National & international biobanking programs and networks

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Chair on Biobanking, Siena University 2010

1

- Literature review

Review MOLECULAR ONCOLOGY 2 (2008) 213 222

Biobanking for better healthcare

Peter H.J. Riegman[a,*], Manuel M. Morente[b], Fay Betsou[c], Pasquale de Blasio[d], Peter Geary[e], the Marble Arch International Working Group on Biobanking for Biomedical Research[1]

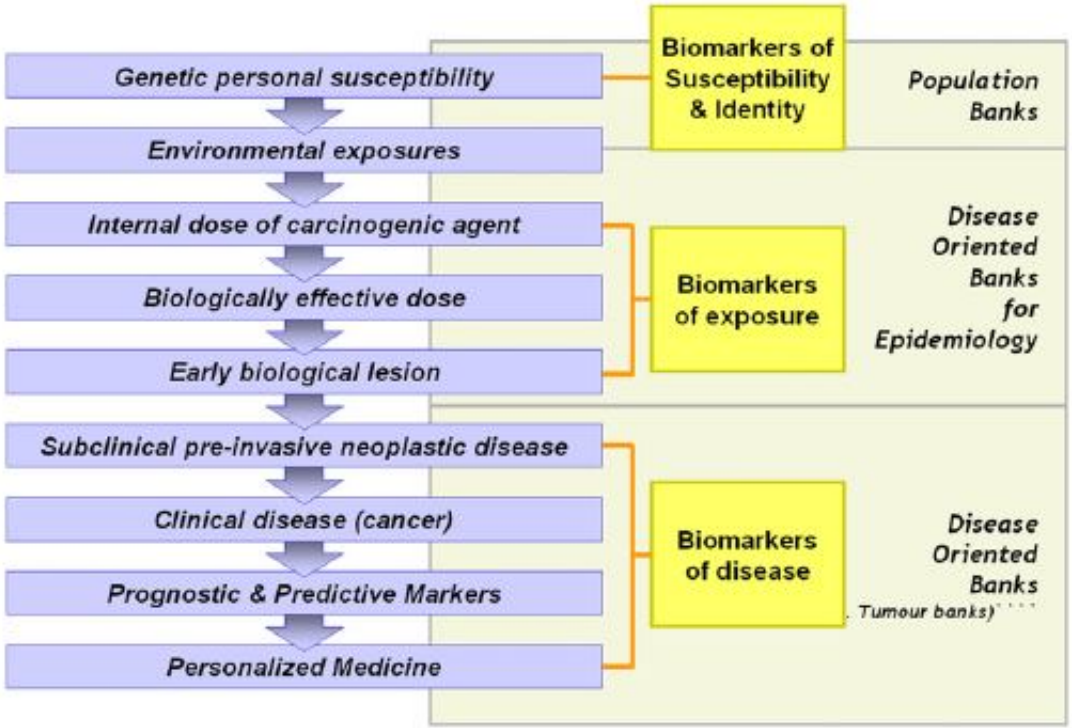

Figure 1 – Relation between type of biomarker research and type of biobank. The first column shows the different phases in the process to disease revelation from susceptibility to the actual disclosure. The second column shows the opportunities of biomarker discovery, whereas the last column shows the associated type of biobank.

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A Review of International Biobanks and Networks: Success Factors and Key Benchmarks

Jim Vaught,[1] Andrea Kelly,[2] and Robert Hewitt[3]

- Biospecimen collection characteristics
- Economic models
- Biospecimen-access policies
- Individual biorepositories and biobanking networks

- **Review of 16 networks NOT aiming at full cost recovery through specimen dissemination fees**

Biobanks & Biobanking Networks

- Collection
- Processing
- Storage
- Dissemination

➔ Biological specimens

Based on Vaught et al, Biopreservation & Biobanking 2010;7:143

Biobanking Models

- … at least 1 freezer …
- Large academic programs
- Commercial biobanks

➔ With specific project(s)

➔ W/o specific project(s)

Based on Vaught et al, Biopreservation & Biobanking 2010;7:143

Biobank types

- 13 disease-based (cancer)
  - *2 project driven (+1 on request)*
- 1 on rare diseases
  - *EuroBioBank*
- 2 with various scopes (samples from general population)
  - *BancoADN*
  - *UK Biobank*

Based on Vaught et al, Biopreservation & Biobanking 2010;7:143

16 biobanks surveyed by Vaught et al.

1. Australasian Biospecimen Network (Australia)
2. Australian Prostate Cancer BioResource (Australia)
3. BancoADN (Spain, various projects)
4. Canadian Tumor Repository Network (Canada)
5. CNIO Tumor Bank Network (Spain)
6. Chernobyl Thyroid Tissue Bank (Russian Federation)
7. Confederation of Cancer Biobanks (UK)
8. Cooperative Human Tissue Network (USA)
9. EuroBioBank (rare diseases)
10. Kathleen Cuningham Consortium for Res into Fam Breast Ca (Australia)
11. onCore UK (UK)
12. Singapore Tissue Network (Singapore)
13. Tubafrost
14. UK Biobank (UK, various projects)
15. Victorian Cancer Research Tissue Bank (Australia)
16. Wales Cancer Bank

Based on tab 1 in Vaught et al, Biopreservation & Biobanking 2010;7:143

Specimen access policy

- Requirements

➔ Ethical clearance

➔ Scientific expertise for specific study

Based on Vaught et al, Biopreservation & Biobanking 2010;7:143

Biobanking issues with general consensus

- Similar specimen access policies
  - *Use only for proposed purpose*
  - *Do not re-distribute w/o written consent*
- Requested info:
  - *Type of study/experiment*
  - *Funding availability*
- Ethical norms for sample handling
  - *Respect donor privacy*

Based on Vaught et al, Biopreservation & Biobanking 2010;7:143

Biobanking issues without general consensus

- Central (5) vs peripheral (11) storage
- Use of non-governmental funds (9)
- Offer derivative samples (eg nucleic acids) in addition to tissues and blood products (4)
- Unused sample return policy (13 yes)

Based on Vaught et al, Biopreservation & Biobanking 2010;7:143

Other biobanking policies

- Internal vs external (4) application reviews
- Intra-country use only (3)
- Statistical justification for sample size
- Acknowledgement (9) vs authorship (3)
- Notification of clinically relevant data (3)
- Mandatory study report (7)

Based on Vaught et al, Biopreservation & Biobanking 2010;7:143

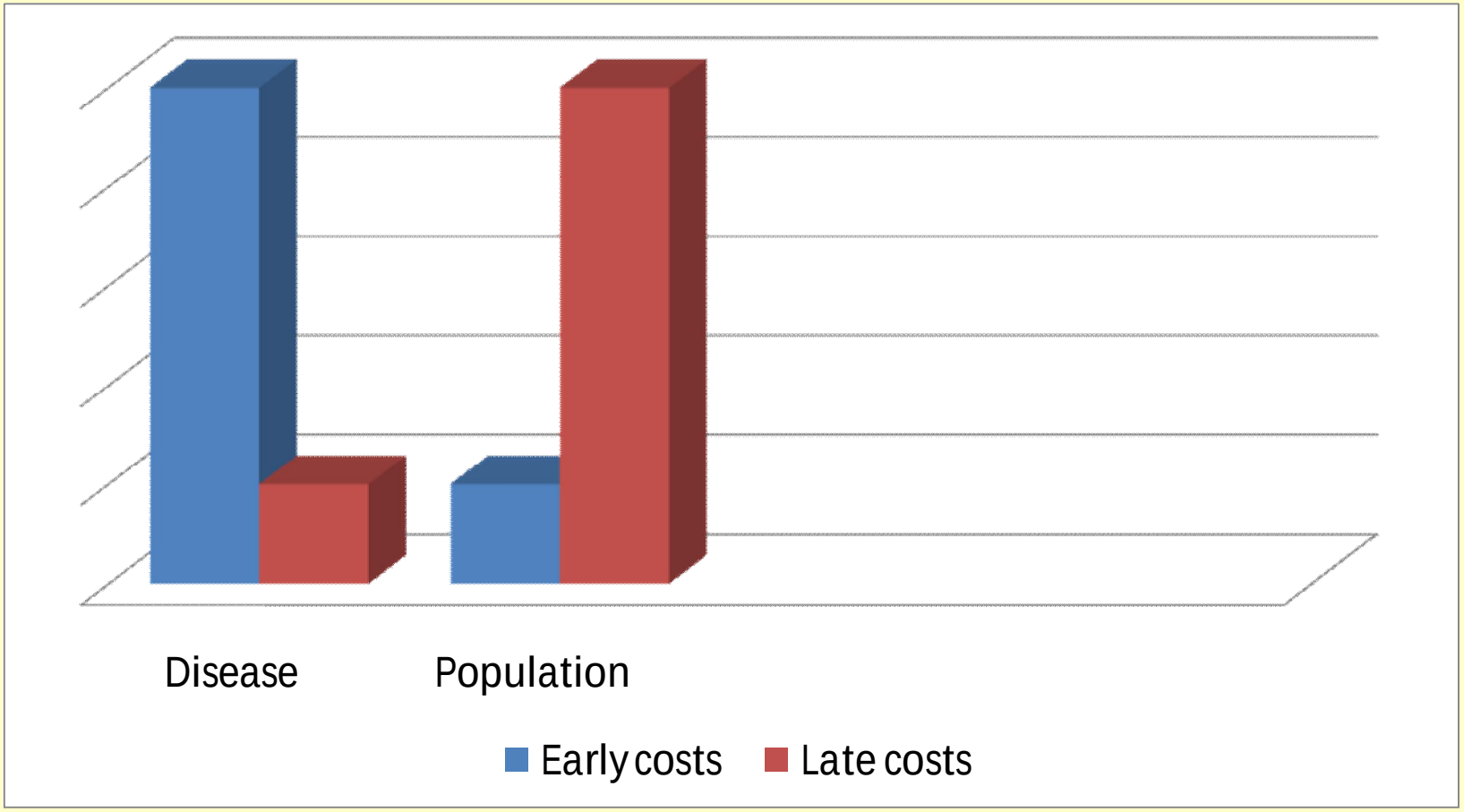
Models for partial biobanking cost recovery

… pay for …

- ➔ Sample transport (research)
- ➔ Sample transport + nominal fee (research)
- ➔ Commercial use (greater fee)

Based on Vaught et al, Biopreservation & Biobanking 2010;7:143

General estimation of early vs late relative costs of disease and population biobanks



Based on Vaught et al, Biopreservation & Biobanking 2010;7:143

Examples of prices

- Australian Prostate Cancer BioResource
  - *A$ 185 for 20 um tissue section*
  - *A$ 30 for 0.5 mL of blood product*
  - *A$ 100 per tissue microarray*
- BancoADN (Spain)
  - *Euro 1 (non-profit) or 1.54 (commercial) per ug DNA*
- CNIO tumor bank network (Spain)
  - *Euro 15 per case*
- kConfab (familial breast ca, Australia)
  - *A$ 300 to 1,500 per year (academia)*
- Victorian Cancer Research Tissue bank (Australia)
  - *A$ 18 per H&E section*
  - *A$ 139 per paraffin block*

Based on Vaught et al, Biopreservation & Biobanking 2010;7:143

Key factor in biobanking

- Sample collection

➔ Strict quality control

➔ Operational control

Modified from Vaught et al, Biopreservation & Biobanking 2010;7:143

Published by Oxford University Press on behalf of the International Epidemiological Association

International Journal of Epidemiology 2008;37:i2–i6
doi:10.1093/ije/dyn019

The UK Biobank sample handling and storage validation studies

Tim C Peakman[1]* and Paul Elliott[2]

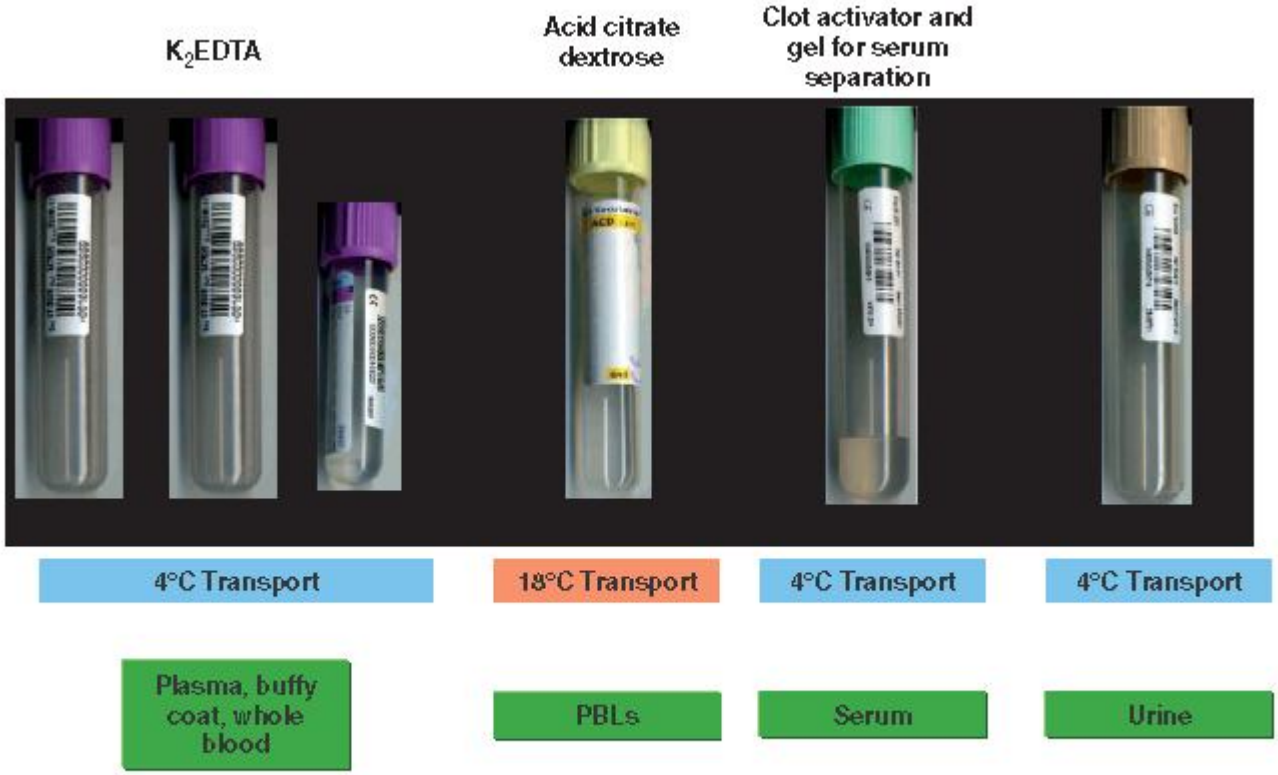


Figure 1 Sample fraction collection schedule from 40 healthy volunteers and transport temperatures for blood and urine for the sample handling validation studies. A 6 ml fluoride/oxalate coated vacutainer was also collected for measurement of plasma glucose. (PBLs—peripheral blood lymphocytes)

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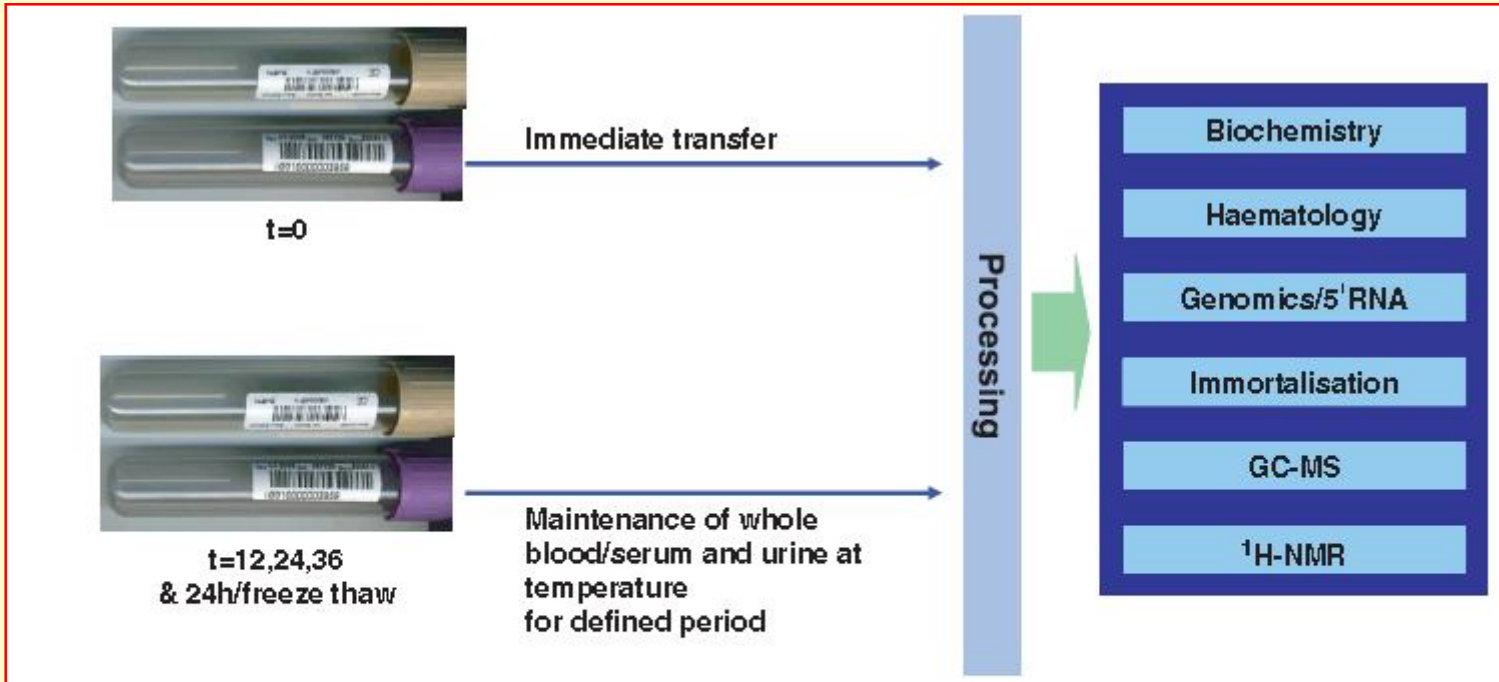

Figure 2 Summary of the approach to validating the UK Biobank sample handling protocol. Samples of blood and urine collected and processed immediately ($t = 0$ h) were compared, in a variety of assays, with samples maintained at specified temperatures* for different times ($t = 12$, 24, 36 h) prior to processing. The impact of short-term freezing and thawing on sample integrity was also examined by maintaining processed sample aliquots at −80°C for 20 days prior to assay. (GC-MS = gas chromatography-mass spectrometry, ^{1}H NMR proton nuclear magnetic resonance, *4°C for all tubes collected except the acid citrate dextrose tube which is maintained at 18°C)

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International Journal of Epidemiology 2008;37:i2–i6
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The UK Biobank sample handling and storage validation studies

Tim C Peakman[1]* and Paul Elliott[2]

Table 1 Processing and assay plan for samples collected from 40 healthy volunteers

			Time (hours from collection to processing)				
Tube	**Processing**	**Assay**	0	12	24	24 (freeze thaw)	36
EDTA-1	Immediate centrifugation	Plasma glucose	√	√	√	√	√
	Snap freezing of plasma for analysis of 5′ RNA molecules		√		√		√
	Cryopreservation of buffy coat fraction for genomic analysis (and analysis of 5′ RNA molecules)		√		√		(√)
EDTA-2	Transfer of whole blood to paper medium	Extensive genomic analysis	√		√		
	Whole blood for haematology	Haematological analysis	√		√		√
Serum separator	Clotting for 25–30 min at room temperature followed by centrifugation	Biochemistry	√	√	√	√	√
	Snap freezing for analysis of metabonome		√		√		√
Acid citrate dextrose	Addition of DMSO followed by cryopreservation	Cell transformation and immortalization			√		
	Centrifugation of remaining sample	Plasma fibrinogen	√	√	√		√
Fluoride/oxalate	Immediate centrifugation	Plasma glucose	√	√	√	√	√
Urine	None	Biochemistry	√	√	√		√
		Snap freezing for analysis of metabonome	√		√	√	√

√ symbol indicates the various time points measured in the different assays.

Biobanking model characteristics shared by most biobanks

- Governance
  - *Technical standards, ethical guidelines, access policies and procedures, scientific rationale, long-term custodianship plans*
- Strong QA/QC program
  - *SOPs, regular audits*
- Comprehensive business model
  - *Sustainable cost recovery plan*
- Adherence to a set of best practices
  - *ISBER, http://www.isber.org*
  - *NCI, http://biospecimens.cancer.gov*

See also the 'Observatory' of the 'Public Population Project in Genomics (P3G)

Based on Vaught et al, Biopreservation & Biobanking 2010;7:143

GeneWatch UK

Criticism and concern?

Bioscience for Life?

Appendix A

The history of UK Biobank, electronic medical records in the NHS, and the proposal for data-sharing without consent

January 2009

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- The BBMRI

- Biobanking and
- Bio-
- Molecular Resources
- Research
- Infrastructure

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The Role of Biobanking in Rare Diseases: European Consensus Expert Group Report

Hanns Lochmüller,[1] Ségolène Aymé,[2] Francesca Pampinella,[3] Béla Melegh,[4] Klaus A. Kuhn,[5] Stylianos E. Antonarakis,[6] and Thomas Meitinger[7]

Biobanking is of high importance for research in rare diseases. There are >6,000 rare diseases with at least 30 million people affected in the European Union (EU). The European Commission (EC) has prioritized rare diseases in recent health and research programs. The rarity and diversity of rare diseases and their associated biomaterials harbor specific challenges and opportunities for biobanking requiring transnational collaboration and harmonization. Small collections or even individual samples may be extremely precious for research. Importantly, most rare disease biobanks work through the active participation of patients and patient organizations, and share benefits with them. This article gives recommendations related to rare disease biobanking reflecting consensus of an expert working group of the Biobank and Biomolecular Research Infrastructure program at a meeting in Munich on December 17–18, 2008.

Lochmuller et al, 2010

Summary

1. Biobanks are highly relevant for rare disorders. Rare disease biobanks have many commonalities with other biobanks, but face additional challenges due to the rarity and the diversity of the conditions and biomaterials.
2. It is rather the quality of the biomaterials and of the associated information than their quantity (number of samples) that is critical in rare disease biobanking.
3. This necessitates the adoption by biobanks of an appropriate disease coding system that accommodates all rare disorders, such as the nomenclature developed by Orphanet.
4. Active participation of and benefit sharing with patients and patients' organizations is pivotal in rare disease biobanking. The Telethon biobanks (Italy) may serve as a role model (prototype) for networking rare disease biobanks on a national level, while EuroBioBank may be a role model (prototype) for networking rare disease biobanks on a European level.
5. Rare disease biobanks have common objectives with BBMRI and recognize BBMRI as an important mechanism to secure the long-term sustainability of biobanks in Europe.
6. Rare disease biobanks may provide their experience and advanced solutions to BBMRI, some of which may be applicable to other biobanks.

3

- The P3G

P3G

- Public
- Population
- Project
- In GENOMICS

P3G

CHARTER MEMBERS

An international, national or regional non-for-profit organization that is conducting, or which will be conducting, a large population genomics project such as a biobank or a large-scale cohort study (N > 10,000 samples).

Avon Longitudinal Study of Parents and Children **UK**
Biobank Popgen **Germany**
CARTaGENE **Canada**
Centre for Integrated Genomic Medical Research **Manchester, UK**
Danubian Biobank Foundation **Central Europe**
Estonian Genome Project of University of Tartu **Estonia**
Generation Scotland **UK**
GenomeEUtwin **Helsinki**
INMEGEN **Mexico**
INSERM **France**
King Abdullah International Medical Research Center **Saudi Arabia**
KORA-Gen **Germany**
LifeGene **Sweden**
LifeLines Cohort **Netherlands**
National Cancer Institute (NIH) **USA**
National DNA Bank **Spain**
National Heart, Lung and Blood Institute (NIH) **USA**
Norwegian Institute of Public Health **Norway**
NUgene **USA**
Ontario Cancer Consortium **Canada**
Singapore Tissue Network **Singapore**
String of Pearls Initiative **Netherlands**
Taiwan Biobank Institute of Biomedical Sciences, Academia Sinica **Taiwan**
UK Biobank **UK**
Western Australia Genome Health Project **Australia**

ASSOCIATE MEMBERS

A not-for-profit organization whose activities are devoted to scientific, ethical, legal or societal research related to population genomics and genetics.

Alberta Cancer Board **Canada**
Centers for Disease Control (Office of Genomics & Disease Prevention) **USA**
Centre de Recherche en Droit Public **Canada**
CIHR-Canadian Institute of Genetics **Canada**
European Collection of Cell Cultures **UK**
Genetics Resource Center **Faroe Island**
Genoma España **Spain**
Génome Québec **Canada**
German Center for Public Health Genomics **Germany**
Hans Mak Institute **Netherlands**
Latvian Biomedical Research and Study Center **Latvia**
McGill University and Génome **Québec** Innovation Centre **Canada**
Marshfield Clinic Research Foundation **USA**
Medical University of Graz **Austria**
National Human Genome Research Institute (NIH) **USA**
Statistics Canada **Canada**

INDIVIDUAL MEMBERS

An individual from an academic, public or private organization committed to complying with the objectives of P³G and to providing P³G with the benefit of their knowledge.

P³G works with biobankers and other subject-matter experts from around the world to

Foster collaboration between researchers and biobankers
Promote harmonization of information
Optimize the design, set-up and research activities of population-based biobanks
Facilitate the transfer of knowledge and provide training to those working in the field

P³G brings the genomics community closer together in person – at conferences and meetings held around the world, and online through the Observatory – a publicly accessible knowledge database. Principles of transparency and collaboration are integral to the P³G approach.

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http//www.P3G.observatory.org

- The OBiBa Project
- The ESPRESSO power calculator
- Repository of P3G comparison charts
- Data SHaPER
- Repository of reference questionnaires
- Inter-Catalogues search

Comparison Chart of Key Health Organizations/Projects Involved in Biobanking

This document presents selected Key Health Organizations/Projects involved in Biobanking. For each organization/project, the table addresses the general mission and indicates if it is particularly involved in the four following domains: (1) Guidelines and scientific tools creation to support biobanks, (2) Networking and harmonization, (3) Scientific Discoveries and (4) Biobanking. A P^{3}G-prepared document (2010).

Mental Disorders Assessment Comparison Chart

This document compares selected reference Mental Disorders instruments. For each instruments, the table addresses the main fields of comparison, i.e. authors, objectives, domains covered, population targeted, time recall, number of items, administration mode, available translations, copyright, condition of use and references. A P^{3}G-prepared document (2009).

Health-Related Quality of Life (QoL) Assessment Comparison Chart

This document compares selected reference health-related quality of life instruments. For each instrument, the table addresses the main fields of comparison, i.e. authors, objectives, domains covered, population targeted, time recall, number of items, administration mode, available translations, copyrights, condition of use and references. A P^{3}G-prepared document (2008).

Nutrition Assessment Comparison Chart

This document compares the different approaches for dietary assessments. For each approach, the table addresses the main fields of comparison, i.e. objectives, quantitative/semi-quantitative approaches, time recall, strengths/weaknesses, number of items, administration mode, references and references of studies using this approach. A P^{3}G-prepared document (2009).

Physical Activity Assessment Comparison Chart

This document compares selected reference physical activity instruments developed to enable comparisons across culturally diverse populations. For each instrument, the table addresses the main fields of comparison, i.e. authors, objectives, domains covered, population targeted, time recall, number of items, administration mode, available translations, copyrights, condition of use and references. A P^{3}G-prepared document (2008).

Physical Fitness Assessment Comparison Chart

This document introduces the main tests which can be used in the assessment of physical fitness and compares their representation among a reference studies/organisms panel. For each test, the objective and a brief description are given. A P^{3}G-prepared document (2009).

Social Support Assessment Comparison Chart

This document compares selected reference social support instruments. For each instrument, the table addresses the main fields of comparison, i.e. authors, objectives, domains covered, population targeted, time recall, number of items, administration mode, available translations, copyrights, condition of use and references. A P^{3}G-prepared document (2009).

Comparison Chart of Guidelines

This document compares selected reference guidelines written by well-known organizations. These guidelines cover all biobanking steps, i.e. biological sample collection, labelling, processing, and storage applied to a wide range of sample types. A P^{3}G-prepared document (2008).

Comparison Chart of Websites for Genetic and Genomic Statistics

This comparison chart summarises the content of a number of websites offering information and tools that are useful for undertaking a wide spectrum of analyses in genetic and genomic statistics. A P^3G-prepared document (2009).

Comparison Chart of Websites for Managing and Interpreting Genomic Data

This comparison chart summarises the content of a number of websites offering information and tools that are useful for the management and analysis of genomic, transcriptomic and proteomic data. A P^3G-prepared document (2009).

P3G Observatory: DNA processing catalogue

1. Alberta Pregnancy Outcomes and Nutrition [APrON]
2. Atlantic Partnership for Tomorrow's Health (The) [Atlantic PATH (The)]
3. BC Generations Project
4. CARTaGENE [CaG]
5. Child and Adolescent Twin Study in Sweden (The) [CATSS]
6. Decode (Icelandic Biobank)
7. Estonian Genome Center of University of Tartu [EGC]
8. FINRISK 2002 [FINRISK 2002]
9. Generation Scotland - Genetic Health in the 21st Century [GS-21GHC]
10. Generation Scotland - Scottish Family Health Study [GS-SFHS]
11. Joondalup Family Health Study [JFHS]
12. KORA-gen - Cooperative health research in the Region of Augsburg [KORA-gen]
13. LifeGene [LifeGene]
14. LifeLines Cohort Study & Biobank [LifeLines]
15. Marshfield Clinic Personalized Medicine Research Project [PMRP]
16. NUgene project
17. National DNA Bank - BancoADN [BNADN]
18. Nijmegen Biomedical Study [NBS]
19. Norwegian Mother and Child Cohort Study (The) [MoBa]
20. Ontario Health Study [OHS]
21. Prostate, Lung, Colorectal and Ovarian Cancer Screening Trial [PLCO]
22. Singapore Consortium of Cohort Studies [SCCS]
23. Swedish Twin Study of Adults: Genes and Environments (The) [STAGE]
24. Taiwan Biobank
25. Tomorrow Project (The) [TTP]
26. TwinGene
27. Västerbotten intervention project cohort (The) [VIP]