Biomonitoring for Environmental Chemicals: Implications for the Future of Public Health Policy

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Biomarkers: A New Lens

Transforming Environmental Health?

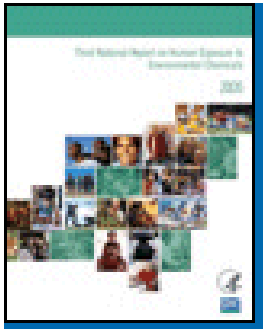
- Has the potential to impact all aspects of environmental health
- Exposure assessment
- Epidemiology
- Toxicity testing
- Risk assessment
- Policy evaluation
- Future priorities?

Background

- Biomonitoring is defined as one method for assessing human exposure to chemicals by measuring the chemicals or their metabolites in human tissues or specimens, such as blood or urine (CDC 2005).

- Repeatedly, biomonitoring data have confirmed environmental exposures and validated public-health policies.

- Lead exposure reduction
- Mercury
- Environmental tobacco smoke
- PCBs, dioxins
- Persistent pesticides



CDC 3rd National Report

- CDC's Environmental Health Laboratory measured 148 chemicals – 38 of which have never been measured in the U.S. population.
- The samples were collected from approximately 2400 people who participated in CDC's National Health and Nutrition Examination Survey (NHANES) from 1999 -2002.
- The report provides exposure data on the U.S. population by age, sex, and race or ethnicity.
- The report includes extensive data for such chemicals as mercury, lead, cadmium, and other metals; phthalates; organochlorine pesticides; organophosphate pesticides; pyrethroid insecticides; herbicides; polycyclic aromatic hydrocarbons; dioxins and furans; polychlorinated biphenyls; and phytoestrogens.

"This is a giant step forward to understanding the relationship between exposure to chemicals and their potential health effects"

Dr. Julie Gerberding, CDC's director

Headlines

- 'Watershed event' finds human body awash in pesticides, solvents, metals
- CDC report says everybody's contaminated
- CDC results are in: We're full of contaminants
- Dozens of Chemicals Found in Most Americans' Bodies

Hold on…..

- Biomonitoring is expanding dramatically
- We are better at measuring than we are at interpreting the public health implications.
- Interpretation and communication of the results of biomonitoring studies present an enormous challenge
- Where do we begin?

THE NATION:
Rocket-Fuel Chemical Found in Breast Milk

Perchlorate is found in almost all samples tested, a study finds, raising concerns about the substance‘s effect on the thyroid and brain effect on the thyroid and brain

Marla Cone. **Los Angeles Times**. Los Angeles, Calif.: Feb 23, 2005. pg. A.12

Cord Serum Concentrations of Perfluorooctane Sulfonate (PFOS) and Perfluorooctanoate (PFOA) in Relation to Weight and Size at Birth

Benjamin J. Apelberg,1 Frank R. Witter,2 Julie B. Herbstman,3 Antonia M. Calafat,4 Rolf U. Halden,5 Larry L. Needham,4 and Lynn R. Goldman5

- PFOA was detected in 100% of cord blood serum samples, and PFOS was detected in > 99% of samples. The median PFOA concentration was 1.6 ng/mL (range, 0.3 to 7.1 ng/mL) and the median PFOS concentration was 5 ng/mL

New contaminant 'stars' include perchlorate, PFCs

Tom Williams, Senior Editor

ORLANDO, FL — Perchlorate, endocrine disruptors and perfluorochemicals (PFCs) are among the "emerging contaminants" gaining the attention of state and federal drinking water regulators….

Test Flin Flon citizens for toxins: MD
Critics say ongoing risk assessment not enough to detect possible harm

Mon Oct 29 2007
By Jen Skerritt

Marc Gallant/Winnipeg Free Press
Recent Flin Flon soil survey found much of the town's soil was above guidelines for human health, and high levels of mercury, lead and arsenic were recorded at schools and playgrounds.

ALL residents of Flin Flon should be tested to see if they have been exposed to high levels of lead, mercury and arsenic, health officials tell the *Free Press*.

Dr. Kapil Khatter, a physician with Toronto-based Environmental Defence, a non-profit group that studies the link between the environment and human health, said a simple blood test could confirm whether a person's health has been adversely affected by lead, and other tests can be done to see whether harmful levels of mercury or arsenic are in the body.

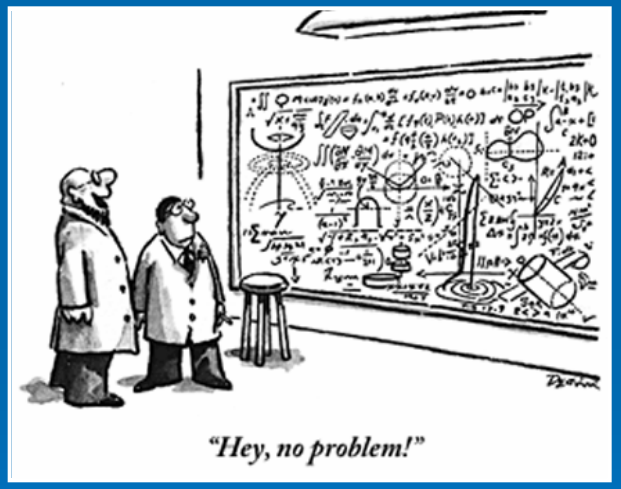
Khatter said emerging research has shown that even low levels of lead contribute to higher incidences of hyperactivity, lower IQ and higher rates of anemia among children.

"I think all the children, in particular, should be tested in Flin Flon," Khatter said during a phone interview from Toronto

If you saw a big boy beating up on a little boy in the playground, your first reaction is (to say), 'stop that,'" May said. "A health-risk assessment approach would be to study how many blows the big boy could deliver to the small boy before he actually sustained any damage.

What does it mean?

- Our ability to measure pollutants has outpaced our ability to understand the health effects.
- Thresholds
- Cumulative effects
- Chronic impacts



HUMAN BIOMONITORING FOR ENVIRONMENTAL CHEMICALS

National Research Council
Division on Earth and Life Studies
Board on Environmental Studies and Toxicology

THE NATIONAL ACADEMIES
Advisers to the Nation on Science, Engineering, and Medicine

Roadmap for Addressing Unanswered Questions

- Framework for Characterizing Biomarkers and Uses of Biomonitoring Data.
- Guidelines to ensure the proper conduct of biomonitoring studies
- Options for interpreting biomonitoring data
- Challenges in communicating results
- Research Agenda
  - Findings and Recommendations

Need to fill in the gaps…..

TABLE 1-1 Numbers of Chemicals in *Third National Report on Human Exposures to Environmental Chemicals* for Which Health-Based Values Are Available

148[a]	Number of chemicals sampled by CDC in third national report
25	Number of chemicals for which EPA reference values (i.e., RfCs or RfDs) and/or cancer slope factors are established[b]
23	Number of chemicals for which TLV-TWAs are established
5	Number of chemicals for which BEIs are established
3	Number of chemicals for which RfDs/RfCs, TLVs, and BEIs are established

[a]The CDC measures 148 total analytes; however many are similar compounds that are members of a broader class of chemicals, such as polychlorinated biphenyls, dioxins and furans, organophosphorus pesticides, and heavy metals.

[b]Many of the chemicals do not have specific health-based values, but because many are in similar classes of compounds, alternative approaches to evaluate toxicity, such as toxic equivalency factors, are available.

Source: CDC 2005.

Framework for Characterizing Biomarkers

- The framework is intended to characterize the properties of biomarkers as a means to inform scientists and the general public about biomarkers and their significance when used in biomonitoring studies.
- Summarizes what is known about a biomarker and thus indicates potential research gaps that need to be addressed to meet the requirements for specific uses.
- Is intended to crystallize scientific discussion over specific biomarker issues and serve as a guide in interpreting the studies, in setting priorities among research needs, and in communicating study objectives to different audiences.

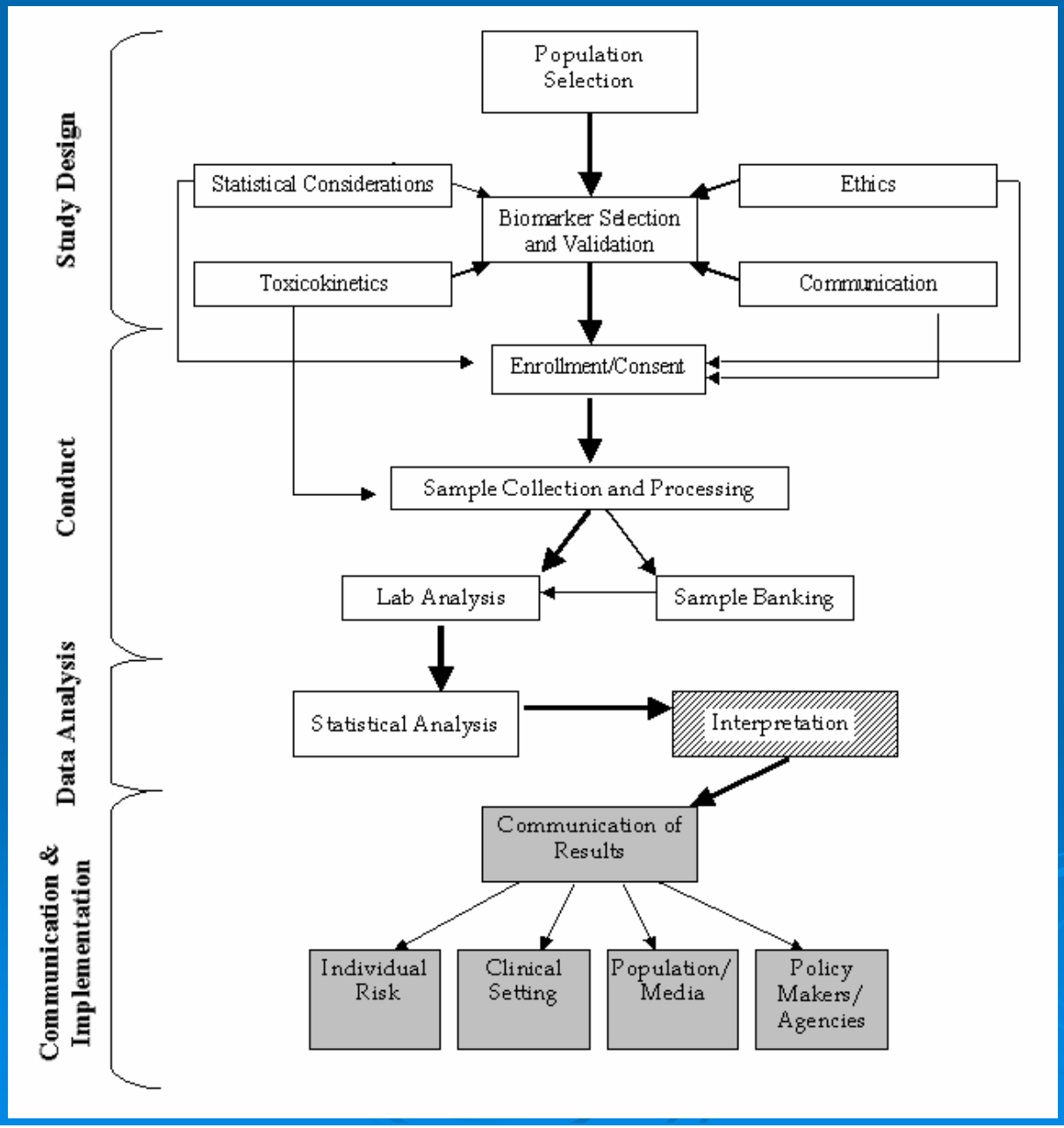
Framework for Characterizing Biomarkers

TABLE 3-1 Framework for Grouping Biomarkers of Exposure[a]

		Biomarker Group						
Properties of Biomarkers		I	II	III	IV	V	VI	VII
Reproducible sampling and analytic method			R	R	R	R	R	R
Known relationship of external dose to [BM] in animals[b]				R				
Known relationship of external dose to [BM] in humans[b]					R		R	R
Known relationship of [BM] to biologic effect in animals							O	
Known relationship of [BM] to biologic effect in humans						R		R
Known relationship of external dose to response in animals							O	
Known relationship of external dose to response in humans							O	
Biomarker informs about	Internal dose		√	√	√	√	√	√
	External dose[c]			√	√		√	√
	Biologic effects[d]					√	√	√
						Potential for risk assessment		

[a]Checkmark in lower portion of table means that biomarkers in group can inform about stated elements of dose and effect.
[b]Implies knowledge of pharmacokinetics of biomarker in relation to exposure to parent chemical.
[c]The relationship between external dose and internal dose may be influenced by metabolic polymorphisms and other factors, including socioeconomic status and racial and ethnic differences.
[d]Biologic effects may include a wide range of observations, from very early biochemical perturbations to clinical signs of alteration of health.
Abbreviations: [BM] = concentration of biomarker; R = required: O = optional (at least one of these is required).

Stages of Biomonitoring Study



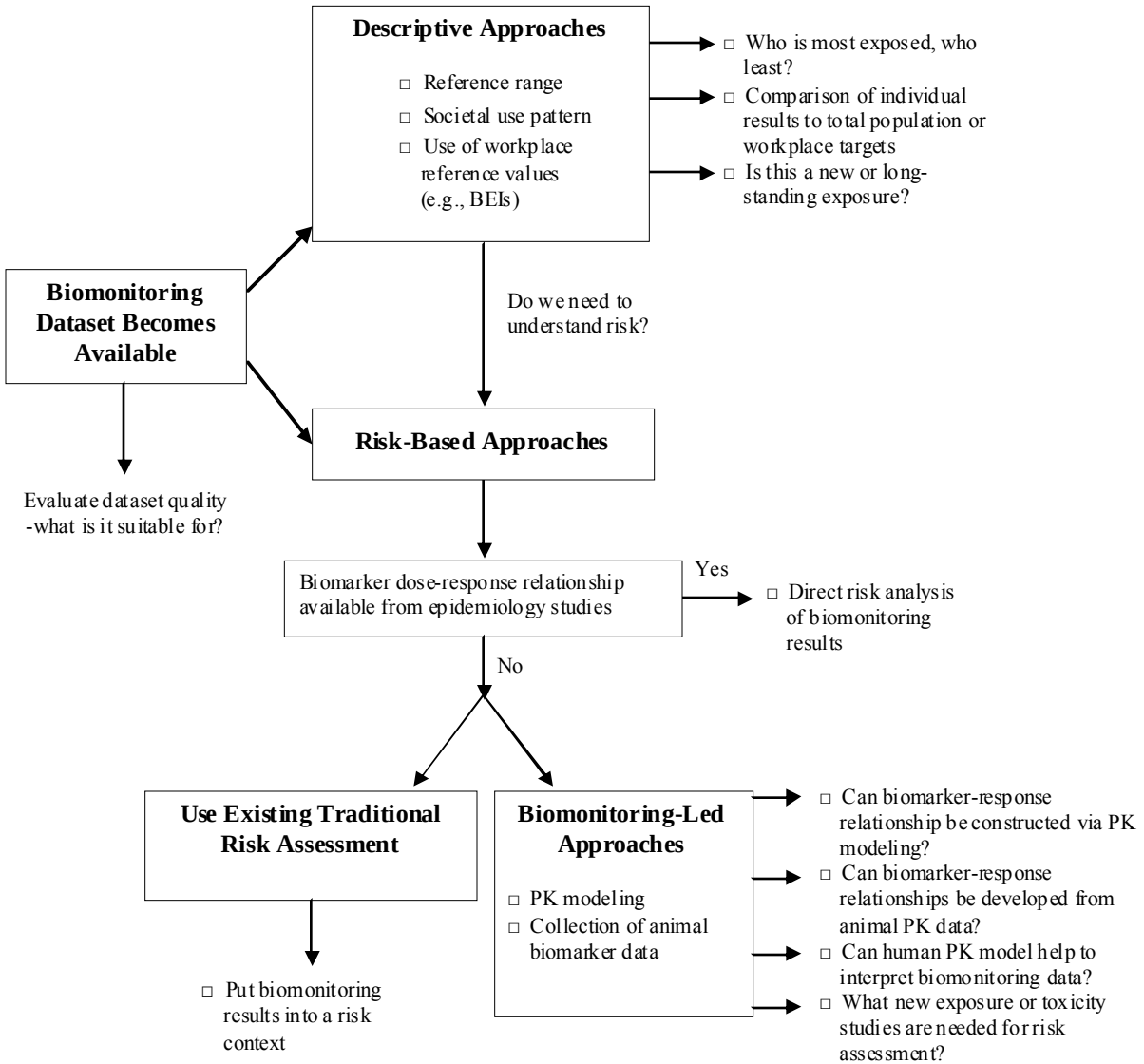
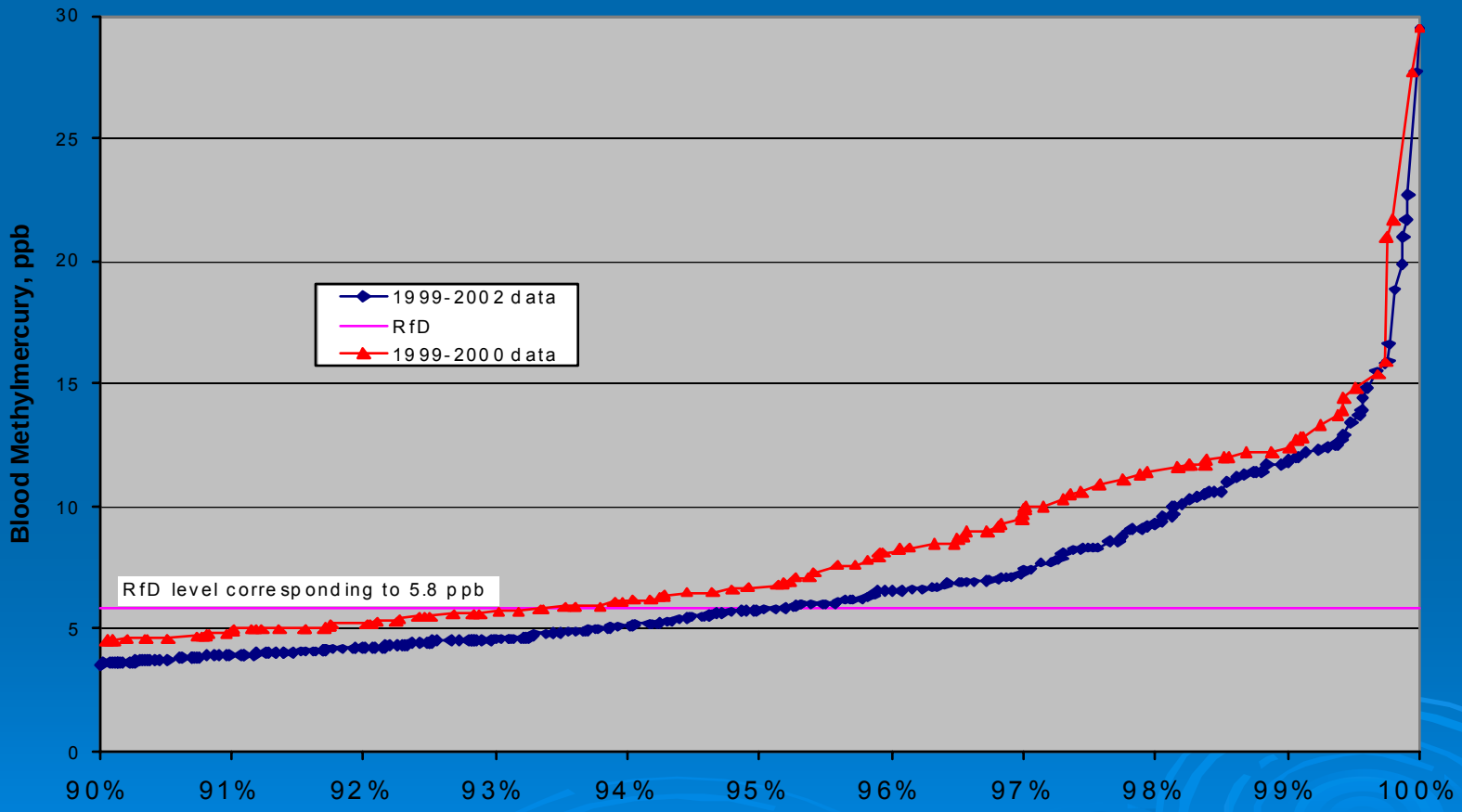


FIGURE 5-1 Overview of interpretive options for biomonitoring data.

Upper 10% of Exposure Distribution, US Women Ages 16-49, from NHANES 1999-2002 and 1999-2000



High Mercury Levels Found in One-Fourth of Adults

July 24, 2007 New York Times
By DIANE CARDWELL

One-quarter of adult New Yorkers, roughly 1.4 million people, have elevated levels of mercury in their blood, mainly from eating certain fish, according to survey results released yesterday by the city's Department of Health.

The survey, part of a comprehensive study of the health of city residents, found that blood mercury levels were highest among Asians, women and higher-income New Yorkers.

Truth is…

- In many cases our knowledge of public health implications will be very limited…
- Expectations for interpretation must be realistic
- This should not stop us from moving forward in understanding exposures

Expanding Applications of Biomonitoring

- National surveillance
- Risk assessment
- Worker protection
- State surveillance
- Epidemiologic investigations
- Community studies
- Individual clinical measures
- Advocacy
- Litigation
- New approaches to environmental health and protection?

Colgate toothpaste recalled in US

Mon, 18 Jun 2007 09:14:33

Colgate-labeled toothpaste sold in discount stores in the United States has been found to contain a toxic chemical called diethylene glycol.

The firm that makes the toothpaste was quick to distance itself from these products, calling them counterfeits.

Colgate-Palmolive said the firm "does not and would never use" diethylene glycol (DEG) - used in anti-freeze - as an ingredient.

Schwarzenegger OKs chemical exposure research

Fri Sep 29, 2006

- "There are literally thousands of chemicals being used in our everyday products in the United States in cleaning supplies, pesticides, cosmetics and more. It's important to know more about how those chemicals are building up in our bodies or how they may be affecting our health," Schwarzenegger said in a statement.

- "Bio-monitoring will do just that by shedding some light on our bodies, our environment and on public health," he added.

In Summary…

- Biomonitoring is already impacting our environmental health policies and the expansion of applications has profound implications for the future
- But, we have to get it right……
- To realize the full potential of biomonitoring as an environmental health tool will require:
  - Prioritizing biomarkers for development.
  - Support of epidemiologic, toxicologic, and exposure-assessment science to interpret biomonitoring data.
  - Improved communication of biomonitoring results.
  - Review of bioethical issues.
  - Enhancement of scientific infrastructure to support research.