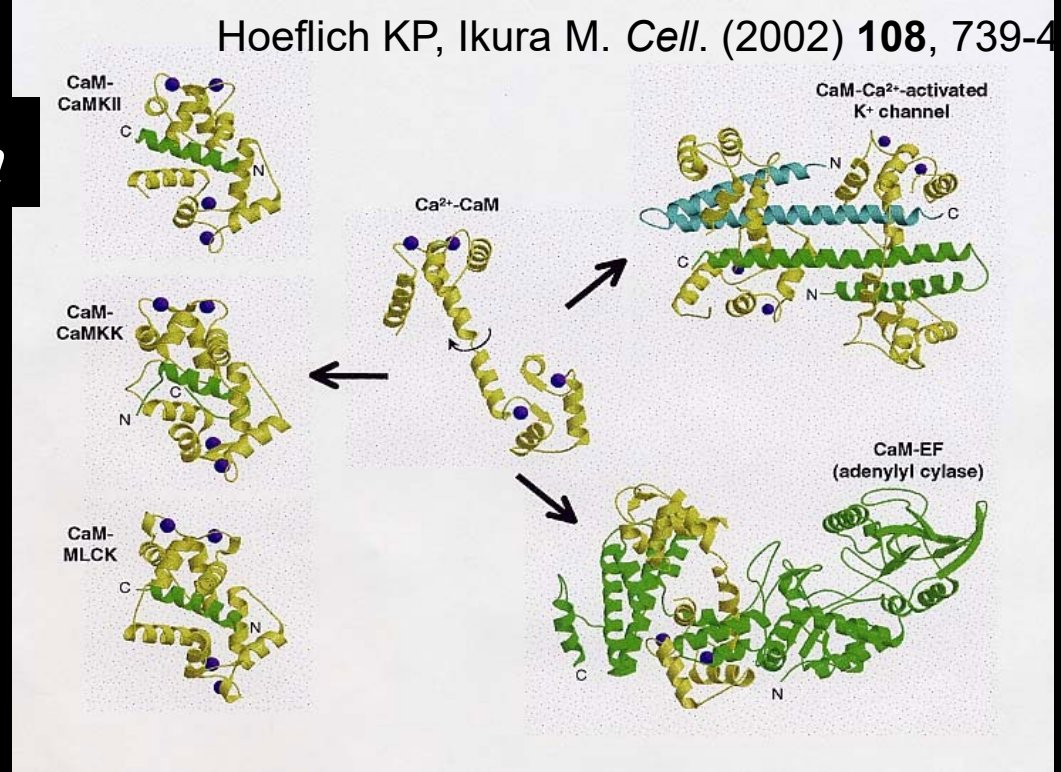
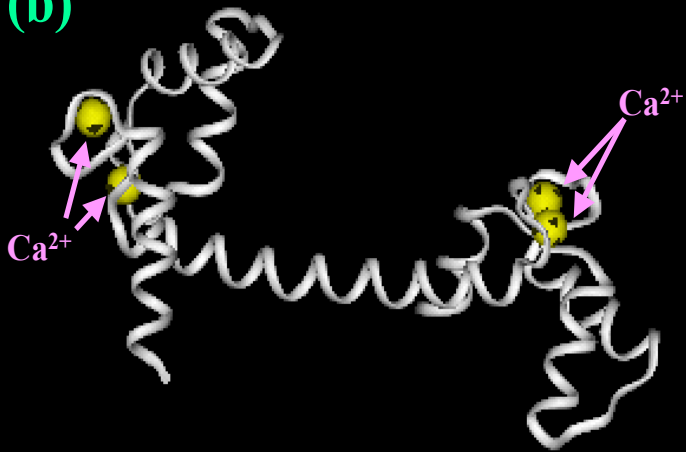


calmodulin

(a)

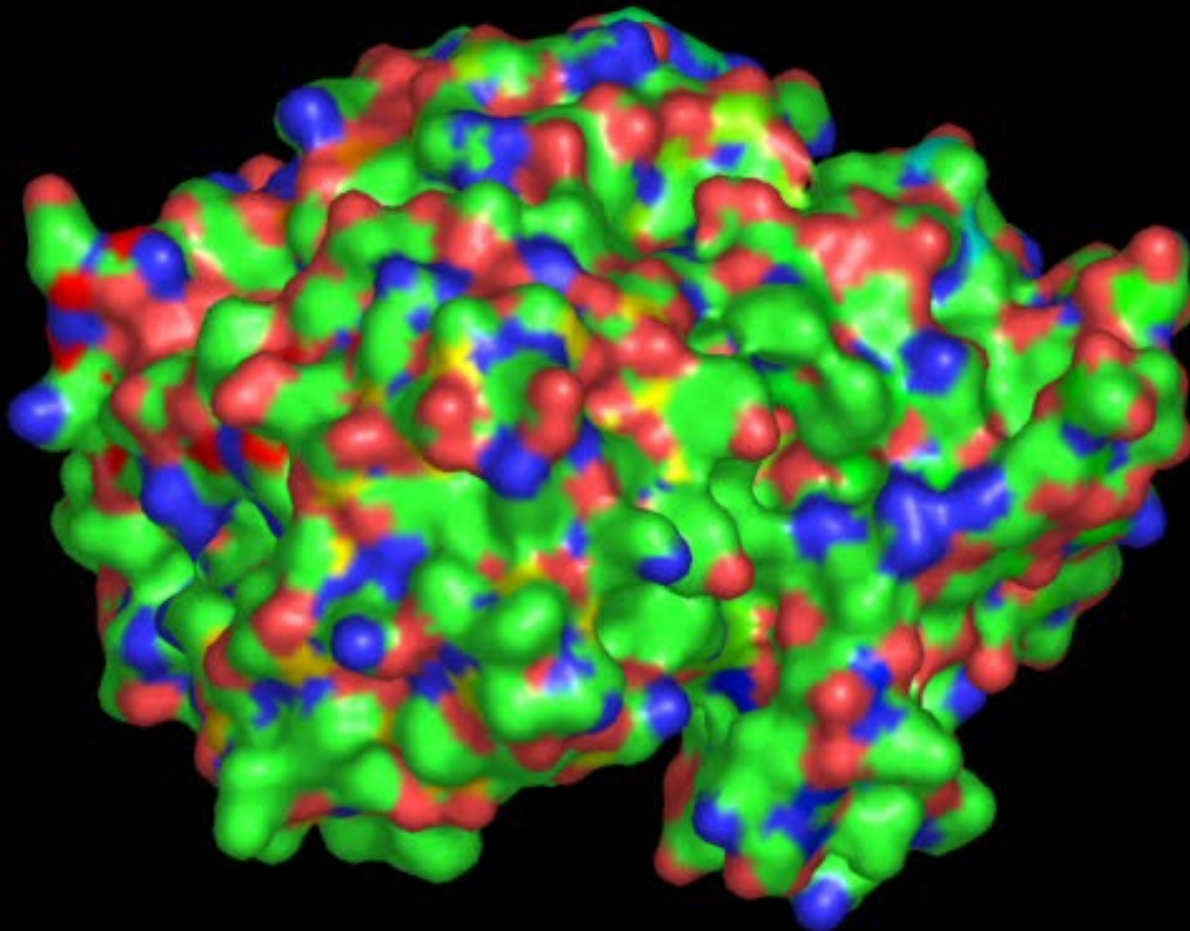


(b)



To eat

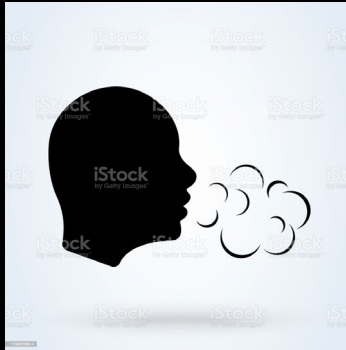


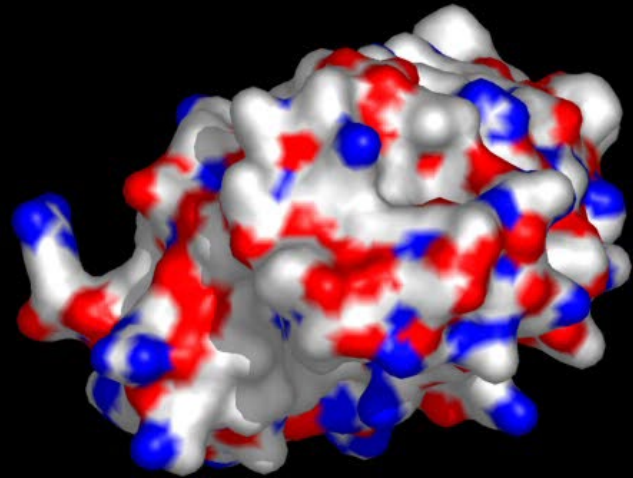
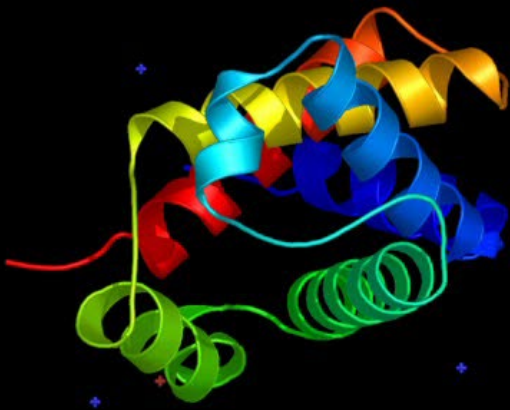


molmovdb.org

Lipase

To breathe

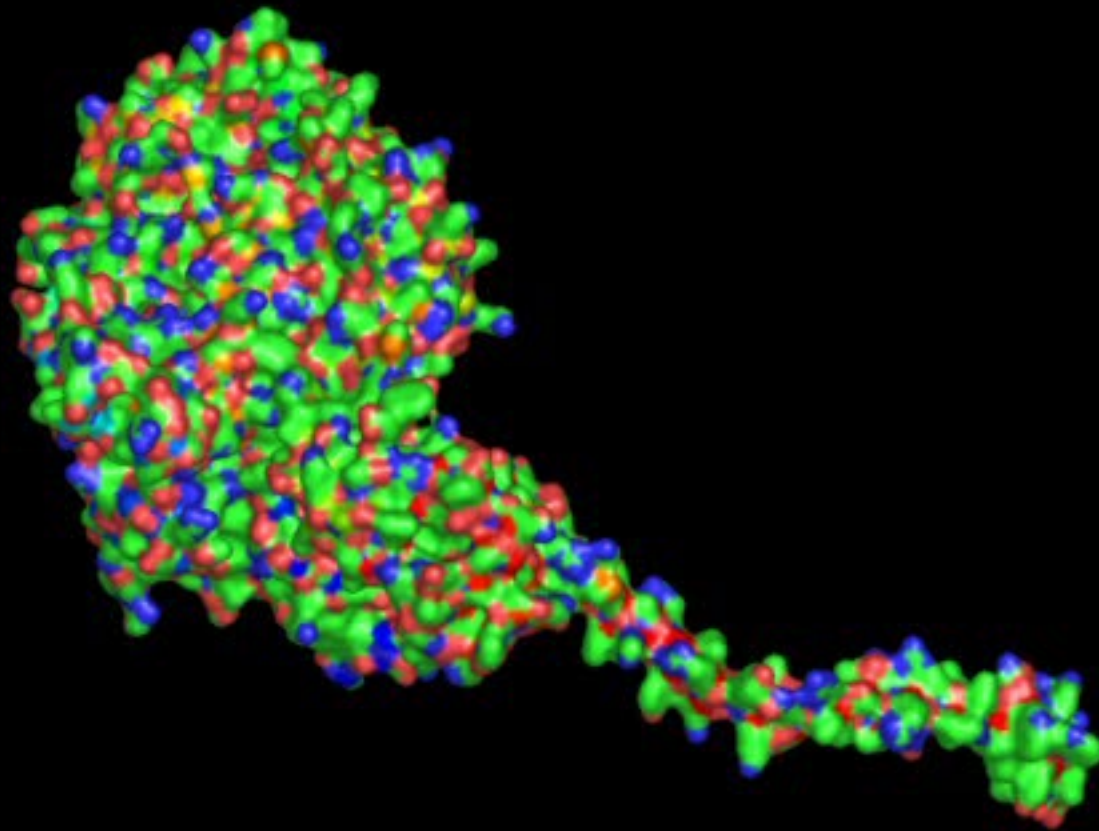




Hemoglobin

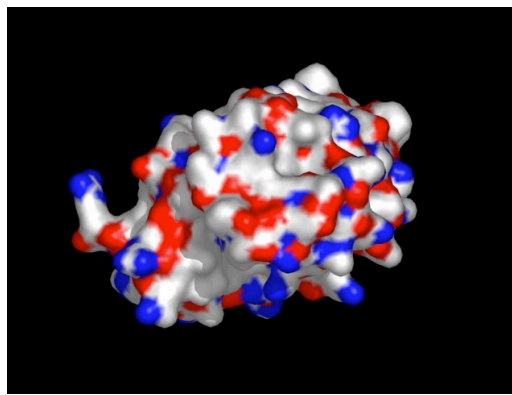
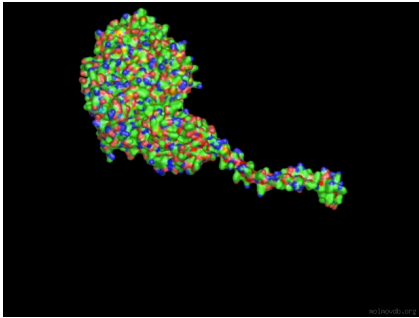
To move



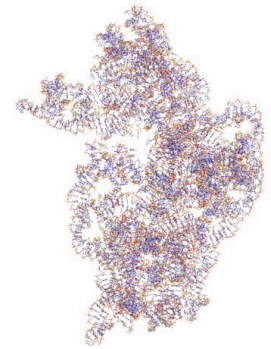


molmovdb.org

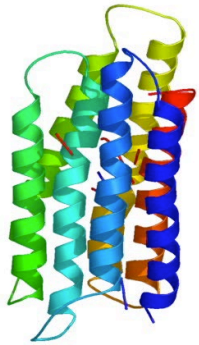
myosin



To eat



To move

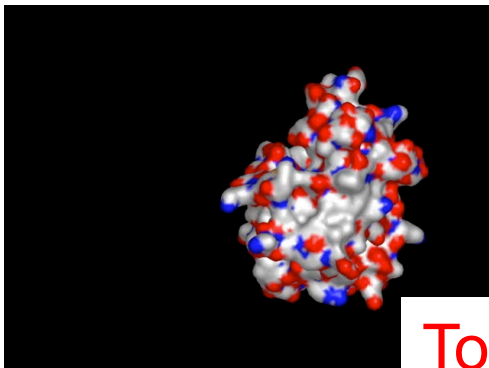
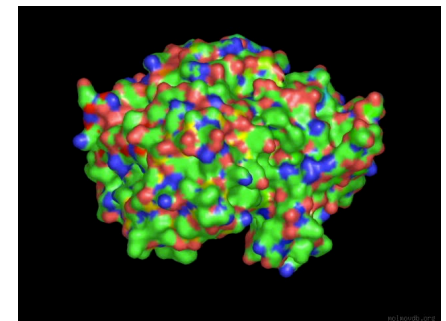


To see



To generate protein

To make body



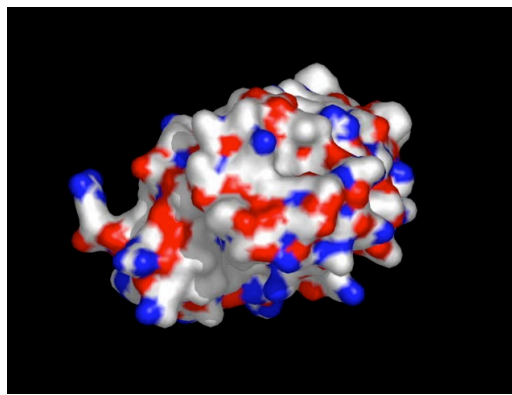
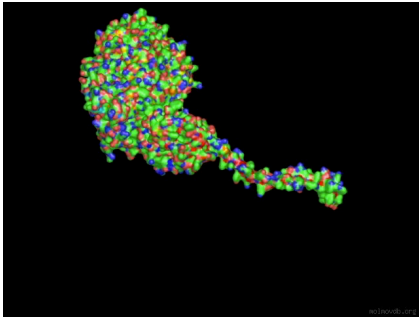
To think



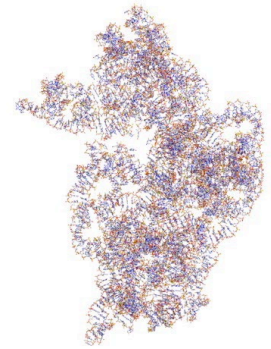
To grow

Agenda

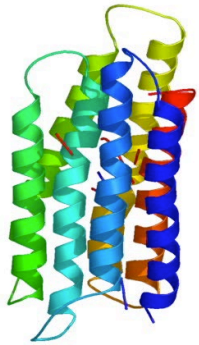
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- **Proteomics**
- AI Proteomics
- The Future we want to realize as a
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- Toward the realization



To eat



To move

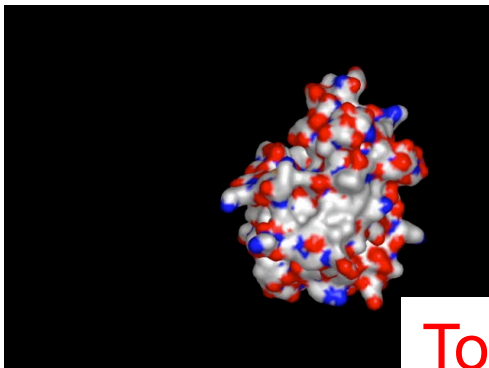
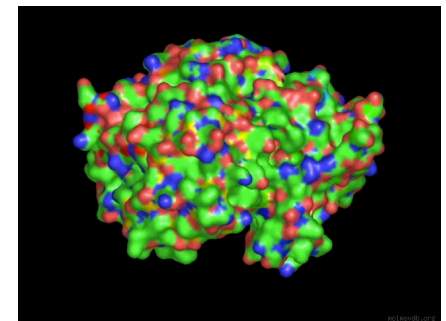


To see



To generate protein

To make body

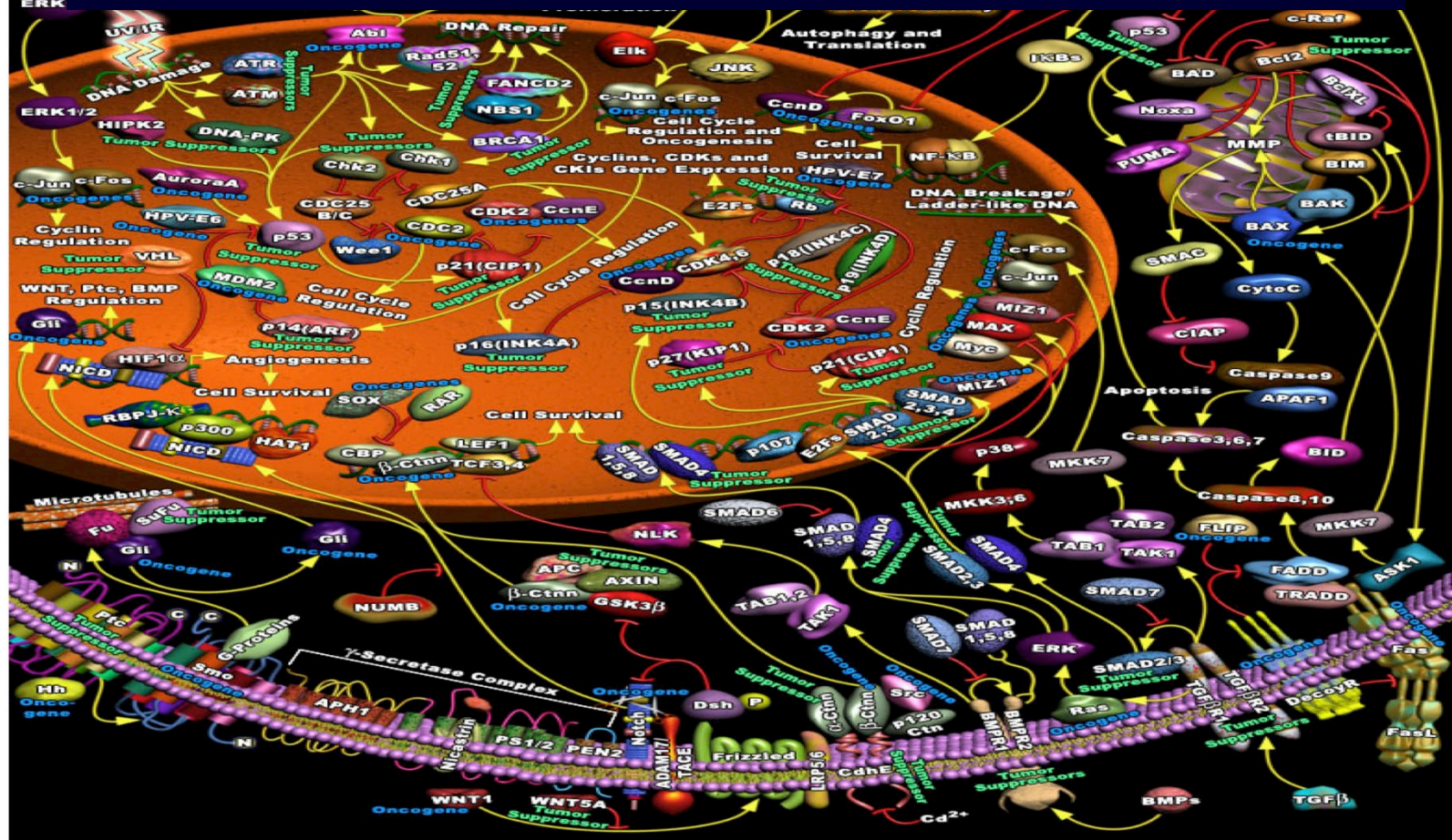


To think

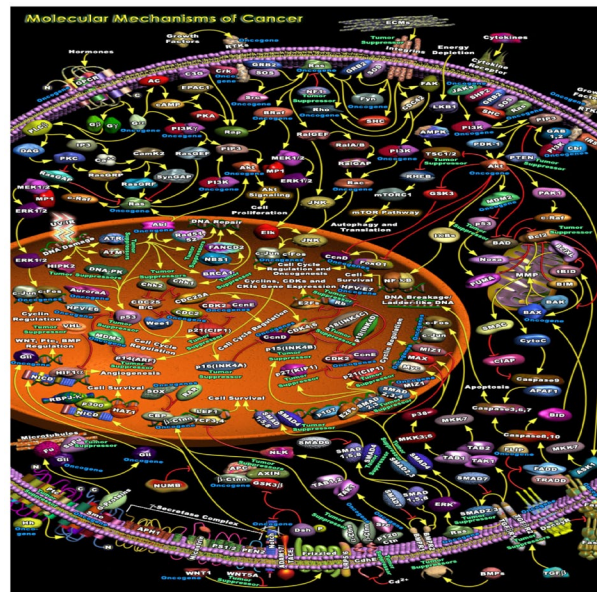


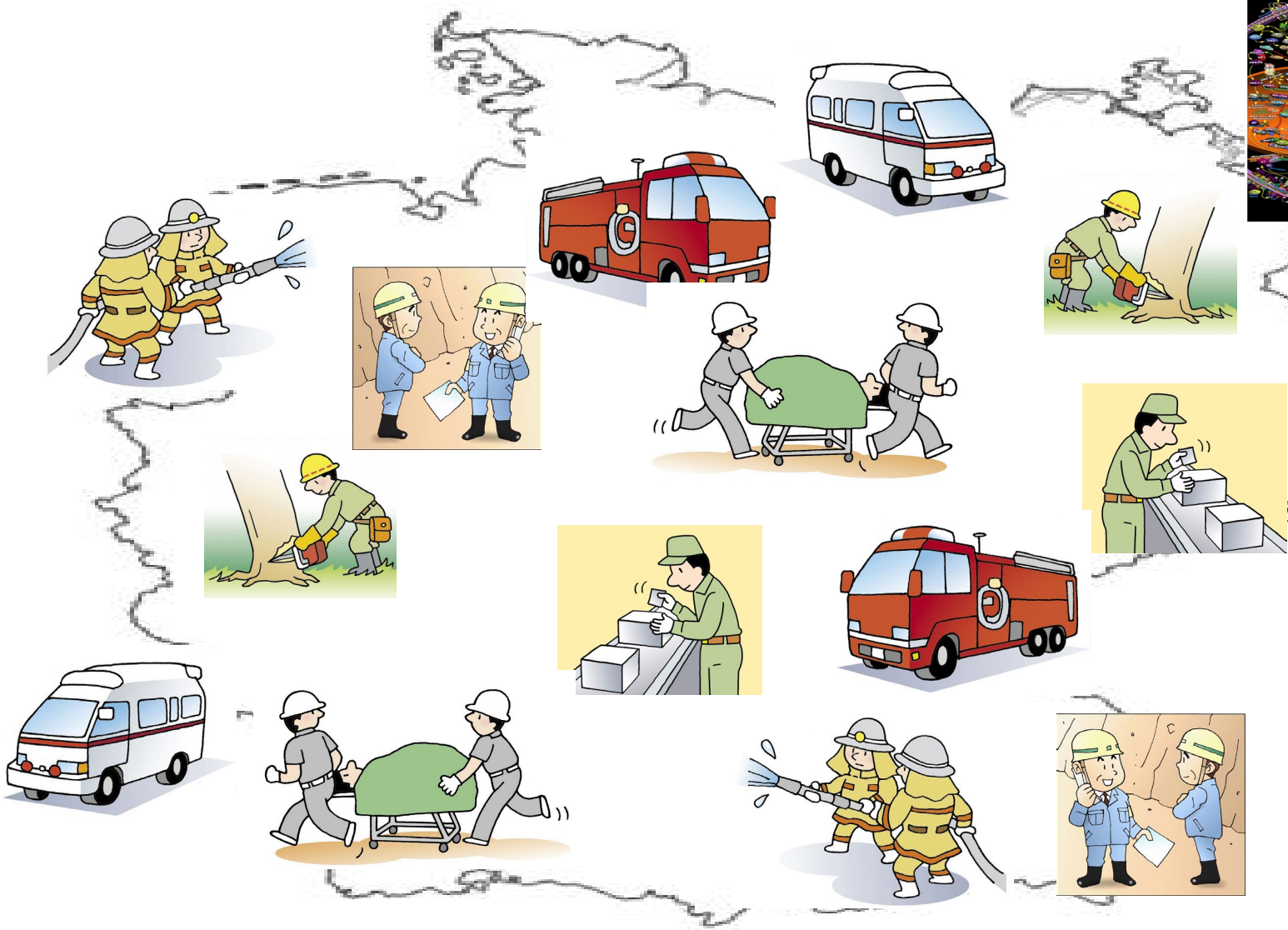
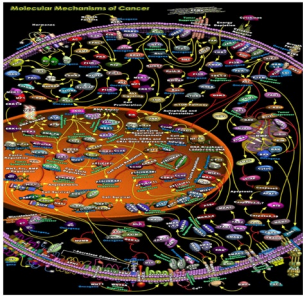
To grow

A cell is a system composed of proteins as the components



The living body is like a protein-supported country







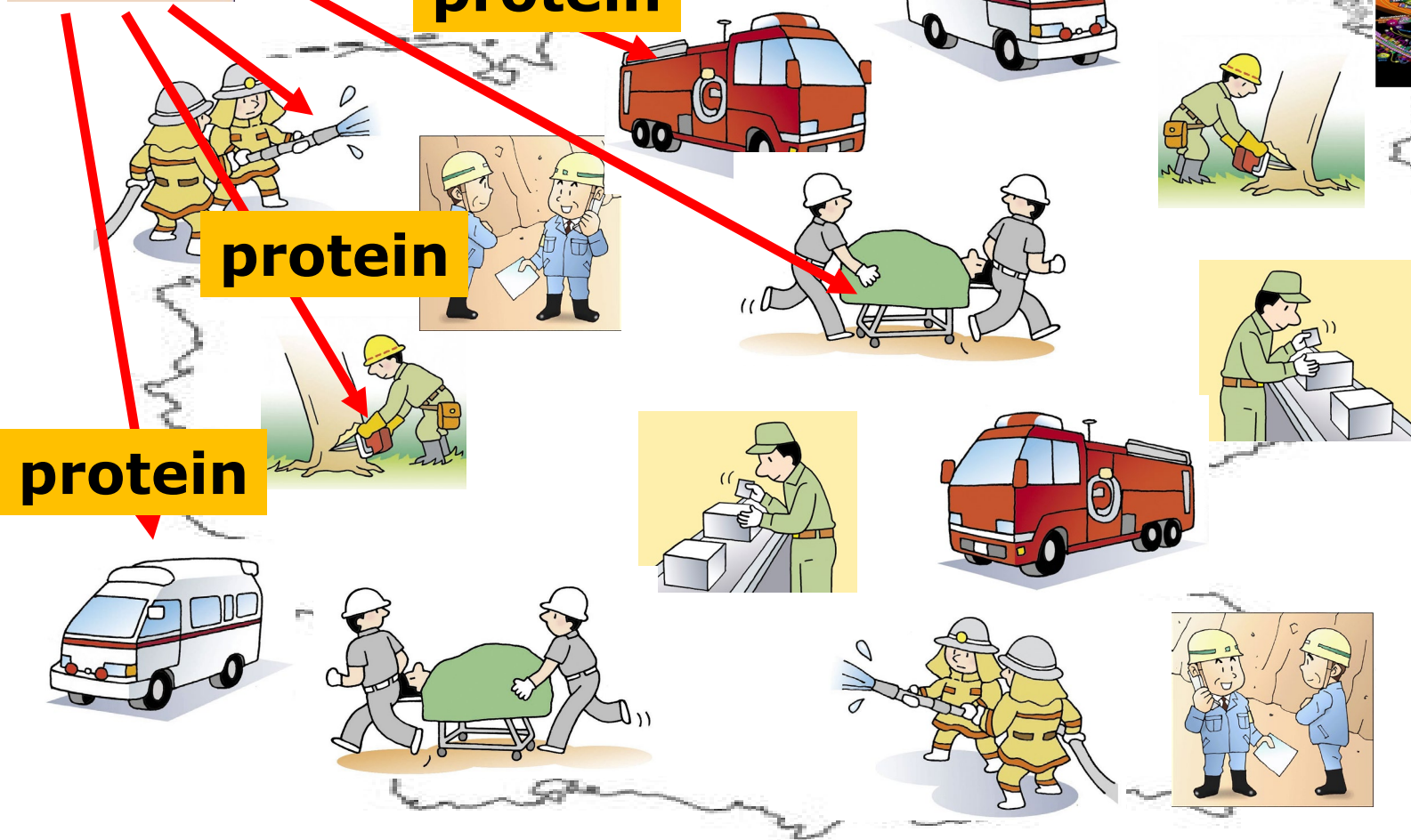
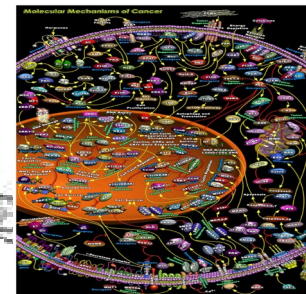
gene

protein

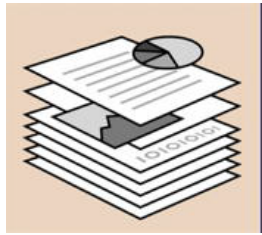
protein

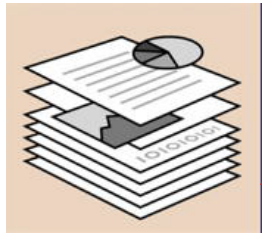
protein

protein

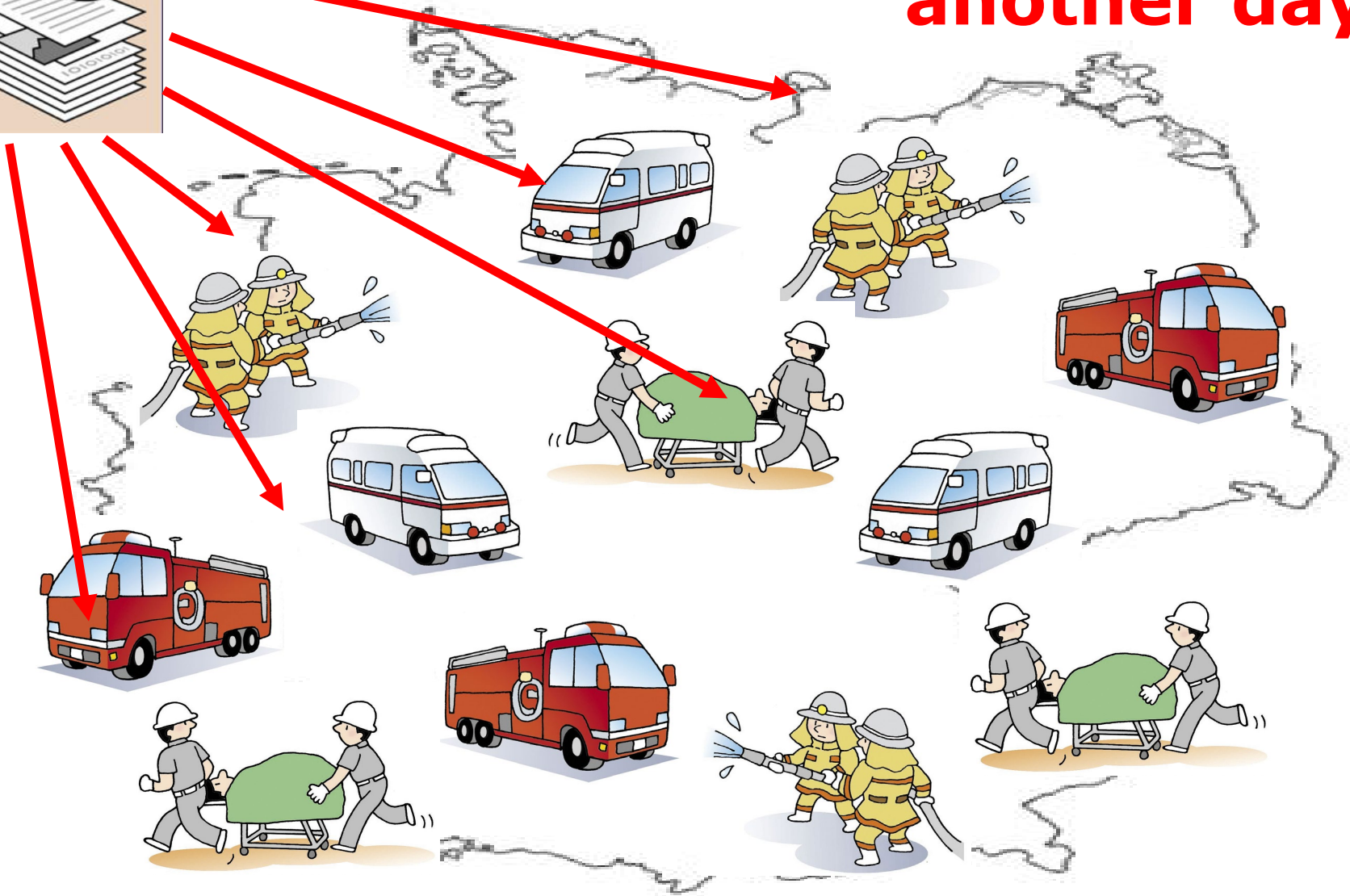


a day ...



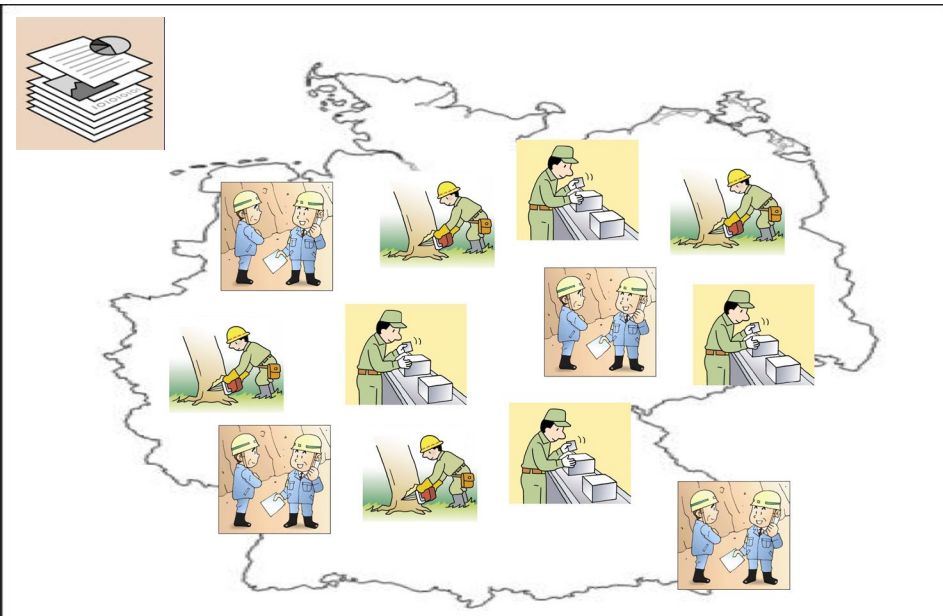


another day...



Concept

Know the state of that society (organism) by looking at the whole picture.

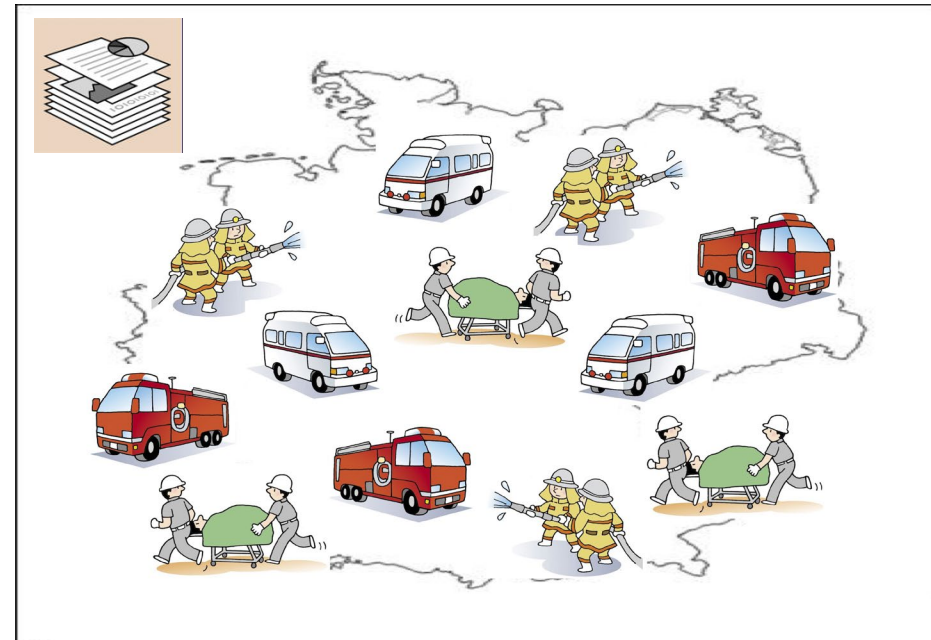


Many people (protein) involved in manufacturing (development)



Development (growth) underway ?!

a day...



Many people (proteins) involved in life-saving (immunization)



Disasters (Diseases) ?!

another day...

What Proteomics is ?

Society is driven by its members.

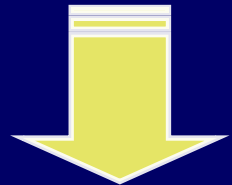
Living body

Protein



The state of the constituent members reflects the state of the society.

Protein



Proteomics

Comprehensive and bird's eye view of constituent members

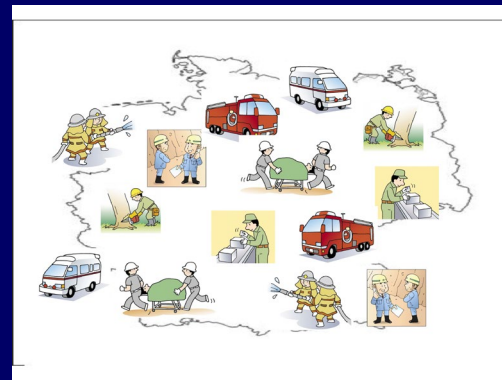
Protein

= Profiling of society

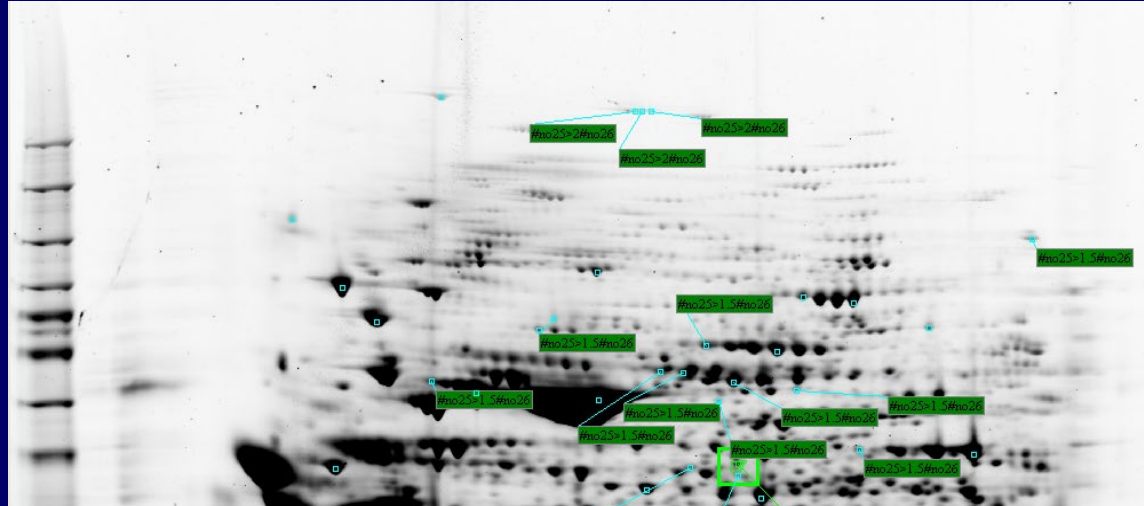
Living body

Proteomics

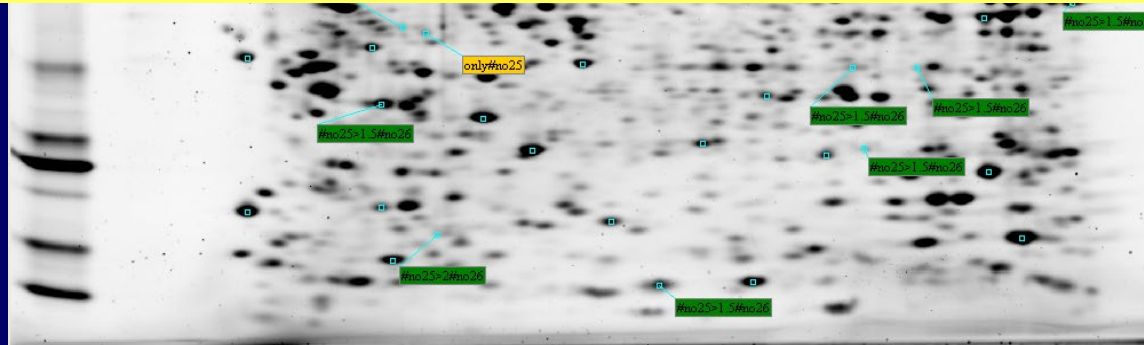
(2D Gel Electrophoresis)



Spot' s ...
position → state
density → amount



Varies depending on the health of the body.

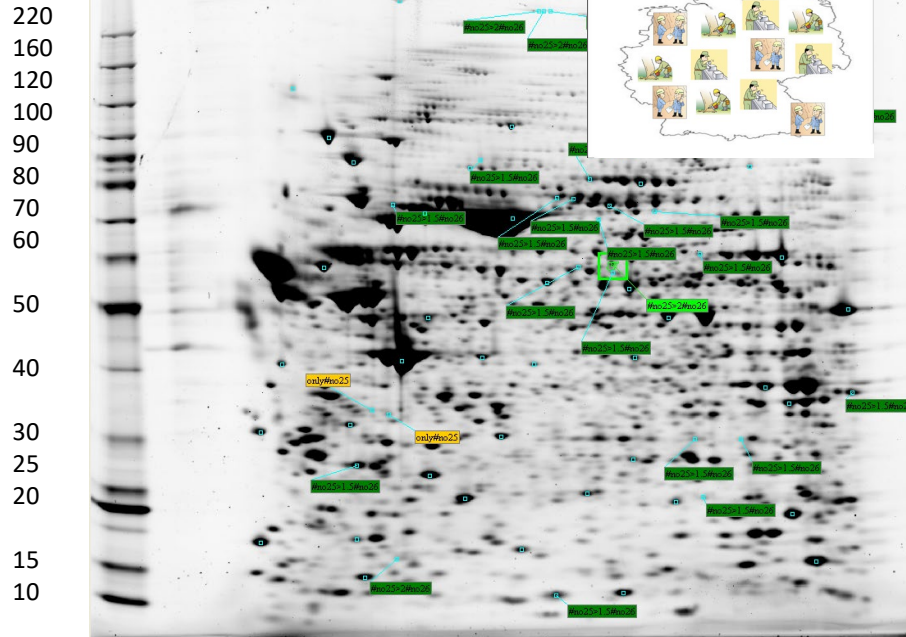


Charge

A cell line.

Disease

MW
(kDa)



3 ← pI → 10

normal condition

MW
(kDa)



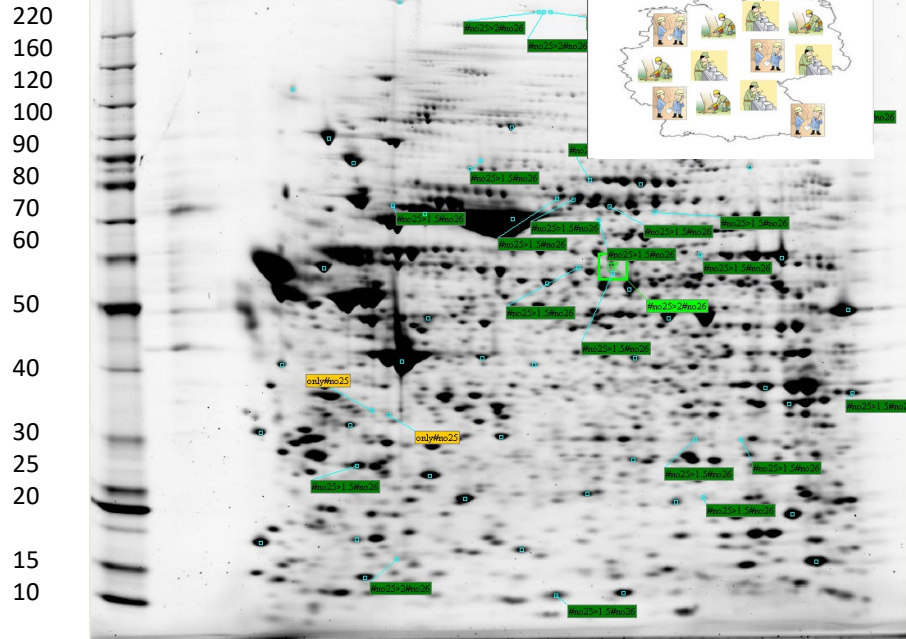
3 ← pI → 10

at the onset

Early diagnosis of disease, whether or not a drug works, which drug works, early diagnosis of effectiveness of treatment, suggestion of appropriate treatment, etc.

Health Food Influences

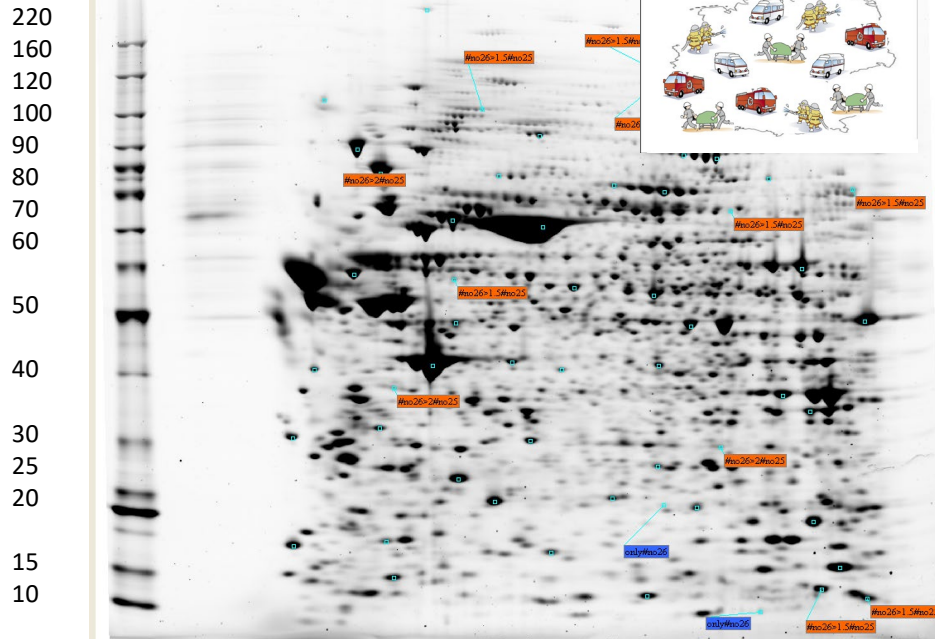
MW
(kDa)



3 ← pI → 10

Before intake

MW
(kDa)



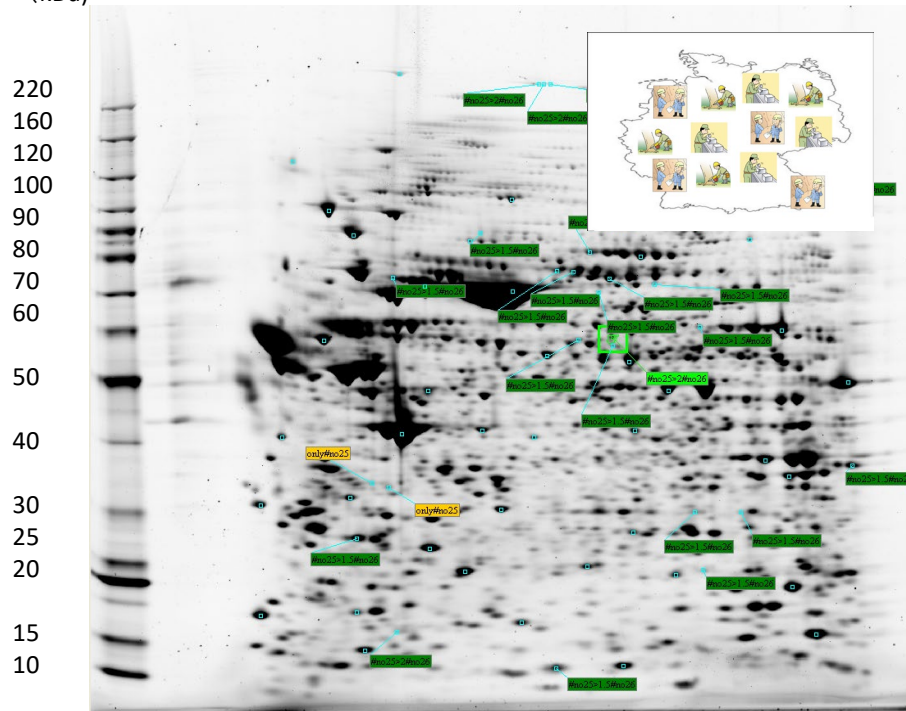
3 ← pI → 10

After intake

Obtaining evidence of food efficacy and elucidating unknown efficacy

Effects of Training

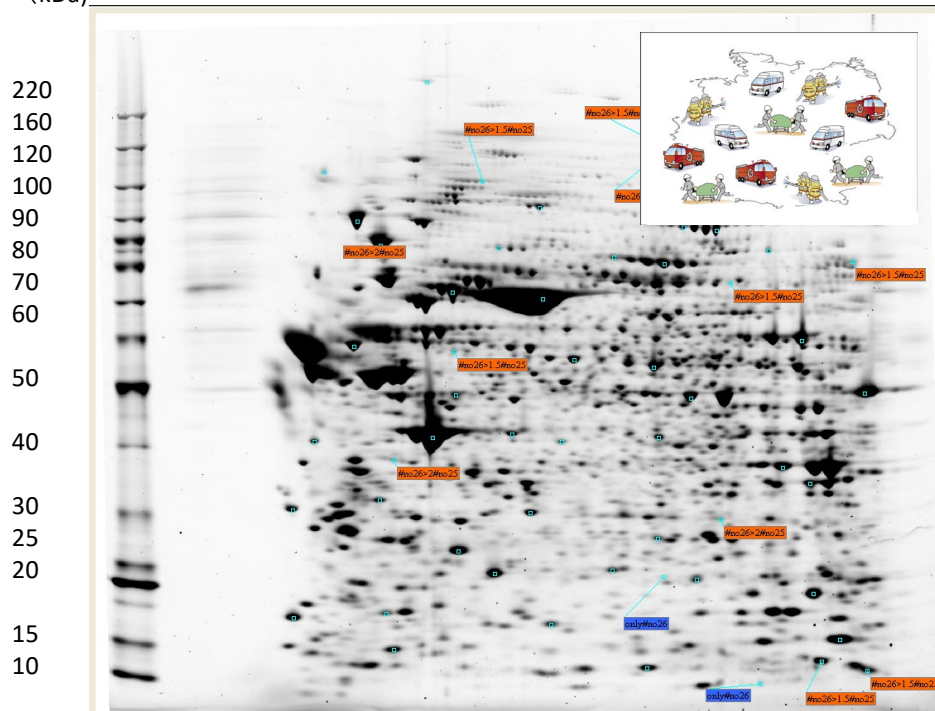
MW
(kDa)



3 ← pI → 10

Before exercise

MW
(kDa)

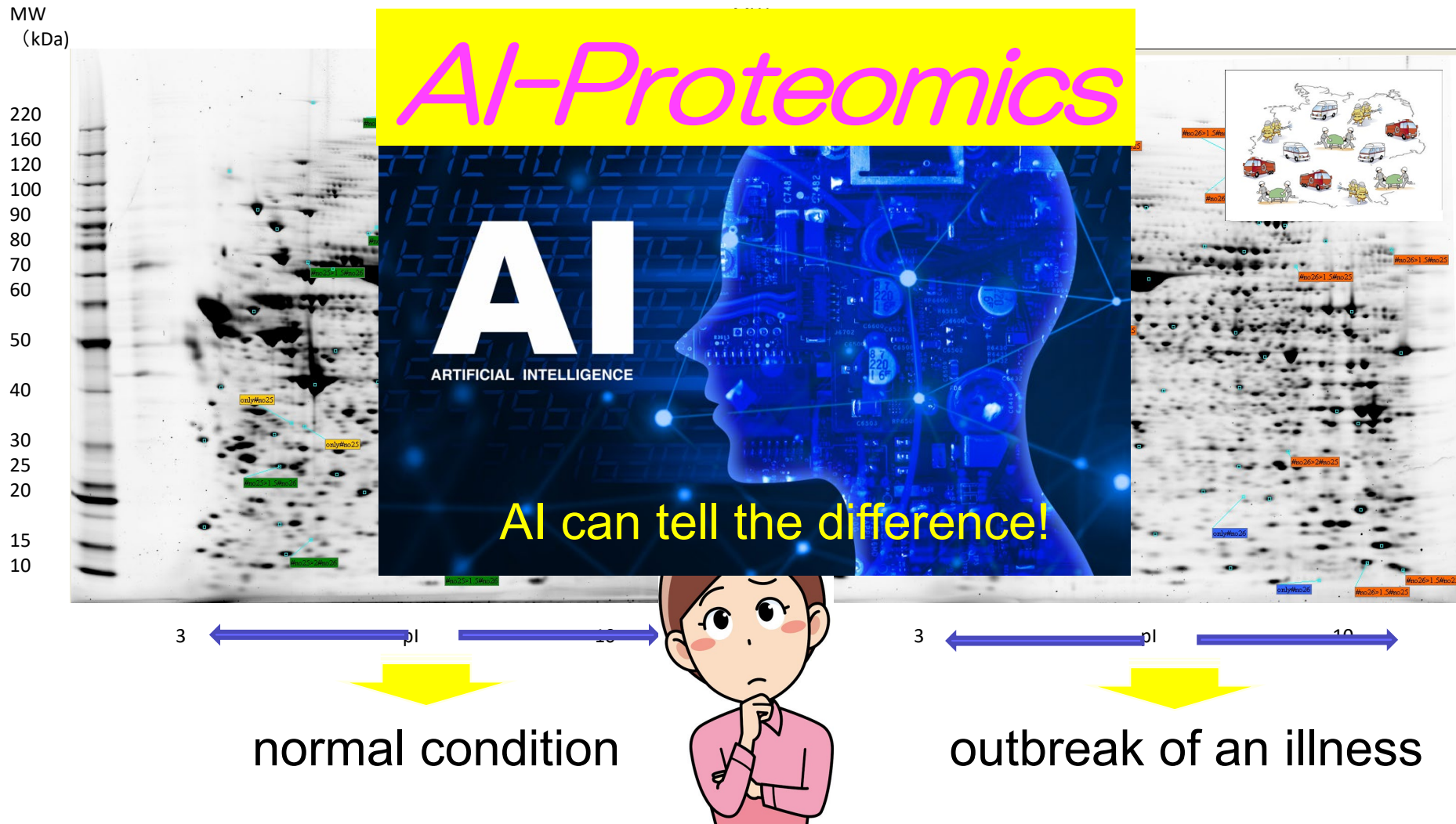


3 ← pI → 10

After exercise

Diagnose the suitability of training methods before they are effective, and furthermore, suggest training methods that are appropriate for the individual.

How do we decipher a complex, information-rich image?



Same? Different? How different?

Agenda

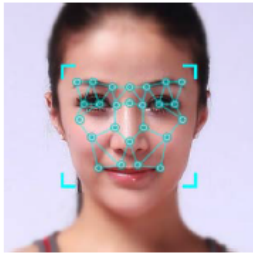
- Proteins
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- **AI Proteomics**
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AI Proteomics

AI deciphers proteomic images

Subject 1

It is unknown what features are valid for 2D electrophoresis images.



Face image



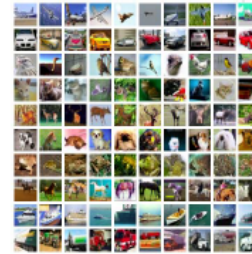
2DE image

Applying Feature Learning

Automatically learns features effective for identification based on the combination patterns of spots in the phoresis images.

Subject 2

Unlike data on the Web, large amounts of data are difficult to obtain



Web images

>>>



2DE images

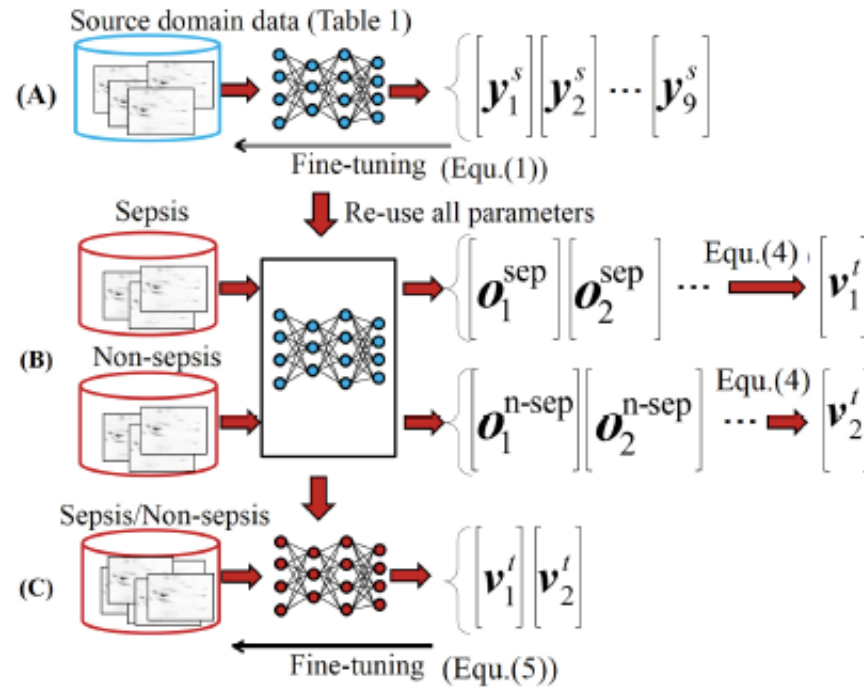
Applying Transfer Learning

Efficiently learn high-performance features and discriminators by utilizing available 2DE-images (without correct labels) as well

Converting the knowledge layer of deep learning to transition learning

← **Educating AI with less teacher data**

Machine Learning Using Two-dimensional Electrophoresis Image Data Diagnosis of sepsis



Converting the knowledge layer of deep learning to transfer learning

Diagnostic accuracy : 98.2%

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Toward a Future Health Care Society for High Quality Health and Longevity



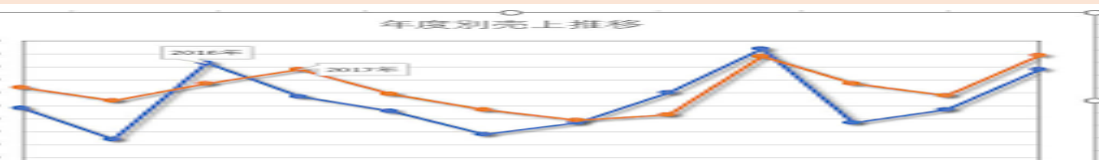
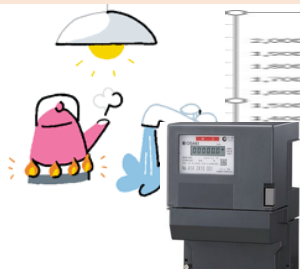
Data collection state . . .

Healthy

Illness



Normal physical examination (blood test) → proteomic data



Water, gas, and electricity usage records



Bedroom Sensors

- Temperature
- Humidity
- Illuminance
- Human Sense



Living Room Sensors

- Temperature
- Humidity
- Dust
- VOC
- CO2



Life Log



Open/close sensor (front door)

Confirmation of when to leave the house by checking the opening and closing of the front door

Toward a Future Health Care Society for High Quality Health and Longevity

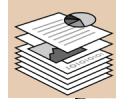


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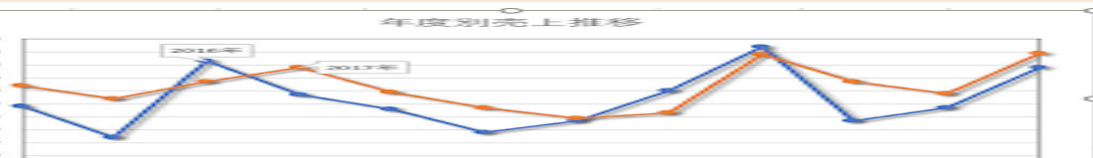


Healthy

Recovery



Normal physical examination (blood test) → proteomic data



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Machine learning . . .



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AI
ARTIFICIAL INTELLIGENCE

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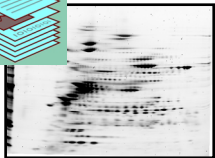
Diagnoses

Diagnose very early (before symptoms appear), share with others...

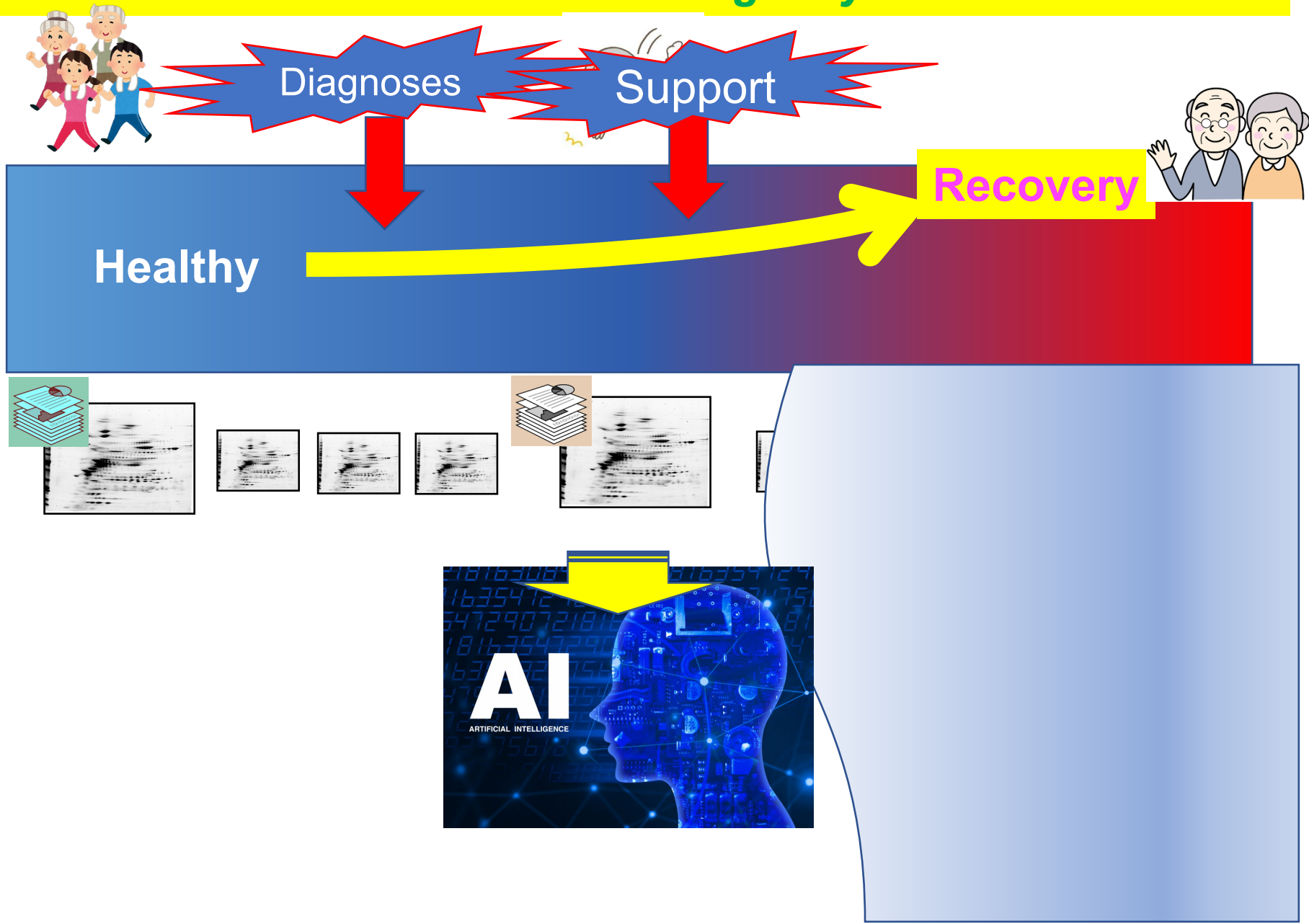


Healthy

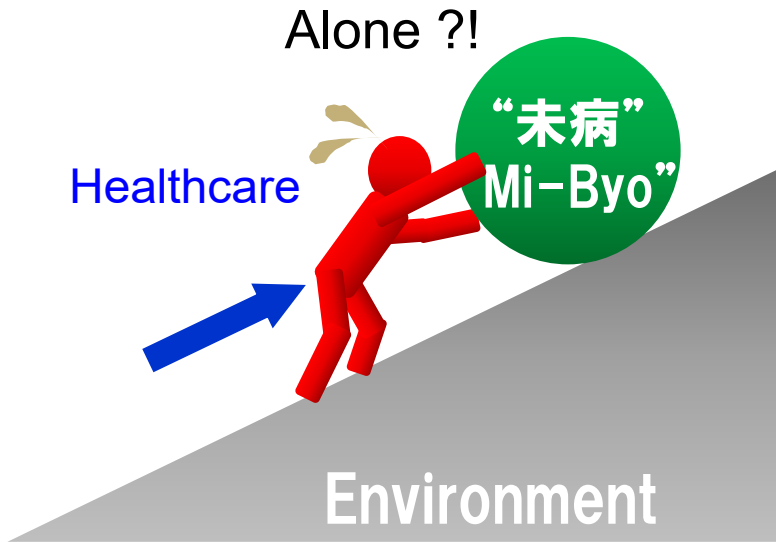
Illness



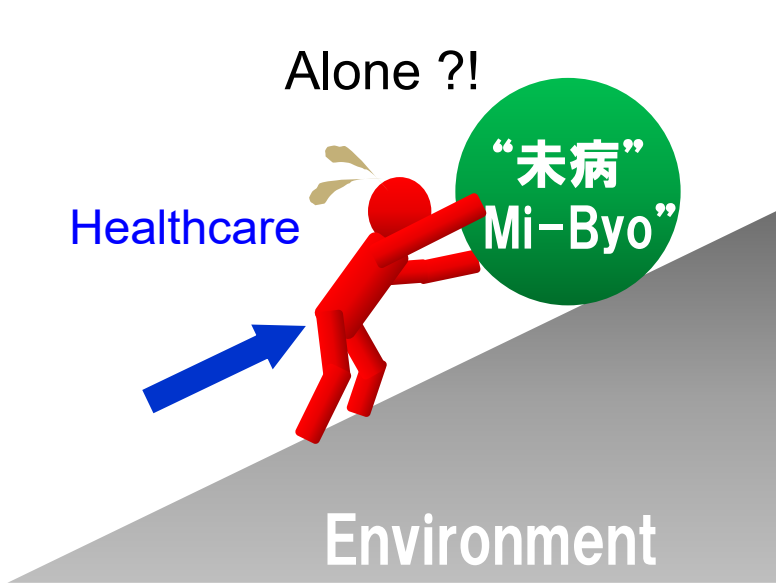
Toward a Future Health Care Society for High Quality Health and Longevity



Working together for a "long life"

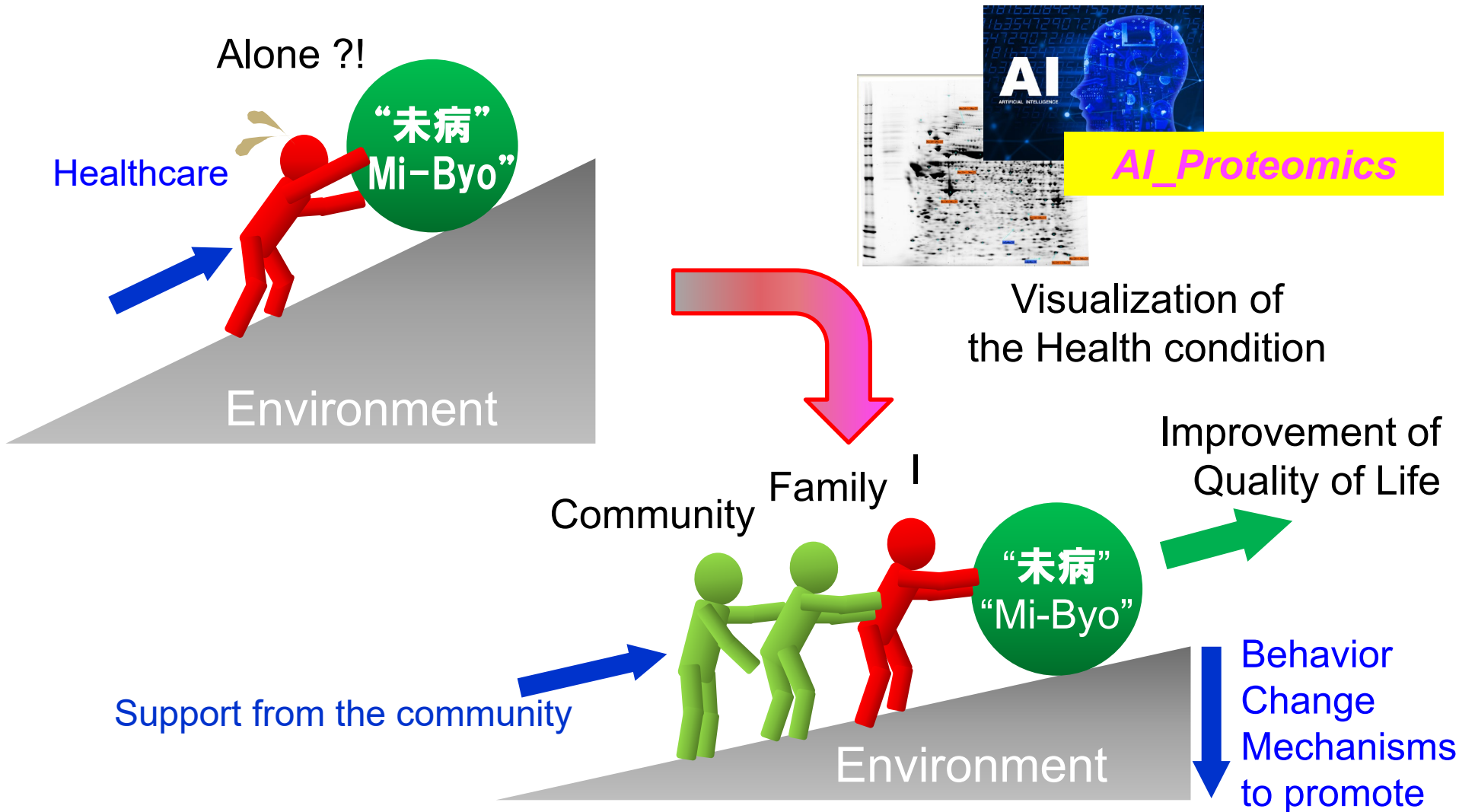


Working together for a "long life"



Visualization of
the Health condition

Working together for a "long life"



Agenda

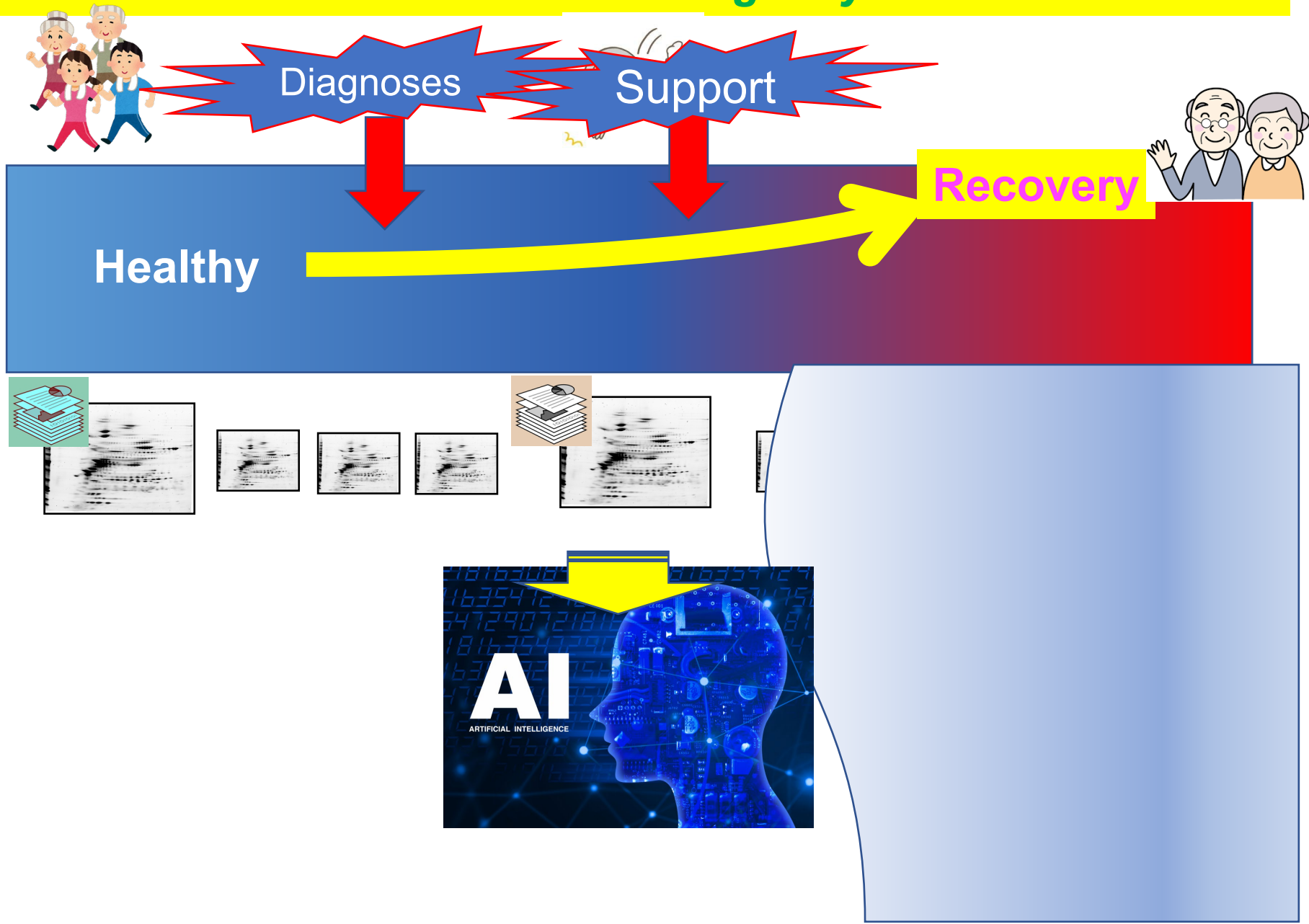
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Toward a Future Health Care Society for High Quality Health and Longevity



Toward a Future Health Care Society for High Quality Health and Longevity

Machine learning . . .



Healthy

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Normal physical examination (blood test) → proteomic data



Water,

AI
ARTIFICIAL INTELLIGENCE

usage records



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Data collection . . .



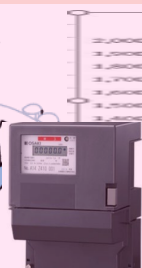
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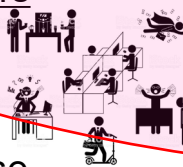


Water, gas, and electricity usage records



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Data Lake

Availability

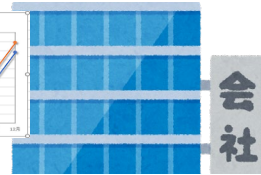
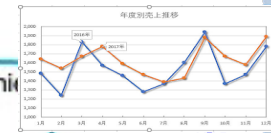
- Anonymization and transversal search
- Research of data availability
- Data catalogue
- Cross-search with international networks

Analytics

- Supply of data analysis services on collective anonymous data
- Development and supply of novel analytical technique
- Relationship with the other analytical services

Innovation

- Incubation of venture companies and/or new enterprises in existing companies
- Acquisition and training of data management persons
- Acceleration of international cooperation



Services



Proteomics serves as a hub to organically integrate data

Data Source

- Life related data held by companies, medical institutions, bio-banks, etc.
- Anonymization, accumulation, integration
 - Association
 - Quality control
 - Standardization
 - Data cleansing

- The world premier mathematical competence
- AI specifications
- High spec secure circuit

- ELSI(Ethical, Legal, and Social Issues) solution model
- Personal data protection law
 - Support for GDPR
 - Procedure for international collaboration project
 - Relation with "Data bank" functions



Records of lives, and two-dimensional electrophoresis images at that time

Records of behaviors, and two-dimensional electrophoresis images at that time



Fostering Big Data

To raise a shift in the situation from "collecting data" to "data are gathering".

Through

- ① Academic research
- ② Practical Application R&D Targeting Industry
- ③ Social Implementation Initiatives

make society aware of proteomics. In parallel, instrumentation is being developed to provide something that can be used every day.

Experimental study at Kakegawa city



Tokyo Tech

東京工業大学
Tokyo Institute of Technology

日本語 English 文字サイズ 標準 大

検索 Google 提供

新着入試情報

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学生の活躍

開催報告

来訪者

自治体と連携し、未病改善に関する実証実験を実施

いいね! 0

シェアす

ツイート

インフラ企業やヘルステックと協働し「未病改善プラットフォーム」構築を目指す

研究 社会連携

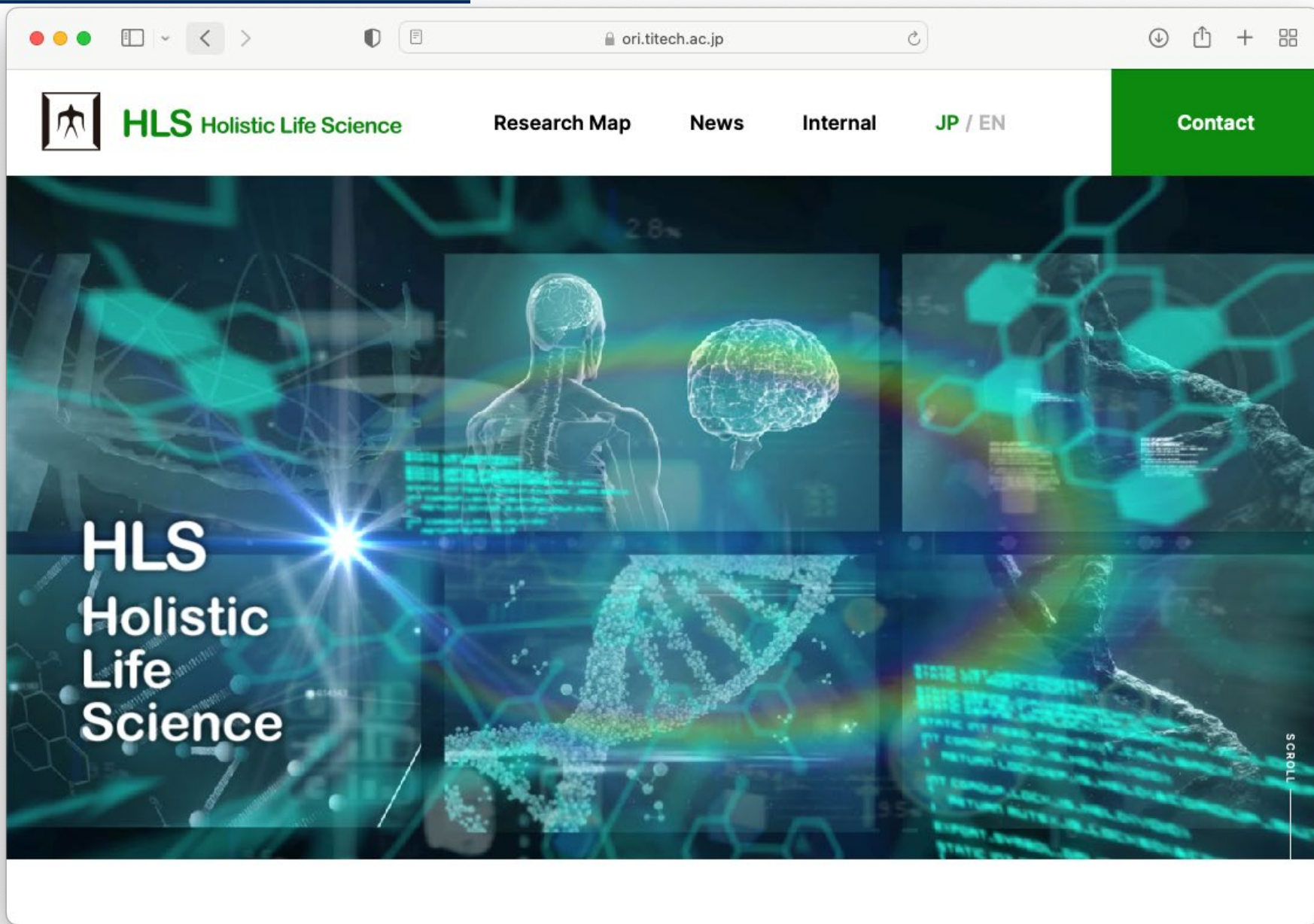
RSS

公開日：2019.05.30

東京工業大学 未来型スポーツ・健康科学研究推進体（代表者 生命理工学院 生命理工学系 林宣宏准教授）は、共同研究先企業であるaiwell（アイウェル）株式会社（以下「aiwell」）と、静岡県掛川市において未病^{用語1}改善に向けた「未病改善のための健康増進プラットフォーム」の構築に向けた実証実験を2019年2月12日～3月26日

Experimental study at Kakegawa city





Realization of a Bio-First Society



"HLS-Holistic Life Science" is a field that aims to advance the science and technology of life science and biotechnology, and thereby realize a bio-driven society that is friendly to humans and the earth; in other words, a "bio-first society".

Tokyo Institute of Technology (Tokyo Tech) has established priority strategic fields with the goal of opening up new frontiers in academia and industry, and has launched initiatives to achieve solutions to social issues and the realization of a prosperous future society as well as systematic and strategic partnerships with industry and the international community. HLS is positioned as one of these strategic areas. In addition, it promotes university-wide bio-strategy.

HLS promotes cross-disciplinary research to create new value through science and technology unique to Tokyo Tech, and builds a "Tokyo Tech bio-ecosystem" to solve various social issues through the formation of communities in cooperation with companies and public authorities, thereby contributing to the realization of a bio-first society.

MESSAGE



In order to realize the frontiers of academia and industry, Tokyo Tech will continue to impart knowledge that will enrich society and lead the way in developing professionals who can build a brighter future and create new value. For this purpose, systematic and strategic partnerships with industry and the international community have become extremely important. Holistic Life Science (HLS), a strategic field, is a priority of the university and an initiative to solve various social issues for a prosperous future. Crucial to achieving an environmentally friendly and bio-driven society, it is a field of science and engineering that is essential for creating innovations that contribute to medicine and health. In order to promote the creation of new value through science and technology that is unique to Tokyo Tech, we have established a cross-disciplinary HLS research system. We hope that you will use this website to collaborate with faculty members in the HLS field at

HLS Holistic Life Science

Realize a bio-first society friendly to humans and the earth

Cross-disciplinary research

New frontiers in academia and industry

Material Bioproduction

Environment,
Food & Agriculture

Drug Discovery

Health & Medical Care

Basic Science • Key Technology

Knowledge to Enrich Society

Professionals opening
up the future

Tokyo Tech Bio-Ecosystem

Creation of New Value

Tokyo Tech HLS Research Map

HLS TOP

language JP / EN

SEARCH



第1階層(社会課題)

第2階層(カテゴリ)

第3階層(研究テーマ)





文部科学省 卓越大学院プログラム

東京工業大学 超スマート社会卓越教育院

Tokyo Tech Academy for Super Smart Society

JP / EN



ニュース

WISE-SSSについて

イベント情報

教育研究フィールド

学生募集

SSS推進コンソーシアム



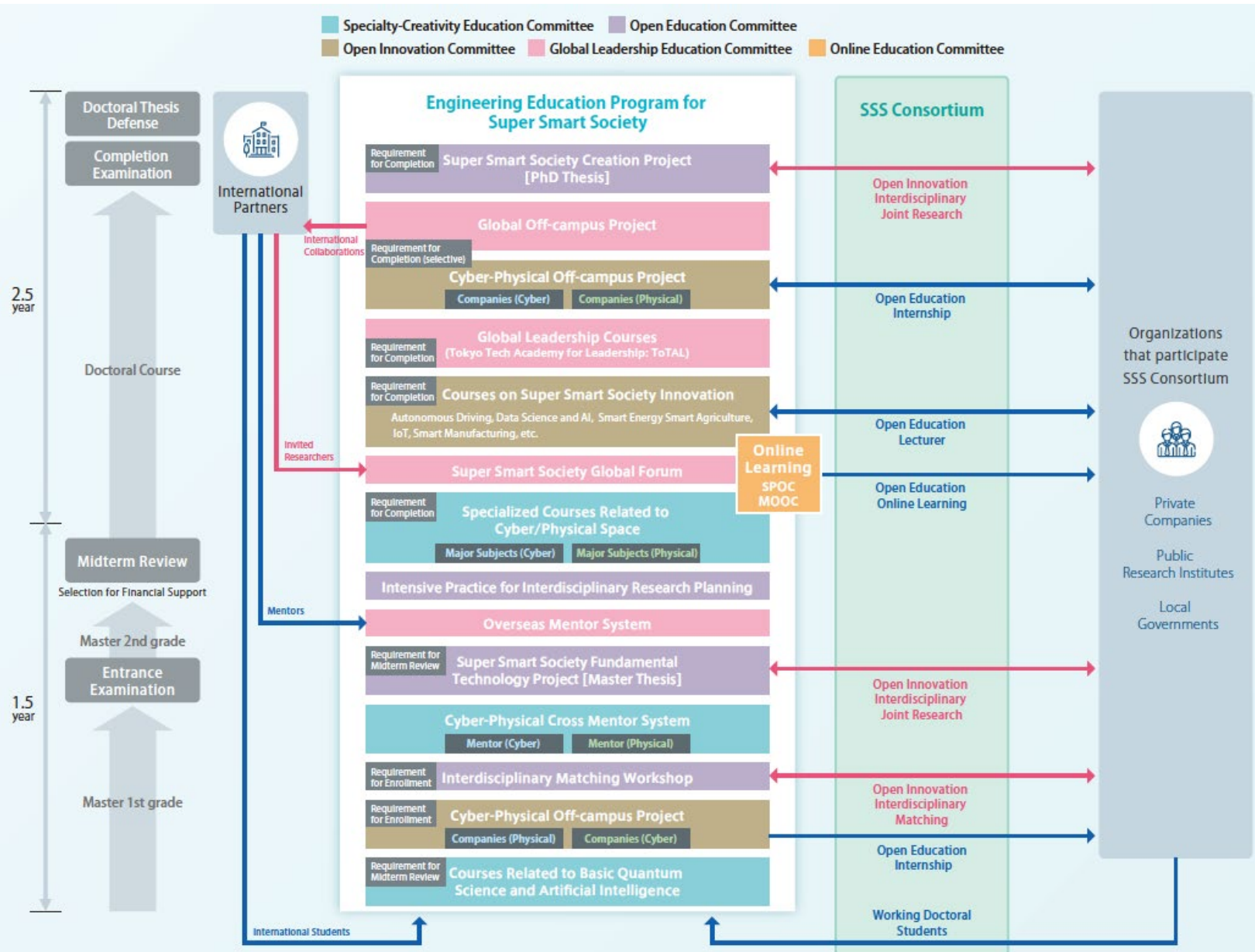
Tokyo Tech Academy for **Super Smart Society**

FOLLOW



<https://www.wise-sss.titech.ac.jp>

SCROLL



プログラム担当者（東工大）



6つの学院・研究院およびリベラルアーツ研究教育院から61名の教員が参加

生命理
工学院



理学院



リベラルアーツ
研究教育院

西森 秀稔 教授
科学技術創成研究院
量子アニーリング理論による
量子コンピュータの実現



量子科学

上妻 幹旺 教授
理学院 物理系
冷却原子を用いた量子
シミュレーションと量子センサ



情報理
工学院

ビッグデ
ータ
人工知能



高安 美佐子 教授
科学技術創成研究院
ビッグデータ数理科学研究ユニット
分野融合型のビッグデータ解析・
多層時空間モデリング



センサ

藤田 政之 教授
工学院 システム制御系
人間とロボット群の協調制御



サイバー
空間

田中 圭介 教授
情報理工学院
数理・計算科学系
量子計算実現後の安全性を担保
するセキュリティ技術



ロボット
自動運転



阪口 啓 教授
工学院 電気電子系
ミリ波を活用する
第5世代セルラネットワーク



スマート
シティ

鈴森 康一 教授
工学院 機械系
人工筋肉など
障害者支援ロボット



フィジカ
ル空間

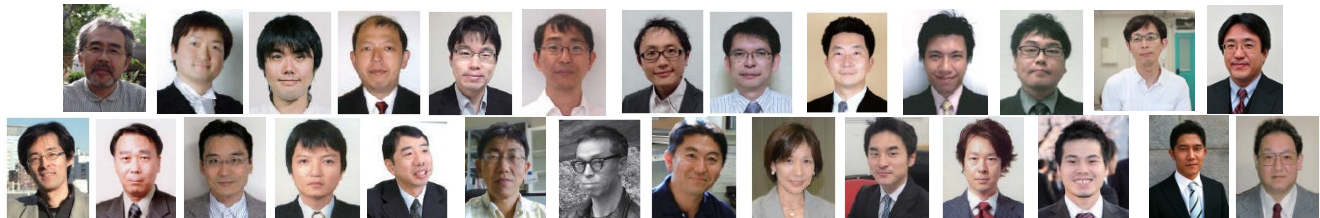
山田 哲 教授
科学技術創成研究院
未来産業技術研究所
超高層建築の
免震・制振技術とモニタリング



科学技術
創成研究院

環境・社会
理工学院

工学院



Collaboration between WISE-SSS and Super Smart Society Promotion Consortium

- What is the Super Smart Society Promotion Consortium?

A next-generation education and research platform

- Students have opportunities to form **interdisciplinary research teams** with the Consortium partners and participate in the team with **financial support.**

学生向けイベント・情報提供を実施！

SSS Matching Workshop

Held twice a year

Nect: Nov 29th (open in the middle of October)

Internship Information

SSS Consortium Partners (refer the right)
provide internship programs

Company tour for students

Open tour of SSS Consortium Partners
(SSS Students Limited)

Etc..

SSS Promotion Consortium partners (as of August, 2023)





↑ WISE Introduction Video

- Opportunities for education and advanced research using multiple research & education fields that bring together the best of cutting-edge science and technology
- Unique educational programs in cooperation with industry
- Substantial financial support

RESEARCH & EDUCATION FIELDS

SSS Research & Education fields

The goal of the super smart society research and education fields is to provide graduate students opportunities to conduct experiments that foster problem-solving abilities for interdisciplinary issues while working alongside corporations, local governments, and Japanese National Research and Development Agencies.



Automated driving cars

Smart Mobility

1 Smart mobility

This research platform is related to automated driving and mobility services utilizing it. We create new mobility services using electric vehicles, controlled by open-source software and cutting-edge wireless systems (5G/millimeter-wave band wireless LAN) to process the sensor information delivered through cameras and LIDAR (a type of laser sensor).



Kazuki Maruta
Tokyo Tech Academy for Super Smart Society
Specialty Appointed Associate Professor

2 Smart robotics

Robot Land

This research and education field is related to ground robots. We offer a smart robotics education research environment utilizing 5G, IoT, and AI. We promote practical education research to tackle social issues such as disaster response, infrastructure maintenance, and an aging society. The University created a quadruped hydraulic-driven robot for an outdoor environment, which can perform tasks in dusty or rainy conditions.



Gen Endo
Department of Mechanical Engineering,
School of Engineering
Associate Professor

3 Smart robotics

Smart Manufacturing

This field offers an experiential learning environment through practice by seamlessly connecting digital manufacturing flow from parts design to processing. We offer cutting-edge education and research in smart manufacturing by combining cameras to obtain 3D data of the shape, position, and posture of a manufactured parts or tools.



Tomohisa Tanaka
Department of Mechanical Engineering,
School of Engineering
Associate Professor

4 Smart robotics

Robot Zoo Sky

Robot Zoo-Sky is the robotics experimental platform for simultaneous coordinated control of multiple robots such as drones. Utilizing cutting-edge distributed control technology, we develop environmental monitoring technologies to realize a reliable and safe society. Furthermore, we offer students opportunities to learn about technology that securely controls multiple components and systems connected in networks, which is a fundamental technical skill in the era of IoT.



Takeshi Hatanaka
Department of Systems and Control Engineering,
School of Engineering
Associate Professor

5 Smart robotics

Robot Zoo Aqua

The oceans – that is, water – account for approximately 70% of the Earth's surface. However, much of this aquatic environment remains unknown. To resolve this shortcoming, Robot Zoo Aqua employs approaches from the standpoint of robotics to social issues related to the aquatic environment. We conduct controlled experiments of underwater robots using real water surface drones. Such a practicum environment is unparalleled within and outside Japan.



Motomu Nakashima
Department of Systems and Control Engineering,
School of Engineering
Professor

Smart Robotics

Supervisor
Koichi Suzumori
Department of Mechanical Engineering,
School of Engineering
Professor

Robot Zoo Sky

Scene of environmental monitoring control

Robot Zoo Aqua

Water surface drone



Quantum Computing

Student experiment using cryogenic equipment

Quantum Sensors

Fabrication and measurement system for thin superconducting quantum films



6 Quantum computing

Quantum computers are expected to be the next-generation ultra-high-speed computers based on quantum mechanics. Manipulating qubits on a large-scale will enable massive parallel computing. Research on potential applications is also underway and should contribute to solving the information processing issues required for a super smart society.



Tetsuo Kodera
Department of Electrical and Electronic Engineering,
School of Engineering
Associate Professor

7 Quantum sensors

A sensor is defined as a device that converts a physical phenomenon and the state of an object into an electric signal. A quantum sensor is a type of sensor that uses the quantum effect (a phenomenon in quantum mechanics). Because quantum sensors are more sensitive than conventional sensors, they are expected to contribute to a super smart society. We are working on the development of such sensors with an emphasis on SQUID, which is a quantum sensor capable of detecting minute magnetic fields.



Toru Hirahara
Department of Physics,
School of Science
Associate Professor

8 Artificial intelligence

Tokyo Tech started "Data Science & Artificial Intelligence Research Group for Social Good" (DSAG), and began preparing for artificial intelligence education for graduate students. As part of this initiative, we retrofitted four lecture rooms with Wi-Fi 6 wireless LAN, which allow students to access the high-speed network for machine learning services in the cloud from their own PCs and tablets.



Koichi Shinoda
Department of Computer Science,
School of Computing
Professor

9 Smart workplace

To create a comfortable living space in the architectural environment, we measure and sense the indoor environment and physical characteristics of occupants. A smart, comfortable, and productive environment is created by AI-controlled air conditioning, which estimates and adjusts the comfort level from the collected data. In this way, we demonstrate indoor environment sensing, air conditioning control, and the occupant specific comfort level in a real space.



Naoki Kagi
Department of Architecture and Building Engineering,
School of Environment and Society
Professor

10 Smart agriculture

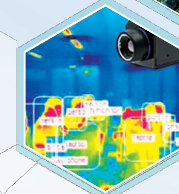
To solve specific issues in Japanese style small-scale agriculture, including long work hours, low productivity, and low profitability, smart agriculture education research aims to realize automated, stable yields of high-quality crops using remote agricultural technology with AI, IoT, and robotics. We offer opportunities for students to learn technical elements related to smart agriculture for small open fields as well as farming. We also provide research opportunities for joint projects with partner organizations.



Kuniaki Uto
Department of Computer Science,
School of Computing
Assistant Professor

Artificial Intelligence

Supercomputer TSUBAME 3.0



Body surface temperature by an infrared thermal image camera

Smart Workplace

Smart Agriculture

Drone field





Tokyo Tech



Tokyo Tech

Tokyo Tech

Center for Entrepreneurship Education (CEE)

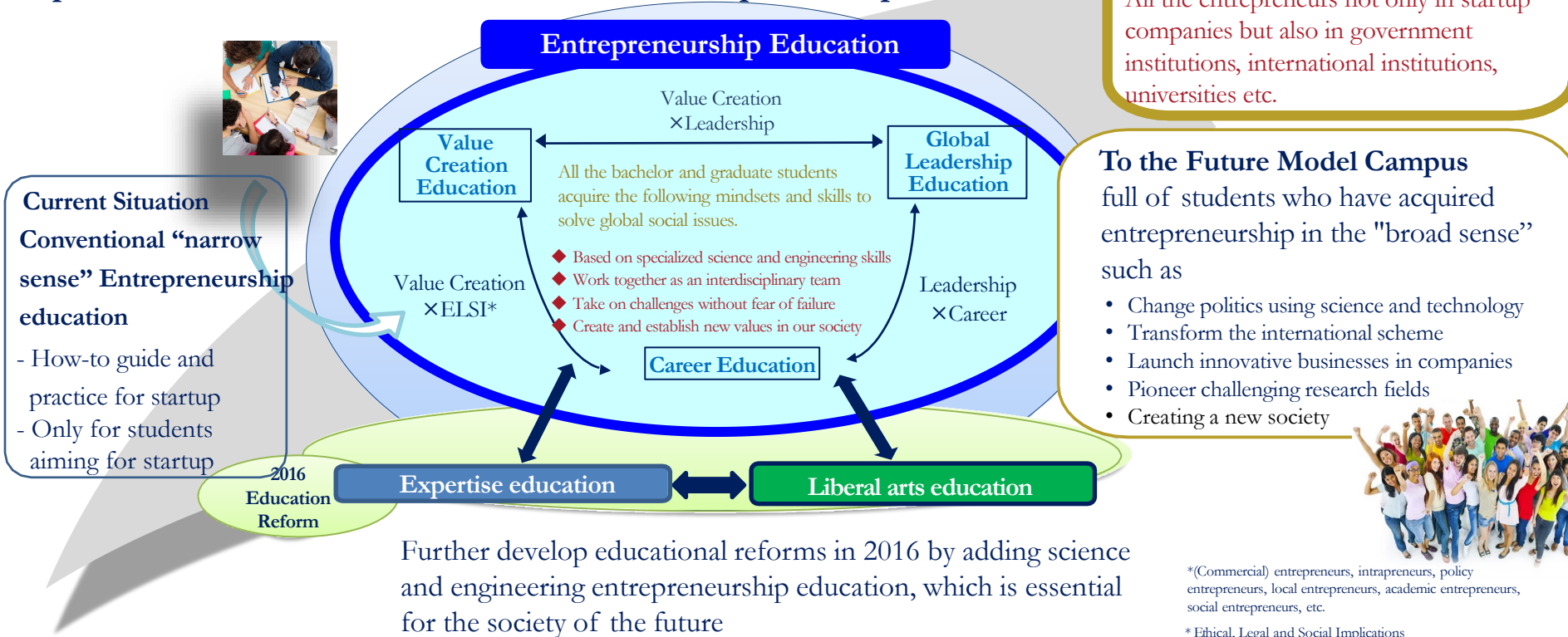
- Mission and Curriculum -

Center for Entrepreneurship Education

- To provide students with opportunities to acquire entrepreneurial skills to utilize their advanced professional abilities
- To develop diverse talents with a mindset and skills to create the future society by utilizing their comprehensive knowledge.

Tokyo Tech Entrepreneurship Education

Expertise education × Liberal arts education × Entrepreneurship education



*(Commercial) entrepreneurs, intrapreneurs, policy entrepreneurs, local entrepreneurs, academic entrepreneurs, social entrepreneurs, etc.

* Ethical, Legal and Social Implications



Institute of Science Tokyo 東京科学大学



National University Corporation **Tokyo Medical and Dental University (TMDU)** (President: Yujiro Tanaka) and National University Corporation **Tokyo Institute of Technology (Tokyo Tech)** (President: Kazuya Masu) have reached an agreement on the **merger of the two national university corporations and their universities**, Tokyo Medical and Dental University and Tokyo Institute of Technology, to form one national university corporation and one university. The merger is targeted for completion in fiscal year 2024.

“Convergence Science”

— New academic fields created by university integration

Future

The creation of groundbreaking academic fields through convergence science, including essential fusion of the humanities and sciences.

Initial foci

Examples of new academic fields

• Earth Environmental Science

- GX & sustainability
- IScT Initiative: Planetary environment



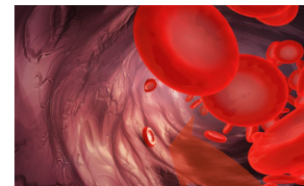
• Generative AI Medicine/ Dentistry

- Drugs for intractable diseases
- IScT Initiative: Wellbeing



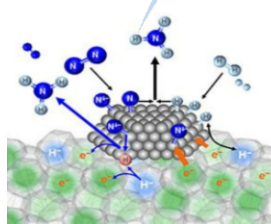
• Quantum Medical and Dental Science

- Early detection of diseases by quantum sensors
- IScT Initiative: Total healthcare

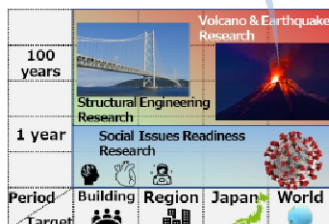


Present

Examples of cutting-edge research



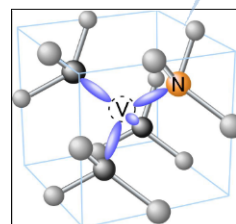
—Ultra-low temperature high-speed ammonia synthesis
—CO2 recycling



Multidisciplinary resilience science



Large-scale language models (LLM)



Quantum sensor (NV center)



Nucleic acid medicine (hetero-nuclear medicine)



Regenerative medicine (regeneration of hematopoietic cells)

A “truly” happy, healthy and log-lived society

A society where people can live long and happy lives, where they can exercise their abilities and individuality in accordance with TPO, and where they can make their own decisions and take care of themselves.



A society where the elderly are not isolated
and live happily
under the watchful of the community
while maintaining self-respect and fulfillment.





Tokyo Tech

Self-Personalized Well-Being for the Elderly Supported by Comprehensive AI Healthcare to Connect the Local Community

*Sustainable futuristic healthy society realized through
AI-assisted proteomics based on practical open innovation*

Nobuhiro HAYASHI
Tokyo Institute of Technology *CEWIT2023 Conference*