Introduction to Preventive Medicine

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TWO BASIC ASPECTS OF MEDICINE

1. Biological and technological aspect

- **Biology**: studying the **structure and function** of tissues and organs in health and disease
- **Technology** - of examination of body structure and functions - **diagnosis**
  - of repairing defects and solving troubles - **therapy**

Object of the study (care) - an individual

Basic question: What are the health problems of Mr. .....

Methods: clinical

2. Social aspect

- **studying health as a mass phenomenon**

Object of the study (care) - group of people (**population**)
e.g. population of the ČR, inhabitants of Brno, schoolchildren in Prague etc.

Basic question: What are the health problems of the population of ....
Methods of diagnostics: epidemiology, statistics etc.

Methods of therapy: health programs

Medical disciplines dealing with the second aspect: public health, preventive medicine, social medicine, community health, epidemiology etc.

EPIDEMIOLOGY

The term is derived from three Greek roots (*epi* meaning upon, *demos* meaning people, and *logia* meaning study). It was originally applied to the study of outbreaks of acute infection diseases and was defined as the science of epidemics.

Definition: Epidemiology refers to the study of the distribution and determinants of diseases or conditions in a defined population.

Epidemiology is based on two fundamental assumptions:

Diseases do not occur by chance

Diseases are not distributed randomly in the population

- Thus, their **distribution indicates** something **about how and why** that disease process occurred.

Historical notes

Hippocrates (c. 460-370 BC)**: environmental factors can influence the occurrence of disease**

Not much progress during the middle age

Some correct measures: isolation of the sick, burning of contaminated objects

No knowledge about causes of the spreading

It was not until the 19th century that the distribution of disease in human population groups has been measured
> onset of modern epidemiology

John Snow (1813-1858), a physician in London, in the time of severe epidemics of cholera (1848, 1853 etc.)

Commonly accepted theory about the cause at that time:

„miasma“ – something in the air („all smell is disease“)

John Snow doubted about that miasma theory
He noticed that the distribution of the disease in the town was not regular: different density of cases in different streets or localities

On a map of London, he located the home of each person who died from cholera in 1848-49 and 1853-54 epidemics

He saw no associatons with polluted air, elevation above sea level, weather and season, social status etc.

He found an apparent association between the source of drinking-water and the deaths (see the table)

CHOLERA MORTALITY IN LONDON IN THE 4 WEEKS ENDING AUGUST 5, 1854

Water Company	Houses Supplied	Deaths in 4 weeks	Rate per 10 000 houses
Southwark and Vauxhall	40 046	286	71
Lamberth	26 107	14	5
All others	287 345	277	9

He proposed the hypothesis about the communication of infectious diseases in general and

> suggested that cholera was spread by contaminated water

30 years before Koch isolated and identified the cholera vibrio

Ignaz Semmelweis (1818-1865), **Hungarian physician, head of Obstetrical Clinic in Vienna (since 1847)**

Puerperal sepsis („puerperal fever“, „childbed fever“) was common in mid-19th-century hospitals
-mortality at 10% to 35%,
-much more than with deliveries at home (or preterm in the street)
-causes not known, believed to be non-preventable

Semmelweis studied the occurrence of cases according to place and time:

two obstetric clinics : mortality in I. Clinic 13,1%, II. Clinic 2,03%

in the same hospital, the same techniques used

Only difference: education of students in the I., of midwives in the II.

Much less cases in summer, in the time of vacations

Semmelweis noticed in autopsies that pathological findings in puerperal sepsis were very similar to the findings in the sepsis after the injury in the dissecting room (1848)

He immediately proposed a connection
cadaveric contamination → puerperal fewer
the students carried some „cadaveric material“ on their hands

The discovery of pyogene streptococcus considerably later: Pasteur 1879, Rosenbach 1884

Semmelweis instituted a policy of using a solution of chlorinated lime for washing hands and later also instruments and bandage

Incidence of puerperal fever: 12,24% → 1,25%

NB: only exact observation, records and their analysis

Goals of epidemiology

- **Identify factors that cause disease or disease transmission**

- **Prevent the spread of communicable and non-communicable diseases and conditions**

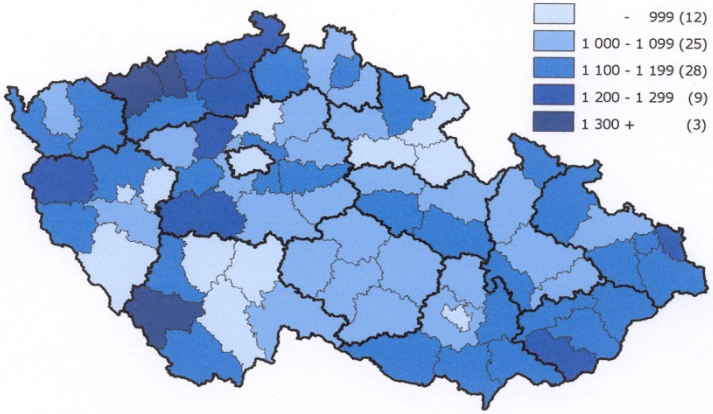
Types of **epidemiologic studies**

1. **Descriptive**
2. **Analytic**

Descriptive studies

describe the distribution of cases by the variables of person, place, and time in order to study and describe acute outbreaks of disease, to follow secular trends of disease occurrence over time, and to develop hypotheses about disease transmission.

Standardizovaná úmrtnost mužů
Standardized mortality rate in males



Standardizovaná úmrtnost žen
Standardized mortality rate in females

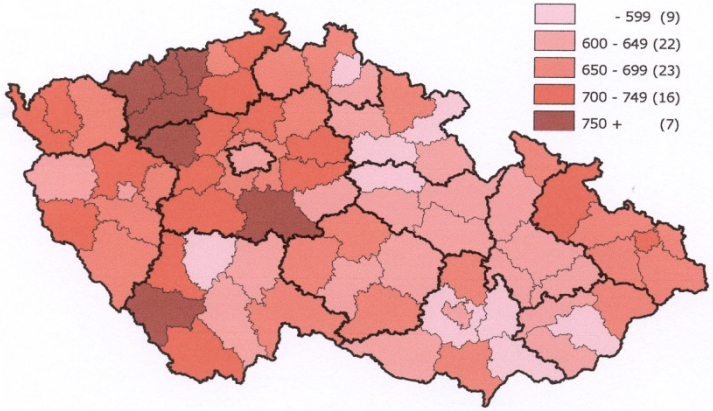
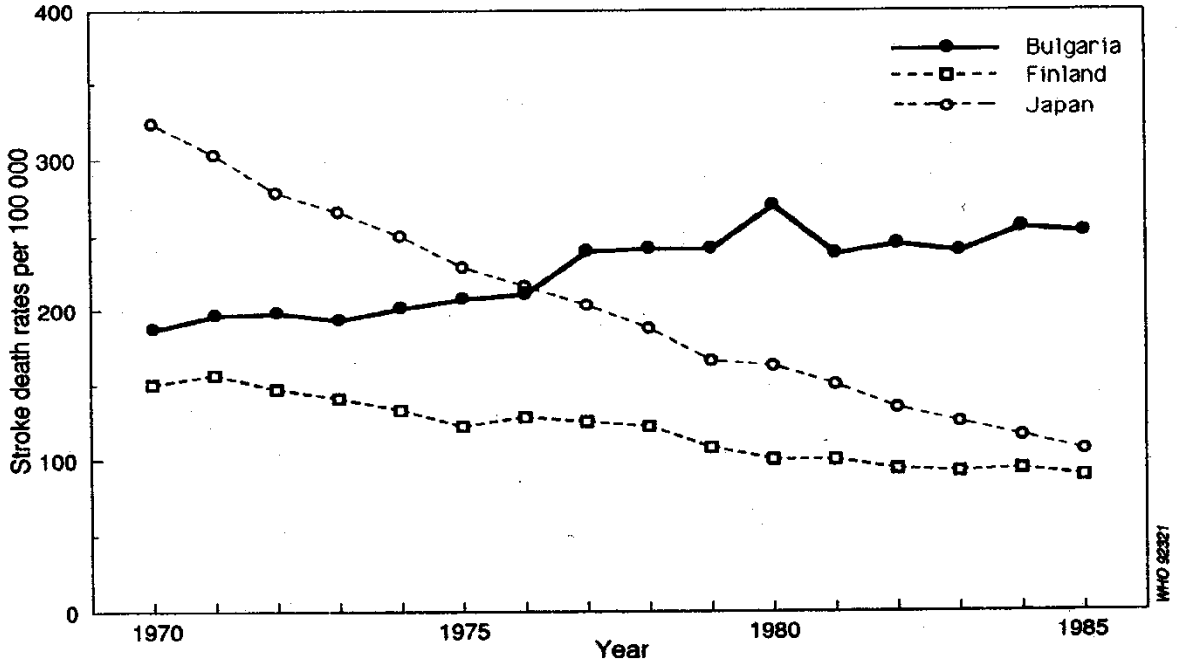


Fig. 3.2. Age-standardized death rates from stroke among men aged 40–69, three countries, 1970–1985



Source: Bonita et al., 1990.

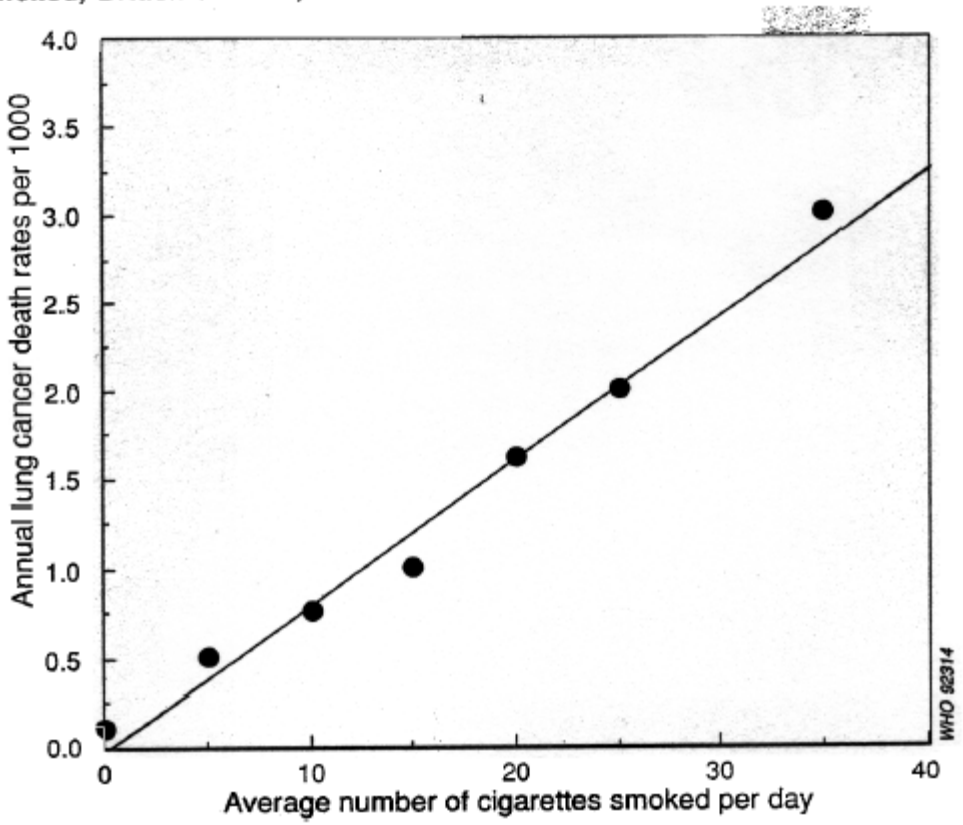
Analytic studies

a) Observational

such as the *retrospective* (case-control) studies and the *prospective* (cohort) studies, identify causal relationships or factors associated with disease. In most cases, analytic studies do not prove cause and effect, but there are used to generate hypotheses that can be tested.

b) Experimental

Fig. 1.1. Death rates from lung cancer (per 1000) by number of cigarettes smoked, British doctors, 1951–1961



Source: Doll & Hill, 1964. Reproduced by kind permission of the publisher.

Experimental studies

are carefully designed to prove an association between a factor and disease outcome

- e.g. vaccine field trials and clinical studies that evaluate therapy

- giving vitamins, antioxidants etc. and studying the preventive effect

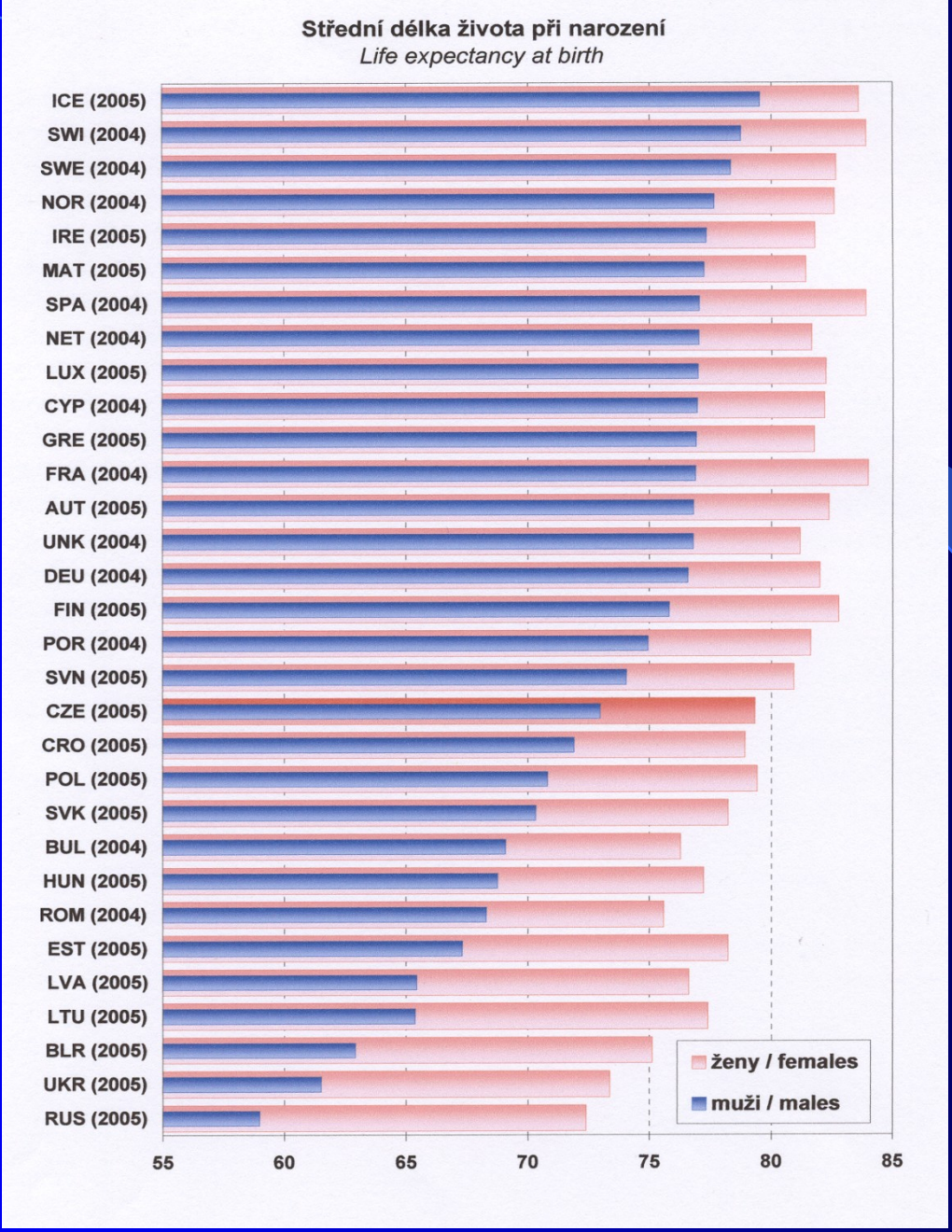
Placebo controlled double blind test

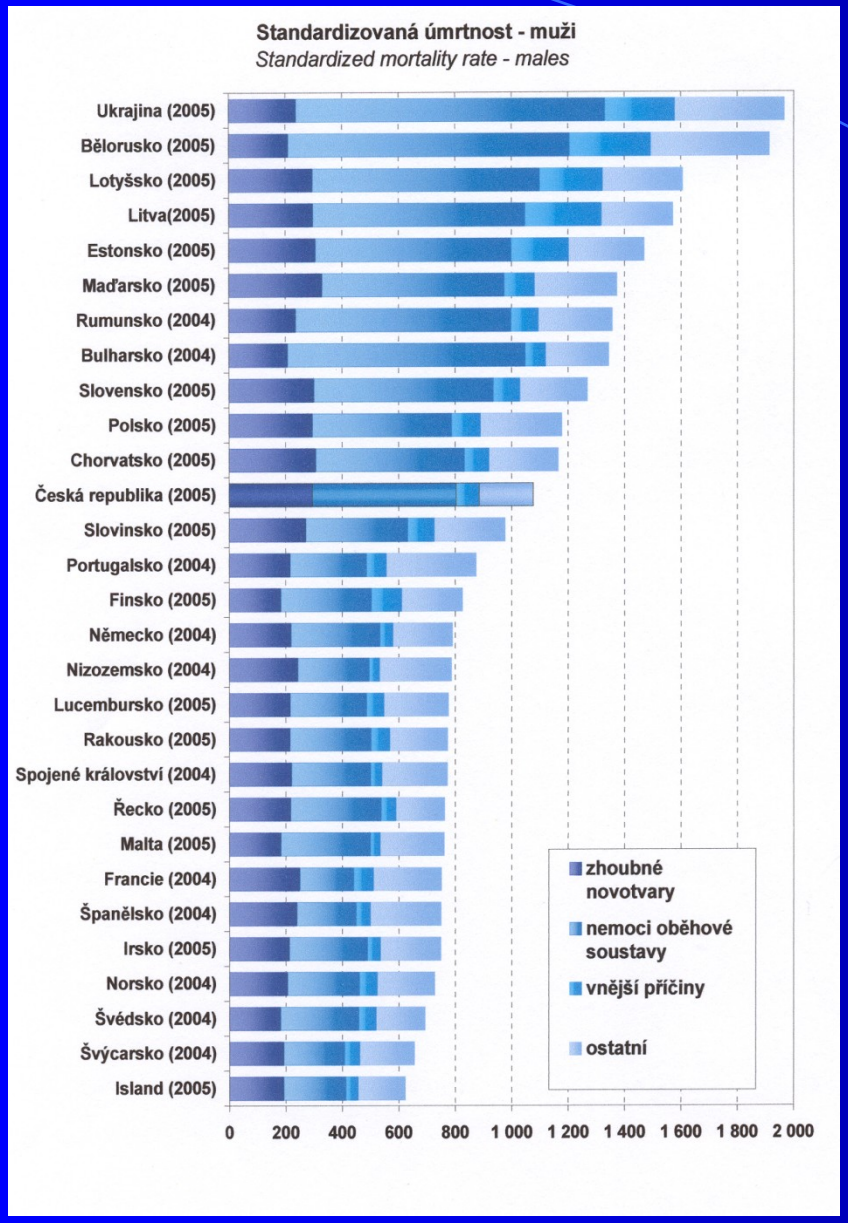
Tools for measuring health status of a population

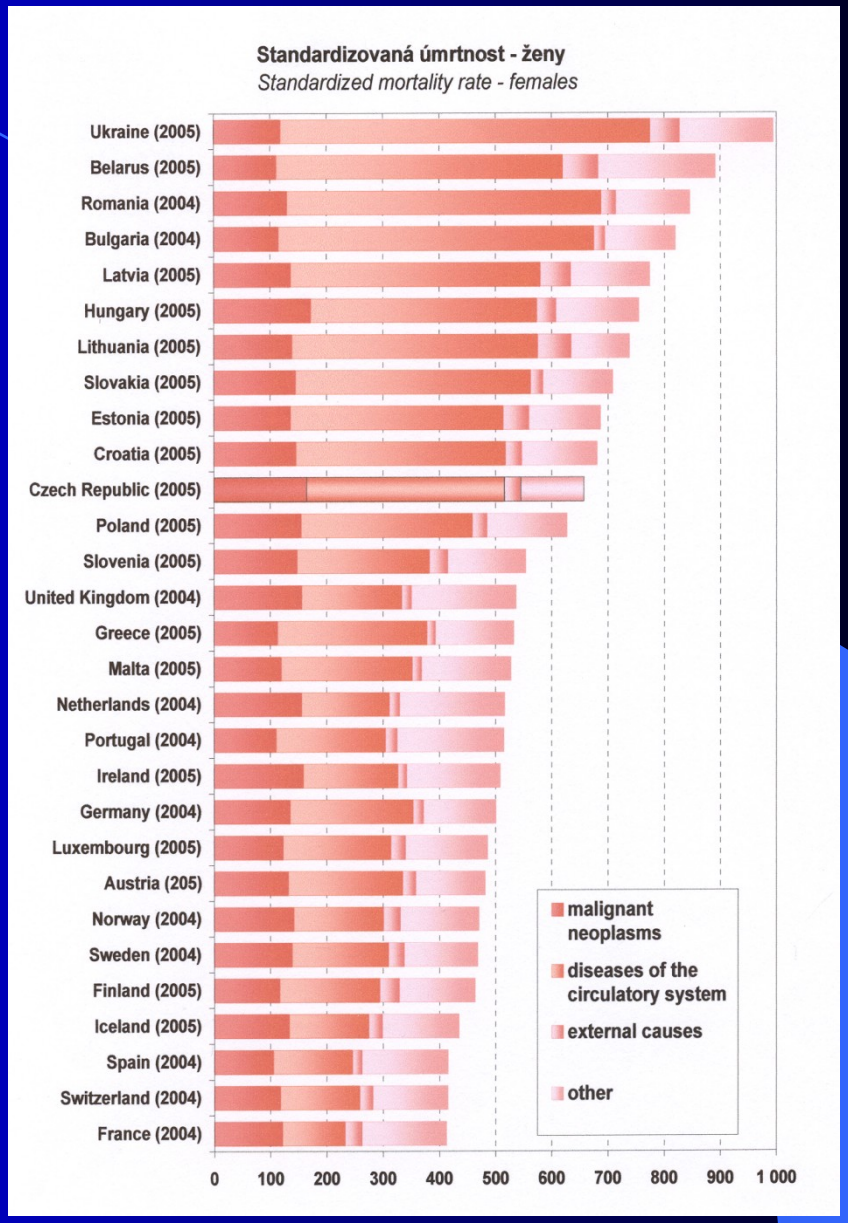
- **Mortality**
  - standardized mortality ratio (SMR), mortality in the productive age, years of potential life lost (YPLL)
  - life expectancy (at birth)
- **Morbidity** - prevalence
  - incidence

Life expectance at birth in Europe

- **Great differences** amongst countries
  - levels
  - trends
- **ČR needs to improve** its position amongst European countries
  - stress on prevention


Střední délka života při narození
Life expectancy at birth
ICE (2005)
SWI (2004)
SWE (2004)
NOR (2004)
IRE (2005)
MAT (2005)
SPA (2004)
NET (2004)
LUX (2005)
CYP (2004)
GRE (2005)
FRA (2004)
AUT (2005)
UNK (2004)
DEU (2004)
FIN (2005)
POR (2004)
SVN (2005)
CZE (2005)
CRO (2005)
POL (2005)
SVK (2005)
BUL (2004)
HUN (2005)
ROM (2004)
EST (2005)
LVA (2005)
LTU (2005)
BLR (2005)
UKR (2005)
RUS (2005)
55
60
65
70
75
80
85
ženy / females
muži / males

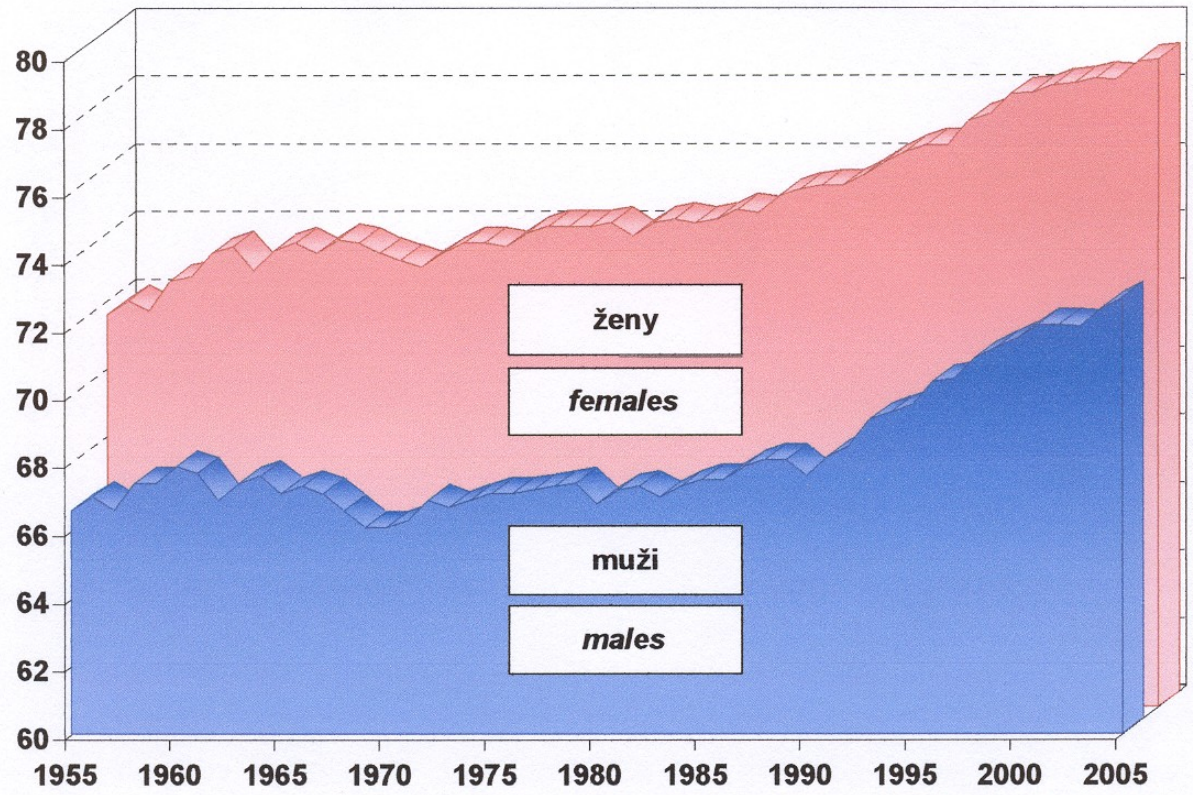

Standardizovaná úmrtnost - muži
Standardized mortality rate - males
Ukrajina (2005)
Bělorusko (2005)
Lotyšsko (2005)
Litva(2005)
Estonsko (2005)
Maďarsko (2005)
Rumunsko (2004)
Bulharsko (2004)
Slovensko (2005)
Polsko (2005)
Chorvatsko (2005)
Česká republika (2005)
Slovinsko (2005)
Portugalsko (2004)
Finsko (2005)
Německo (2004)
Nizozemsko (2004)
Lucembursko (2005)
Rakousko (2005)
Spojené království (2004)
Řecko (2005)
Malta (2005)
Francie (2004)
Španělsko (2004)
Irsko (2005)
Norsko (2004)
Švédsko (2004)
Švýcarsko (2004)
Island (2005)
0
200
400
600
800
1 000
1 200
1 400
1 600
1 800
2 000
zhoubné novotvary
nemoci oběhové soustavy
vnější příčiny
ostatní


Standardizovaná úmrtnost - ženy
Standardized mortality rate - females
Ukraine (2005)
Belarus (2005)
Romania (2004)
Bulgaria (2004)
Latvia (2005)
Hungary (2005)
Lithuania (2005)
Slovakia (2005)
Estonia (2005)
Croatia (2005)
Czech Republic (2005)
Poland (2005)
Slovenia (2005)
United Kingdom (2004)
Greece (2005)
Malta (2005)
Netherlands (2004)
Portugal (2004)
Ireland (2005)
Germany (2004)
Luxembourg (2005)
Austria (205)
Norway (2004)
Sweden (2004)
Finland (2005)
Iceland (2005)
Spain (2004)
Switzerland (2004)
France (2004)
0
100
200
300
400
500
600
700
800
900
1 000
malignant neoplasms
diseases of the circulatory system
external causes
other

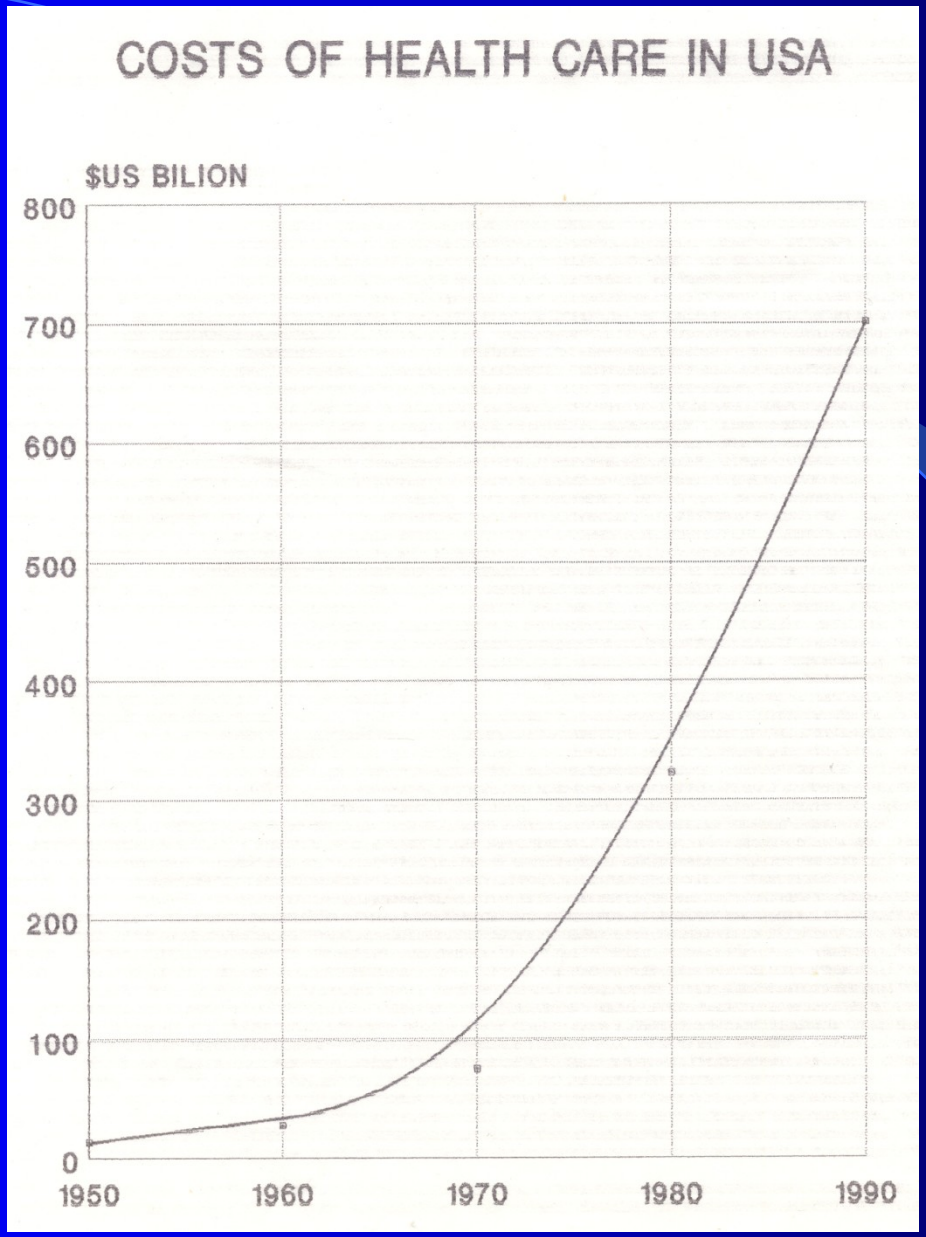
Causes of the health differences amongst European countries

- Nutrition?
- Smoking?
- Obesity? Hypokinesis?
- Stress?
- Polluted environment?
- Health care quality?

ZDRAVOTNICKÁ ROČENKA ČR 2005 / CZECH HEALTH STATISTICS 2005



- **Necessity of better prevention is felt also in affluent countries**
  - **reason: rapidly growing expenses on health care**
  - **eg. USA: Program Healthy People 2000**


COSTS OF HEALTH CARE IN USA
$US BILION
800
700
600
500
400
300
200
100
0
1950
1960
1970
1980
1990

Determinants of National Health:

- **life style** (nutrition, autoagression, stress, work and rest, health habits)
- **environment** (regional, local, professional, individual)
- **health care**

Health Programmes

- „Postinfectious era“
- First Health Programs: North Karelia etc.
- Types of programmes
  - disease approach
  - factor approach
  - settings approach („Healthy City“, „Healthy School“ etc.)

Complex Programs

- **Health for All 2000, HFA 21**
- **Healthy People 2000 Healthy People 2020**
- **National Programs**

PREVENTIVE MEDICINE

Preventive Medicine is the branch of medicine that concentrates on keeping people well.

Goals of Preventive medicine

a. Disease prevention deals with techniques that **prevent the occurrence** of disease (physical, mental, or emotional) or lead to an **early diagnosis** where therapy may cure, prevent, or modify the progression of disease.

b. Health promotion deals with techniques that **foster physical and emotional well-being** and increase the length and quality of life. It deals with the fact that many diseases are not caused by unknown or unpredictable factors, but by personal, **modifiable lifestyle habits**. Modifying a few lifestyle habits, such as poor diet, infrequent exercise, unprotected sexual intercourse, lack of prenatal care, failure to use seat belts, and the use of tobacco, alcohol, and drugs, could reduce one-third of all cases of acute disability, two-thirds of all cases of chronic disability, and 40% - 70% of premature death.

Levels of prevention

a) primary, b) secondary, c) tertiary

a. Primary prevention is the prevention of disease or injury. Primary prevention activities can be directed at individuals or at the environment.

(1) Health education: encouraging people to develop good health habits (nutrition, exercise), to avoid harmful substances (alcohol, tobacco, drug abuse) and harmful circumstances (driving while intoxicated) and to use specific protective measures (e.g., immunizations, condom use).

(2) Environmental modification can decrease injuries from falls, fires, or automobile accidents. Environmental sanitation is used to provide an adequate sewage system, safe drinking water, clean air, and environment free of toxic substances.

b. Secondary prevention

is the early detection and prompt treatment of disease.

(1) Screening programs are used to detect diseases in early preclinical stages, when effective therapy may either cure the disease or limit its progression (e.g., neonatal detection of phenylketonuria, the Pap test to detect in situ carcinoma of the cervix, glaucoma testing).

(2) Primary medical care is the predominant form of secondary prevention. Most health expenses are spent on, and most health care personnel are employed in, primary care.

c. Tertiary prevention is the limitation of disability and the rehabilitation from disease. It emphasizes a person's remaining abilities and attempts to restore the person to as normal a life as possible.

Epidemiology and prevention of infectious diseases

- Elimination of disease-causing **agent:** **desinfection, sterilization, chlorination, pasteurization etc.**
- Control of the **reservoir:** **isolation, quarantine, chemotherapy, animals (wild animals, pets), mosquitoes etc.**
- Control of the **transmission:** ***direct*** **transmission (hand washing, individual towels, condom use etc.),** ***indirect*** **transmission (air, water, food, arthropod vectors - mosquitoes, mites, ticks),**
- Protection of the **susceptible host:** **(immunization, chemoprophylaxis, good health habits etc.)**

Epidemiology and prevention of chronic illnesses

Most important:

Heart disease, Cerebrovascular disease

Cancer

Chronic obstructive pulmonary disease

Cirrhosis

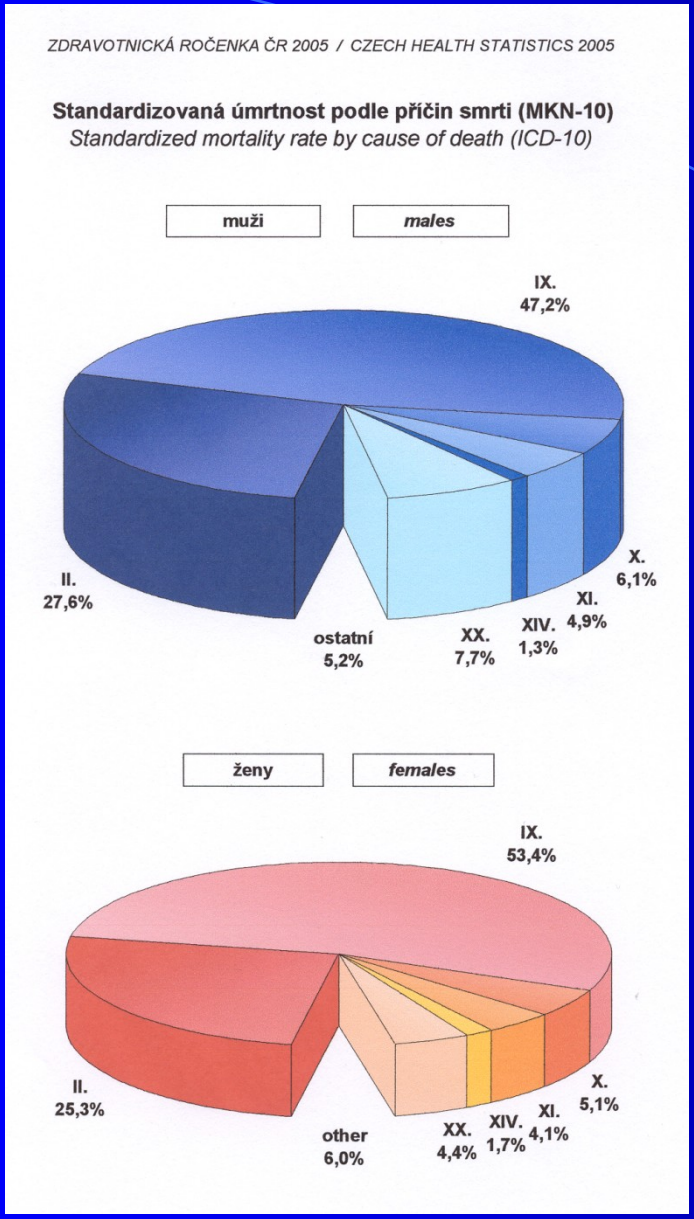
Diabetes

Renal Disease

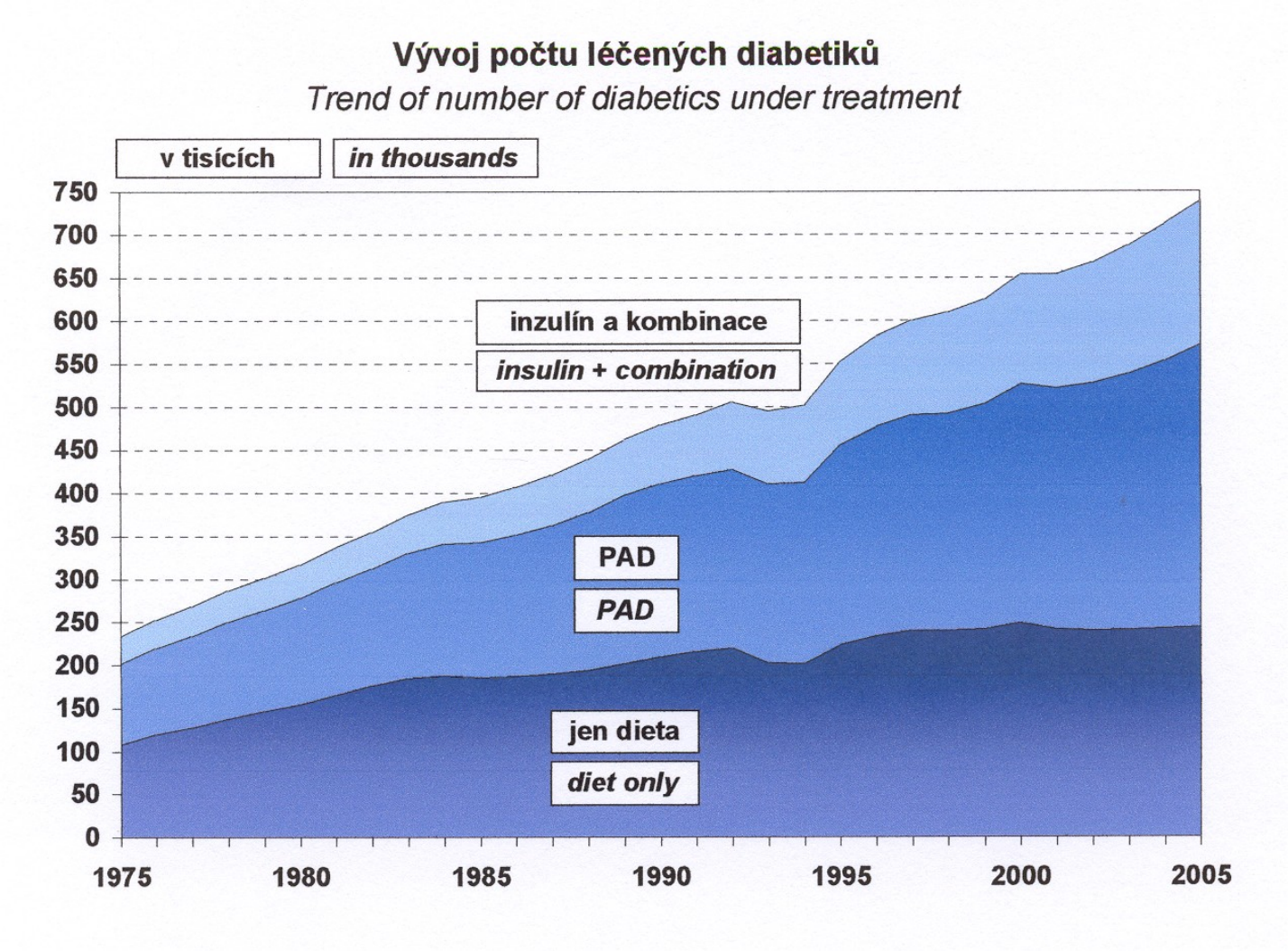
Anaemia

Peptic ulcer

Osteoporosis etc.



- II. Neoplasms
- IX. Circulatory system
- X. Respiratory system
- XI. Digestive system
- XIV. Genitourinary system
- XX. External causes
  (injury, poisonings)



PAD … Peroral antidiabetics (derivatives of sulphonilurea, biguanides etc.)

Branches of preventive medicine

Environmental health

Basic problems:

- Air pollution (ambient air, indoor air)
- Water pollution, water supply, drinking water
- Food contaminants
- Noise
- Radiation
- Wastage, sewage

In continental Europe: Hygiene

NEW ISSUES – SOME INSTANCES

Endocrine disruptors

= exogenous substances that interfere with the endocrine system and disrupt the physiologic function of hormones

Some of them block the cell receptors, others stimulate or inhibit the endocrine system

They have adverse biological effects in animals
- adverse developmental and reproductive effects on fish and wildlife
- **Modulation of reproductive endocrinology, adrenal, thyroid, and growth hormone function**

Rising concerns that low-level exposure might cause similar effects in human beings

Xenoestrogens mimic the hormone action of estrogens
(xenos = foreign)

Diethylstilbestrol (DES),

a drug that for years had been prescribed to women to prevent miscarriage

In the 1970s, its hormonal toxicity was discovered

- later causing cancer and infertility in some of the children of these mothers

Other endocrine disruptors

phtalates – chemicals used in plastics > mouthing toys for children, plastic tubing in medical devices

bisphenol A (BPA) used in manufacture of plastics and epoxy resins (rezin)

food can liners, food storage containers, baby bottles, water supply pipes, dental resins.

The alone United States produces 700 000 kg BPA annually, nowadays is found in stream water, in adult´ s blood, in amniotic fluid, and placental and fetal tissues –lifelong exposure may be hard to avoid

Dioxins (polychlorinated dibenzodioxins), PCBs (polychlorinated biphenyls), PAHs (polycyclic aromatic hydrocarbons)

furans, phenols,

several pesticides (also DDT dichloro- diphanyl trichloroethane)

17- beta ethynilestradiol (the contraceptive pill)

genistein –phytoestrogen found in soy

etc. - a long list.

Nanotoxicology

Nanotechnology

= using engineered materials with diameters of < 100 nm (size of molecules and atoms)

For comparison, typical carbon-carbon bond length, or a spacing between these atoms in a molecule, are in the range 12 – 15 nm and DNA double-helix has a diameter around 2 nm.
The smallest bacteria of the genus Mycoplasma are around 200 nm in length.
2g of 100 nm diameter nanoparticles contains enough material to provide every human worldwide with 300 000 particles each.

Materials reduced to the nanoscale can suddenly show very different properties compared to what they exhibit on a macroscale, enabling unique applications.
For instance:

- **opaque substances become transparent (copper)**
- **inert materials become catalysts (platinum)**
- **stable materials turn combustible (aluminium)**
- **solids turn into liquids at room temperature (gold)**
- **insulators become conductors (silicon)**

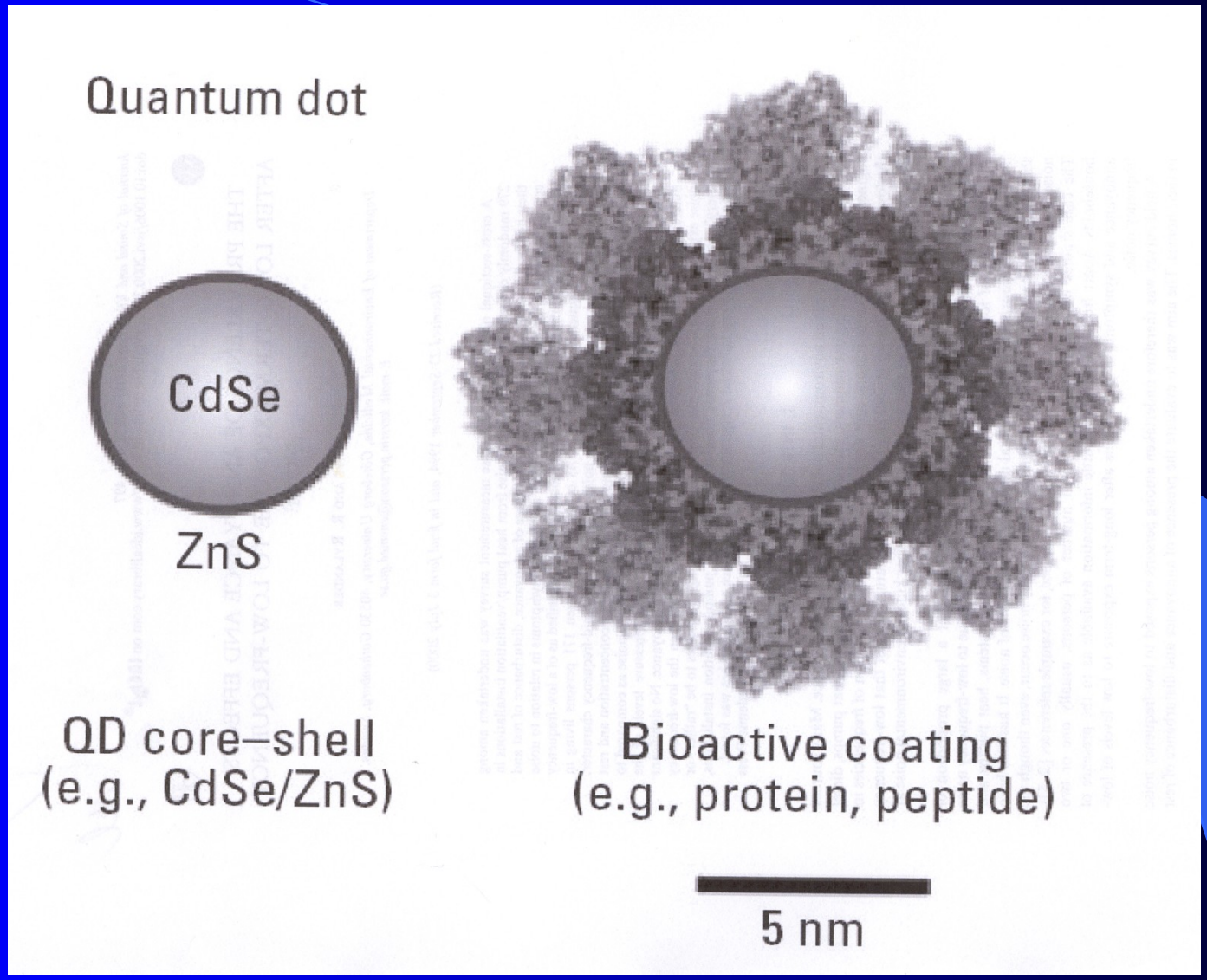
Widespread applications in medicine, plastics, energy, electronics (molecule sized transistors, chips, PCs), aerospace etc.
„The biggest engineering innovation since the Industrial Revolution“

In medicine: *in vivo* biomedical imaging, disease diagnoses, drug targeting, cancer treatment

"Quantum dots" (QD) – semiconductor nanocrystals (2 – 100 nm) with unique optical and electrical properties.

Their fluorence spectrum renders them optimal fluorophores for biological imaging. Fluorescent QDs can be conjugated with bioactive moieties (e.g. antibodies, receptor ligands) to target specific biologic events and cellular structures, such as labeling neoplastic cells. They are being explored as tools for site-specific gene and drug delivery.

Combination of their crystalline metalloid core structure and a "cap" or "shell" that shields the core and renders the QD biovailable


Quantum dot
CdSe
ZnS
QD core–shell
(e.g., CdSe/ZnS)
Bioactive coating
(e.g., protein, peptide)
5 nm

The worldwide market for production using nanotechnology is estimated to reach US$ 1 trillion by 2012.

Nanoproducts are sold by more than 200 companies globally (electronic, cosmetic, suntan lotions, protective coatings, stain resistant clothing).

These materials in society will be increasing, as will the likelihood of exposures.

Exposure through inhalation, ingestion, skin uptake and injection.

Potential adverse human effects

New discipline – nanotoxicology. Studies of absorption, distribution, metabolism, excretion and toxicity of nanoparticles.

Occupational health (1)

Possible impacts:

death

disease

impairment (the objective description of the loss of function of the human body)

disability (the effect of an impairment on the ability of an individual to function in the society)

Occupational health (2)

Potential hazards

Metals (arsenic, cadmium, chromium, lead, mercury etc.)

Solvents (aliphatic and aromatic hydrocarbons, alcohols, glycols, esters, halogenated hydrocarbons etc.)

Dusts (asbestos, coal, silica, organic dusts etc.)

Pesticides: Insecticides (organophosphorous compounds, organochlorine compounds - e.g. DDT, etc), fungicides (organic mercury compounds), herbicides etc.

Asphixiant gases (carbon monoxide, hydrogen cyanide etc.)

Physical stressors (noise, vibration, heat, cold, injury)

Radiation (ionizing, ultraviolet)

Biologic hazards (brucellosis, tularaemia, leptospirosis, hepatitis, fungal diseases etc.)

Community health

Epidemiolody and prevention of injuries

Mental health

etc.

Thank you
for your

attention