Trend in diagnostic biochip development

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Handling of the early stage is important for the treatment of diseases, and the importance of early discovery and diagnosis has been pointed out since the era of Hippocrates in Greece.
What is “biochip”? 
‘Biochips’ are defined as boards on which biomolecules, such as DNA, proteins, sugar chains, and cells containing these are fixed in a large number, termed DNA, protein, glyco-, and cell chips, respectively.

A large number of target molecules and compounds which specifically interact with biomolecules on chips can be simultaneously analyzed in a large number of samples in parallel, and DNA chips are typical ones.
Requirements for expansion of diagnostic biochip market

Technological problem

Social/institutional problem

Market/economic problem
Requirements for expansion of diagnostic biochip market

**Technological problem**
- Social/institutional problem
- Market/economic problem

**Detection technology**
- In some cases, greater accuracy and reliability are required compared to biochips for research. (depends on each field)

**Convenience**
- Identical results should be obtained by anybody. Simple operation with an easy procedure is required.

**Cost reduction**
- Utilization of resin-made chips, mass production technology, and reduction of the use of reagents, etc.

**Content development**
- Improvement of the quality and breadth of diagnosis, expansion of contents mounted on diagnostic biochips, such as specific genes, proteins characterizing diseases, antibody discontinuation, regulatory pathways, lot to lot variation, etc.
Requirements for expansion of diagnostic biochip market

Technological problem

Social/institutional problem
Market/economic problem

Systematization
Utilization of network and electronic medical records for effective utilization of diagnostic data.

Social aspect
Adverse effects of drugs, protection of personal information, and solving of ethical problems.

Institutional aspect
Pharmaceutical approval.
Requirements for expansion of diagnostic biochip market

Technological problem
Social/institutional problem

**Market/economic problem**

Actualization of molecular target drugs, increased importance of diagnosis with advancement in personalized medicine.

Growing awareness of preventive medicine and health problems.
Fields expected to involve biochips

- Diagnosis of disease risk
- Preventive diagnosis
- Early diagnosis
- Definite diagnosis (support for decision-making on therapeutic policy)
- Diagnosis prior to drug administration
- Prognostication
- Diagnosis in drug development
Fields expected to involve biochips

**Diagnosis of disease risk**
Preventive diagnosis
Early diagnosis
Definite diagnosis (support for decision-making on therapeutic policy)
Diagnosis prior to drug administration
Prognostication
Diagnosis in drug development

<table>
<thead>
<tr>
<th>Type of diagnosis</th>
<th>Test and measurement items</th>
<th>Effect</th>
<th>Diagnostic technology</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diagnosis of disease risk</td>
<td>oral mucosa, blood</td>
<td>Identification of individual constitutions associated with polymorphism of genomic base sequence information and protein biomarkers. Elucidation of correlation of diet, lifestyle, and genomic polymorphism information with disease information is necessary.</td>
<td>Genomic sequence, Invader assay, DNA chip, Immunoassay</td>
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Fields expected to involve biochips

Diagnosis of disease risk

**Preventive diagnosis**

Early diagnosis

Definite diagnosis (support for decision-making on therapeutic policy)

Diagnosis prior to drug administration

Prognostication

Diagnosis in drug development

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<td>Preventive diagnosis</td>
<td>sweat, urine, saliva, expired gas, blood</td>
<td>Support for health management corresponding to the individual disease risk.</td>
<td>Immunoassay, Protein chip</td>
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Fields expected to involve biochips

Diagnosis of disease risk
Preventive diagnosis

**Early diagnosis**

Definite diagnosis (support for decision-making on therapeutic policy)
Diagnosis prior to drug administration
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<td>Early diagnosis</td>
<td>blood, urine, saliva, expired gas mRNA Protein, Saccharides</td>
<td>Addition of diagnostic items corresponding to the age to periodic examination, such as health checkups: support of fast screening for early discovery of diseases.</td>
<td>DNA chip, Immunoassay RT-RCR</td>
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Fields expected to involve biochips

Diagnosis of disease risk  
Preventive diagnosis  
Early diagnosis  
**Definite diagnosis (support for decision-making on therapeutic policy)**  
Diagnosis prior to drug administration  
Prognostication  
Diagnosis in drug development

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| Definite diagnosis | blood, urine, saliva, diseased tissue | mRNA  
Identification of disease type by discovery of disease-related genes and analysis of profiles. Support for deciding on an optimum therapeutic policy in combination with clinical information. For infectious diseases, diagnosis of the presence or absence of infection by detecting virus-specific mRNA. | Internal diagnostic device, such as PET and MRI  
Tissue staining, RT-PCR, mass spectrometry technology, DNA chip, Protein chip |
| Protein,          |                             | mRNA  
Identification of disease type by detection of biomolecules, such as disease-specific protein. Support for deciding on an optimum therapeutic policy in combination with clinical information. | Internal diagnostic device, such as PET and MRI  
Tissue staining, RT-PCR, mass spectrometry technology, DNA chip, Protein chip |
Fields expected to involve biochips

Diagnosis of disease risk
Preventive diagnosis
Early diagnosis
Definite diagnosis (support for decision-making on therapeutic policy)

**Diagnosis prior to drug administration**

Prognostication
Diagnosis in drug development

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<td>Diagnosis prior to drug administration</td>
<td>Dose of drug</td>
<td>oral mucosa, blood, Polymorphism</td>
<td>Genomic sequence, Immunoassay DNA chip</td>
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<td></td>
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<td>Avoidance of adverse effects by dose setting corresponding to inter-individual differences in drug metabolizing ability based on polymorphism analysis of liver drug-metabolizing enzymes.</td>
<td></td>
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<td></td>
<td>diseased tissue blood, urine, saliva</td>
<td>Protein</td>
<td></td>
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<td>Avoidance of adverse effects by dose setting corresponding to inter-individual differences in drug incorporation ability of the target cells.</td>
<td></td>
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<td>Response to drug</td>
<td>target molecule, blood, urine, saliva</td>
<td>Protein</td>
<td>Immunoassay Tissue staining, Protein chip</td>
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<td>Selection and administration of drugs for individual cases based on whether the drug is effective or not.</td>
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Fields expected to involve biochips

- Diagnosis of disease risk
- Preventive diagnosis
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**Prognostication**

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<td>Prognostication</td>
<td>blood, urine, saliva</td>
<td>Support for appropriate treatment based on judgment of the therapeutic effect and tendency of recovery.</td>
<td>Immunoassay, Mass spectrometry technology, Protein chip</td>
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Protein
Fields expected to involve biochips

**Diagnosis of disease risk**

**Preventive diagnosis**

**Early diagnosis**

**Definite diagnosis (support for decision-making on therapeutic policy)**

**Diagnosis prior to drug administration**

**Prognostication**

Selection of a biomarker matching the objective of diagnosis utilizing knowledge obtained in drug development

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<td>Diagnosis in drug development (<strong>pharmacogenomics</strong>)</td>
<td>blood, urine, saliva, diseased tissue</td>
<td>mRNA, Protein</td>
<td>Reduction of dropout risk by performing a clinical study based on profiles analyzed in patients who respond to the drug through the pharmacological mechanism being developed.</td>
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What changes are expected in medical care with the spread of diagnostic biochips?
Medical expenses for the elderly have been markedly increasing continuously in Japan.

For the elderly to spend an active daily life, prevention is important.

And high expectations are placed on biochip development enabling simple and reliable simultaneous diagnoses of many items in a small blood sample collected at home.
For personalized medicine, it is important to diagnose the hereditary background and disease condition by prior tests.

And the expansion of needs for these diagnoses with the spread of personalized medicine is predicted.
However, although the basic technologies of biochips for research and development and diagnosis have some commonality, specifications to be realized are markedly different.

And a technological **breakthrough** is necessary.
5 years view of diagnostic biochip development
As biochip technology further progresses, mobile and wearable disease diagnosis systems will be developed.

And connection to a ubiquitous network may facilitate diagnoses at home.

It is expected that the application of these technologies will facilitate not only ‘super’ early diagnosis of diseases and disease prevention based on the diagnosis, but also ‘super’ early treatment.
Reference

• **Every man knows his own business best**
• **One should go to specialists for the best results.**