



# Advances in Biomedical Research at Comenius University Bratislava

Vladimír Kováč

Faculty of Natural Sciences, Comenius University  
Bratislava, Slovakia

# What is biomedicine?

Biomedicine is a branch of medical science that applies biological and other natural-science principles to clinical practice


Biomedicine draws from a number of disciplines, e.g. anatomy, physiology, genetics, pathology, zoology, botanical sciences, chemistry, biochemistry, microbiology, etc...

# What is biomedicine?

There are two main areas of research within biomedicine:

preclinical research and clinical research

Preclinical research is a large field of biomedicine that handles everything leading up to the actual clinical trials of new techniques and treatments.



# Biotech/Biomedicine Projects (mostly Structural funds EU) at Comenius University



# Center of Competence for Molecular Medicine at Comenius University

08/2011- 11/2014

Main aim: to build up a center of competence  
to support applied R&D in molecular medicine

private and public sector  
(12 partners)





# Center of Competence for Molecular Medicine at Comenius University

This center joins top research institutions in Slovakia  
to develop transfer of knowledge to clinical practice in  
the field of diagnostics and therapy of serious human  
diseases

genomics, proteomics, metabolomics and  
bioinformatics

**predictive and personalized human diagnostics**



# Centers of excellence at Comenius University Faculty of Natural Sciences

Biomakro1 (05/2009 – 10/2011)

information biomacromolecules applied to prevent  
diseases and to improve the quality of life

infrastructure for R&D in molecular biomedicine  
**diagnostics, therapy** and bioinformatics

Biomakro2 (02/2010 – 01/2013)



# Centers of excellence at Comenius University Faculty of Natural Sciences

Transmed1 (05/2009 – 4/2011)  
translation research in molecular medicine

to improve infrastructure for research of molecular  
mechanisms of human diseases and to transfer new  
knowledge into clinical medicine

Transmed2 (06/2010 – 05/2012)





# Centers of excellence at Comenius University Faculty of Natural Sciences

Biorekprot (11/2010 – 10/2013)

Production of biologically active agents based on  
recombinant proteins

cooperation with private industrial sector  
infrastructure for applied research in production of  
**recombinant proteins with therapeutical potential**



# Centers of excellence at Comenius University Faculty of Natural Sciences

Revogene (03/2011 – 02/2014)  
Research center for molecular genetics

Common research center of GENETON s.r.o. and the  
academic project partner

**complex analysis of human genome, exome,  
transcriptome, also metagenomics**

Vladimír Kováč  
Faculty of Natural Sciences, Comenius University



# Centers of excellence at Comenius University Faculty of Natural Sciences

Rekprotein (06/2010 - 05/2013)

Industrial research of new drugs based on recombinant  
proteins

**industrial pharma research**

(heterologous expression and purification of  
recombinant proteins with therapeutical potential)

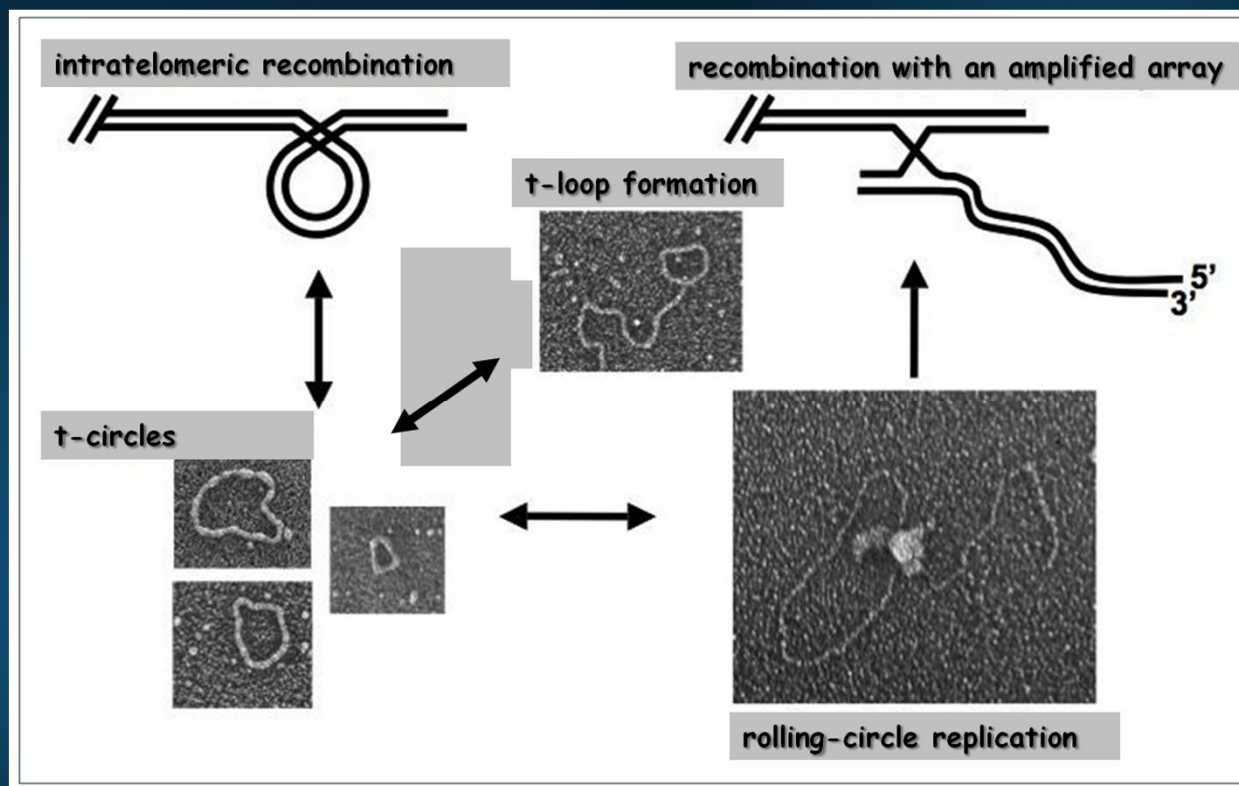


# Further Research Activities Comenius University Faculty of Natural Sciences

Vladimír Kováč  
Faculty of Natural Sciences, Comenius University



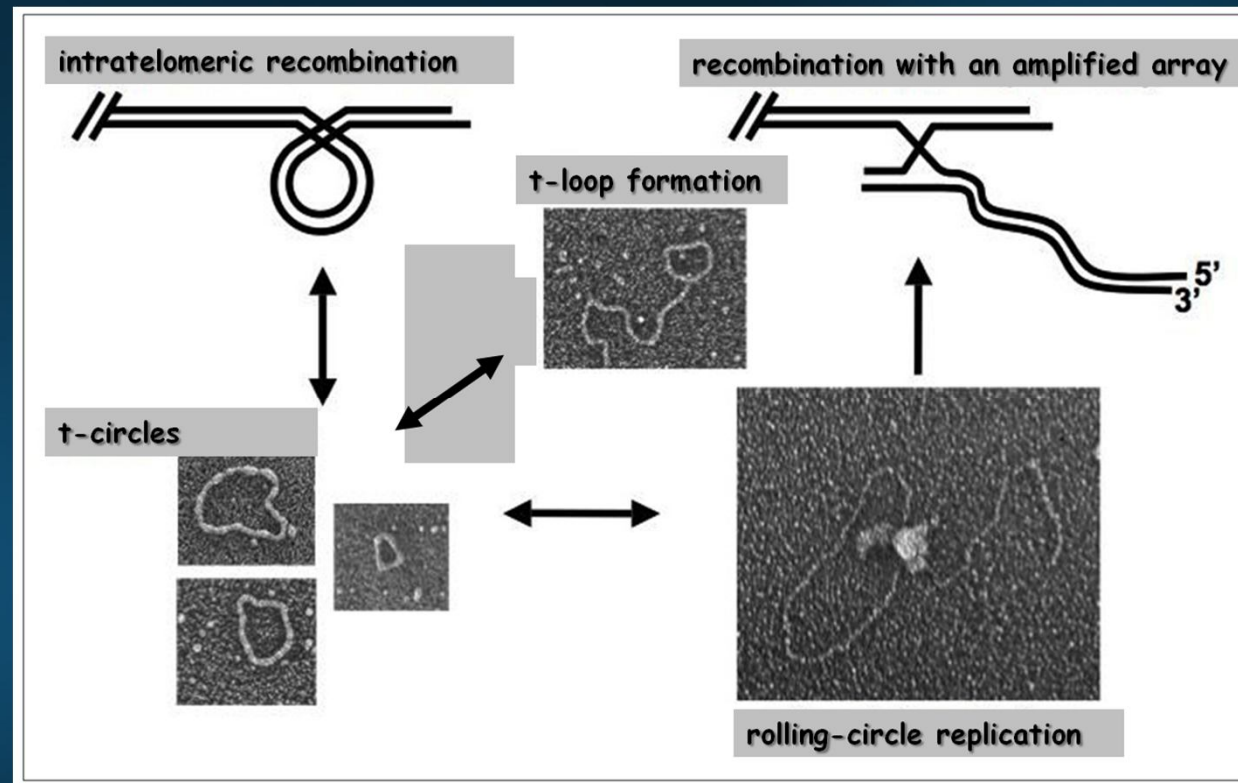
# Laboratory for comparative and functional genomics





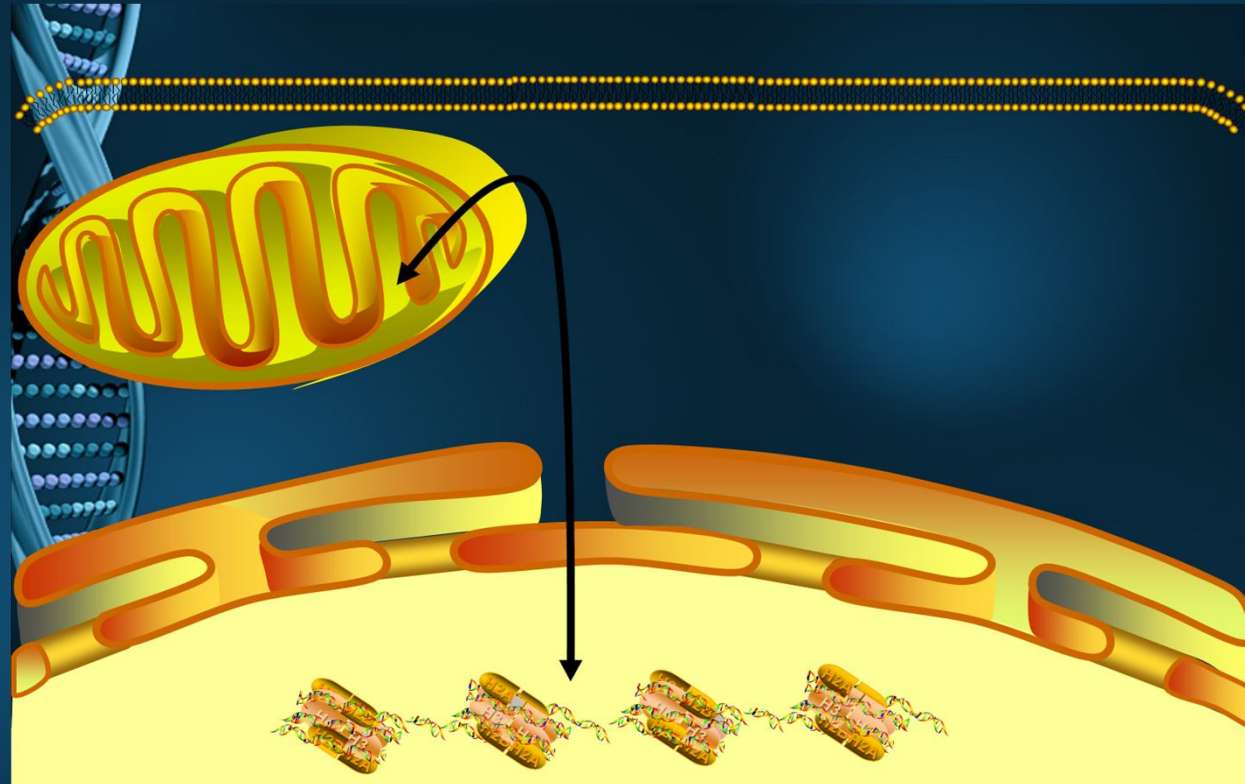
## Transactions at the ends of linear chromosomes

(important for maintaining genomic stability)



**Implications: oncogenesis, aging**

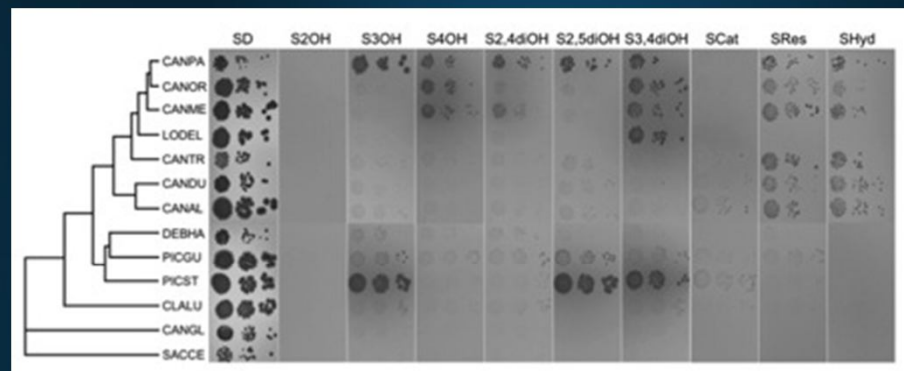
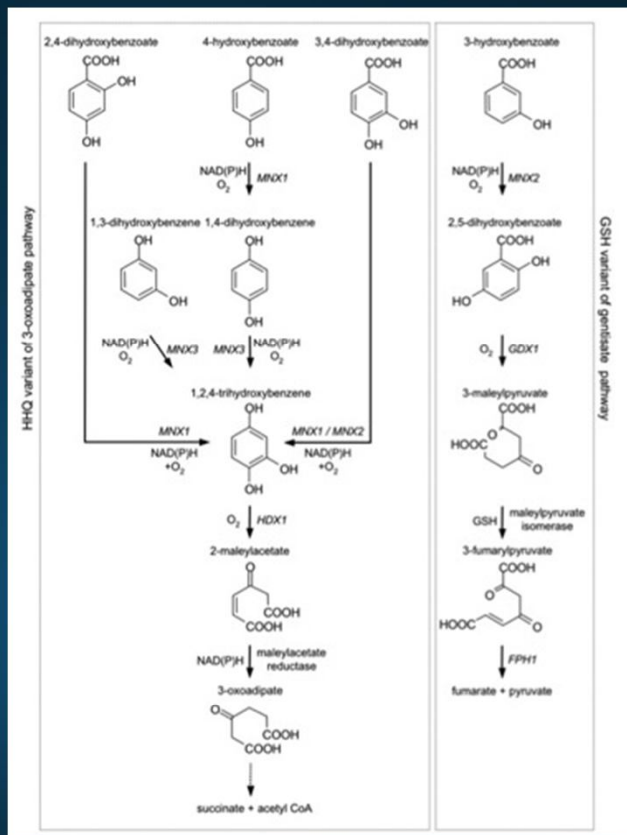
## communication between cellular organelles (essential for proper functioning of each cell)



**Implications: unlimited (basic research)**

Laboratory for comparative and functional genomics

## Functional analysis of yeast genes involved in degradation of phenolic compounds (hydroxybenzenes and hydroxybenzoates)



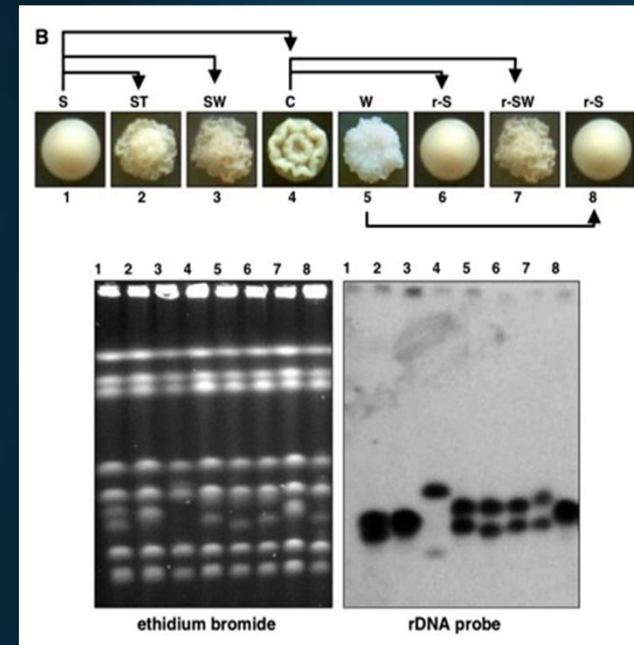
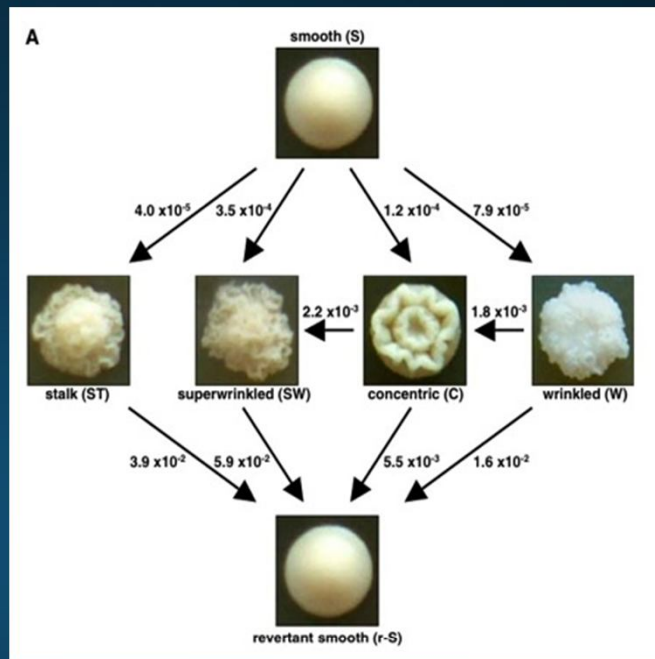
**Implications: Potential to apply the pathways in biotechnology and/or bioremediations of phenol contaminated substrates**



Laboratory for comparative and functional genomics

## Molecular mechanisms in cell and colony morphology of yeasts

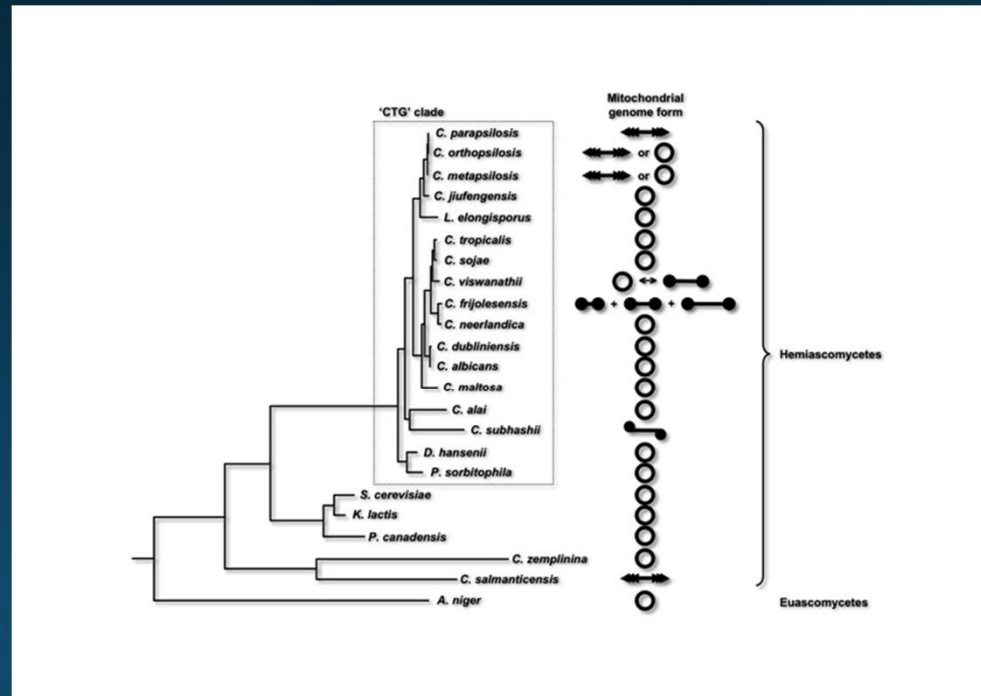
(Processes of dimorphic transition play a key role in virulence of pathogenic yeasts)



**Implications: therapeutic interventions against fungal pathogens (e.g. *Candida* spp.)**

Laboratory for comparative and functional genomics

## Comparative analysis of complete mitochondrial genomes of yeast species from the CTG clade



### Implications:

1. natural telomerase-negative pathways of telomere maintenance (oncogenesis, aging)
2. identification of pathogenic species (e.g. *Candida* spp.) in clinical samples



# Computational Biology @ Faculty of Mathematics, Physics and Informatics

## 1. Computational analyses of biological data:

- Searching for genes
- Evolution of genes and gene clusters
- Bioinformatics of mitochondrial genomes
- Contributions to international genome sequencing projects

## 2. Development of new methods and software:

- Algorithmic improvements of probabilistic models for sequence analysis
- Improved algorithms for homology search



Laboratory for comparative and functional genomics

## Recent projects and international collaboration

Gene prediction in human parasite *Schistosoma japonicum*  
with Chinese Human Genome Center at Shanghai

Positive selection in giant panda genome  
with Beijing Genomic Institute and Veterinary University Vienna

Positive selection and evolution of gene families in orangutan  
genome  
with the Genome Institute at Washington University



Laboratory for comparative and functional genomics

## Recent projects and international collaboration

Evolutionary histories of biomedically important primate gene clusters (ongoing)

with Penn State University and NIH / NHGRI

Genome rearrangement and evolution of linear chromosomes (ongoing)

with Faculty of Natural Sciences in Bratislava and University of Bielefeld

New algorithms for searching for RNA motifs (ongoing)

with UC Irvine

## Further Research Teams: Mycobacteria, Trypanosomatids, Streptomyces

identification of the genes involved in the biogenesis of  
mycobacterial cell wall (*Mycobacterium tuberculosis*)  
respiratory chain and associated metabolic pathways in  
*Trypanosoma brucei*, *Leishmania tarentolae*,  
*Crithidia fasciculata* and *Phytomonas serpens*

**Implications: candidates for novel antituberculars  
development**

**Therapy of Sleeping sickness and other serious diseases of  
humans, animals and plants**

# Scientific Publications

Nucleic Acids Research

Journal of Computational Biology

Cell Cycle

Current Genetics

**Science**

Nature Structural & Molecular Biology

Bioessays

**Nature**

etc...



# Summary

## Biomedical research

protects our health and saves lives

is based on the most advanced knowledge in  
biology, chemistry and bioinformatics

needs, applies but also develops HiTech methods  
and devices

# Summary

## Research teams from Comenius University

work in modern laboratories with the latest technologies, applying the most advanced methods

are composed from top leading scientists and young enthusiastic researchers

# Summary

## Research teams from Comenius University

have a great potential for further development and collaboration with both academic and private companies

Bratislava Science Park  
(135 mil. €)





# Thank you!

