The Danish Biobank System
– a unique resource for biomedical research and development

Professor Stephen Hamilton-Dutoit
Chair of Pathology, Aarhus University
Denmark
Denmark
– a great little country for biobank research

Population = 5.7 million
What is a Biobank?

- An organized collection of human biological material
- The associated data, stored in a readily analysable format
Why are Biobanks Useful?

Biobanks hold the key to:

• Unravel the molecular basis of disease subtypes and enable **precision medicine**
• Understand gene-environmental/lifestyle interactions
• Develop biomarkers
• Identify new targets for therapy
• Boost development in drug discovery
Clinical Medicine = Precision Medicine

Precision medicine

“an approach to disease treatment and prevention based on individual variability in genes, environment, and lifestyle for each person.”
Precision Medicine

RIGHT TREATMENT
RIGHT PATIENT
RIGHT TIME
Translational clinical research

BASIC RESEARCH
TRANSLATION
From basic science to human studies

CLINICAL RESEARCH

IMPROVED HEALTH
TRANSLATION
Of new knowledge into clinical practice

Precision Medicine - the hunt for BIOMARKERS!
Every era has transformative events!

1850s:

The birth of modern cancer histopathology
Every era has transformative events!

Since 2000:

New ways to hunt for biomarkers of disease
Biobanks are hot!

10 Ideas Changing the World Right Now

The global economy is being remade before our eyes. Here's what's on the horizon

WHAT'S NEXT 2009

Biobanks

By Alice Park | Thursday, Mar. 12, 2009

Now that major banks in the U.S. are getting by on a government bailout, the idea of creating yet another repository to safeguard your most valuable assets might seem downright ludicrous. And even irresponsible. But that's exactly what some federal officials are hoping to do.

Relax — it's not your money they're after. It's your blood. Folks at the National Cancer Institute (NCI) are heading up an effort to establish the U.S.'s first national biobank — a safe house for tissue samples, tumor cells, DNA and, yes, even blood — that would be used for research into new treatments for diseases.

Inside Huntsman Cancer Institute's vaults: Pancreatic
Using Biobanks for Drug Discovery and Development

- Tissue banks for investigation of target expression in diseased and non-affected organs.
- Tissue banks for validation of animal model relevance to human disease.
- Tissue, sera and plasma collected in clinical trials for biomarker validation (companion diagnostics).
- Tissue banks to investigate target expression in large patient cohorts to support the design of clinical trials.
- Archived tissue, sera and plasma for biomarker discovery.

Zatloukal & Hainaut 2010
The Basis for Precision Medicine

Biospecimens
Molecular analysis

Electronic medical records
Linked health data

Clinical knowledge

DENMARK!
Health Data Research – the Danish Model

- The world’s most valuable epidemiological research infrastructure
- Unique system of registers and clinical databases
- Enormous financial investment in registers
- Now – coordination of biobanks
- The key is the CPR-number system
The Danish Registers

When an Entire Country Is a Cohort

Denmark has gathered more data on its citizens than any other country. Now scientists are pushing to make this vast array of statistics even more useful.

*Science* 31 March 2000:
Vol. 287 no. 5462 pp. 2398–2399

- Neonatal history
- Clinical history
- Specific disease register
- National Danish Pathology Databank
- Disease Screening
- Other laboratory tests
- Vaccination history
- Social, school and education
- Prescription database
- Clinical Quality databases
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CPR-number
The Danish Registers

Health data from cradle to grave

........and beyond the grave

Danish biobanks can follow disease over generations
The Danish Biobanks

- Danish National Biobank
- Danish Cancer Society biobanks
- Danish National Birth Cohort biobank
- Danish Phenylketouria Cards (blood from all Danes since 1976)
- The National Danish Cancer Biobank
- Danish Pathology Bank (approx. 25 million tissue samples)
- Disease specific biobanks
- Local hospital and research project biobanks
Danish Biobanks – state of the art facilities

New installations

- Economic water cooled systems extracting excess heat energy (35% re-use)
- Total storage capacity of 31 mill 0,5 ml tubes

-196 °C liquid nitrogen tanks (31)

-80 °C upright freezers (115)

Ground floor – level 1

Basement – level 0

‘Walk-in freezer’ -20 °C

-20 °C and -80 °C automated storage systems
Danish Biobanks – state of the art facilities

- DNA extraction
- Manual lab
- Laboratory
  - 8 pins
- Sample registration
- Processing of daily SSI samples
- Research lab.
Danish Biobanks - Organization
Danish Biobank Register

**BIOBANKS**
- DK Cancer Society
- Hospital Biobanks
- Pathology Bank
- National Biobank
- DK Cancer Biobank

**NATIONAL REGISTERS**
- Civil Registration System
- Danish National Patient Registry
- Danish Family Relations Database
- Danish Medical Birth Registry
- National Danish Pathology Registry

**ONLINE ACCESS**

![Image of a person using a laptop]
Accessing Data and Specimens in the Danish Biobanks

National Biobank Register

- In principle, data and specimens are freely accessible
- Easy online access
- Modest retrieval costs
- Necessary permissions
  - Danish Data Protection Agency
  - Ethical Board approval
Accessing Data and Specimens in the Danish Biobanks

National Biobank Register

• See the video of how to do it here!

biobankdenmark.dk "Register"
The Danish National Biobank
Danish Guthrie (PKU) Card Biobank

- Blood cards from all Danes since 1976 (ca. 2 million)
The National Danish Cancer Biobank

- National, population based cancer biobank
- Collect blood, cells, tissues, molecules
- **From all Danish cancer patients at first diagnosis**
- 6 University-based centres
  - Departments of Pathology
  - Departments of Biochemistry

www.cancerbiobank.dk/en/aboutus
The National Danish Cancer Biobank
The National Danish Cancer Biobank

Local and Regional
- Biospecimen collection
- Biospecimen storage
- Online data registration
The National Danish Cancer Biobank

Local and Regional
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National
- Administration
- Data management
Specimens in the National Danish Cancer Biobank
Specimens in the National Danish Cancer Biobank

Blood
- EDTA-blood
- Blodet tappes
- Blod i gelglas
  - 1 x 1½ml fuldbloed
  - 2 x 2ml plasma
  - 1 x 1½ml buffycoat
  - Centrifugering
  - Hvidt mellemlag (buffy coat)

Tissue
- Tissue
  - Formalin/paraffin
    - 3x10x10 mm
    - 3x5x5 mm
  - Fresh frozen
    - 3x10x10 mm
    - 3x5x5 mm

Molecules
- miRNA
- DNA
- RNA
The National Danish Cancer Biobank - Local Organization

Department of Oncology
- Obtains patient consent
- Blood sample
The National Danish Cancer Biobank - Local Organization

Department of Oncology
- Obtains patient consent
- Blood sample

Blood specimen taken

Cancer biopsy or operation
The National Danish Cancer Biobank - Local Organization

Department of Biochemistry
- Blood preparation & storage

Department of Pathology
- Tissue selection & storage
The National Danish Cancer Biobank
- Local Organization

Department of Biochemistry
• Blood preparation & storage

Department of Pathology
• Tissue selection & storage
Paraffin Block Archive, Institute of Pathology
Aarhus University Hospital

Part of Denmark’s largest biobank!

- Routine diagnostic specimens from ca. 1960
- Stored indefinitely
- Millions of paraffin blocks
- A treasure chest for researchers
The National Danish Pathology Data- and Tissue Bank

- National database
- Paraffin block archives stored at 19 pathology departments
Danish National Pathology Registry

- Developed routine diagnostic for Danish pathologists
- Real-time updating of all pathology analyses performed throughout Denmark
- > 14 million biospecimens
- Complete from 1997
  - some data back to 1960s
- CPR ID-number based
- Available for researchers

- **Unique in the world**
Danish National Pathology Registry

- CPR-number based
- Enables powerful molecular epidemiological studies
- We can find >90% of paraffin blocks for 30 year-old cohorts
- Blocks suitable for molecular studies

Good for:
- Biomarker discovery and validation
- Cheap, efficient retrospective drug studies (phase 3 & 4)

http://www.patobank.dk/
What can we do using the Danish National Pathology Registry?
HOLYDAN: HOdgkin LYmphoma in DANmark

AIM

• Study the molecular profile and viral association of ALL cases of Hodgkin Lymphoma diagnosed in Denmark 1990-2010
HOLYDAN: Hodgkin Lymphoma in Denmark
HOLYDAN: Hodgkin LYmphoma in DANmark

- Database-linkage via CPR (ID) number
HOLYDAN: HOdgkin LYmphoma in DANmark

- Database-linkage via CPR (ID) number
- 2520 cases diagnosed as cHL identified (1990-2010)
- 2432 cases biopsied
- Review - 52 not cHL
- Paraffin block retrieved in 2237 cases
- (94% success rate)
HOLYDAN:
HOdgkin LYmphoma in DANmark

ON-GOING in >2200 cases!

• Protein studies
  – TMAs & immunohistochemistry
  – proteomics

• DNA studies
  – GWAS

• RNA & miRNA
  – Gene expression profiling
    (NanoString)
The Danish Biobanking System - has the key components for success

LINKED TO HEALTH DATA!!
Japanese inspired garden in Aarhus, Denmark
有難う 御座います

Tak!