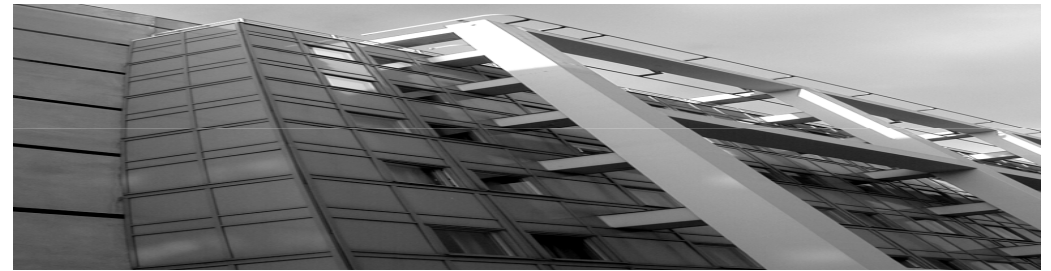


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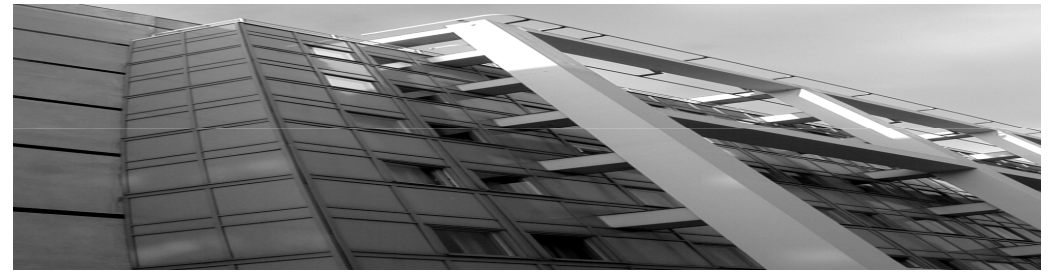


central european institute of technology

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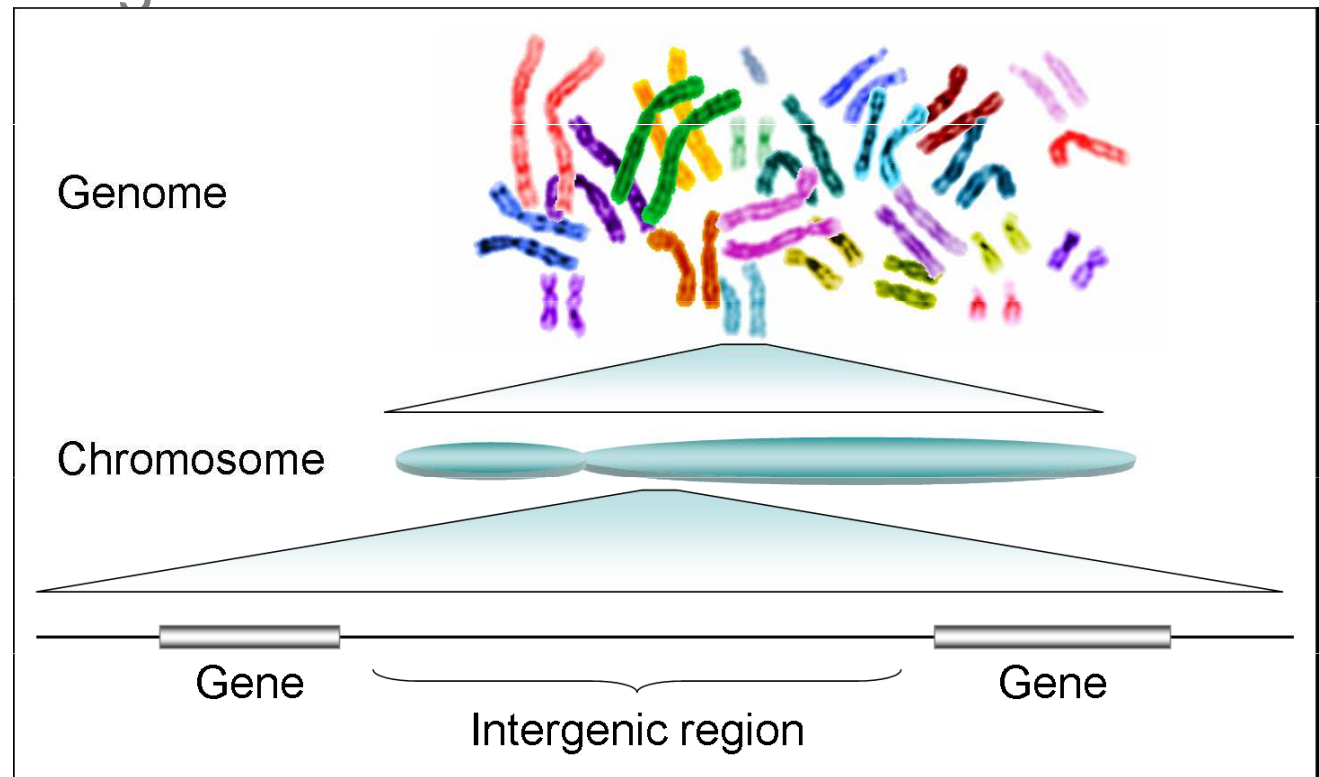
Genomics and proteomics at MU
Jiří Fajkus

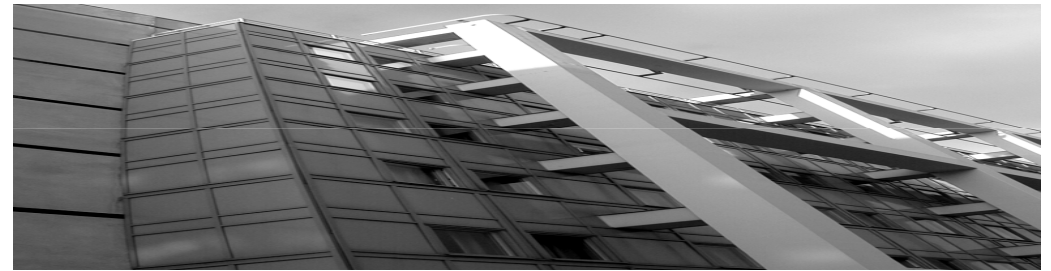
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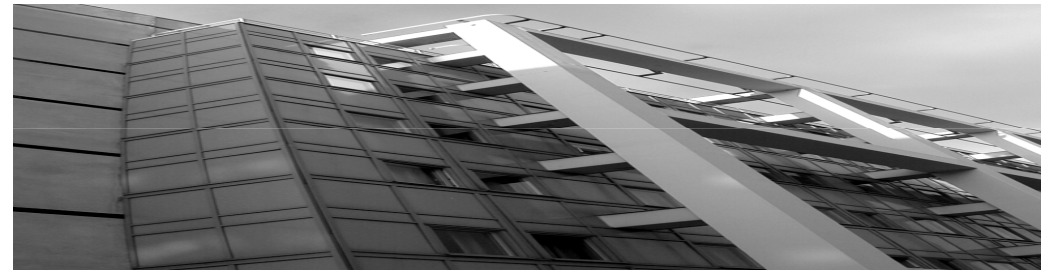
Genomics

- ✓ interested in GENOME – complete genetic info (DNA/RNA sequence) of an organism (3Gb-human)
- ✓ ca. 25 000 human genes
- ✓ $\approx 2\%$ genome



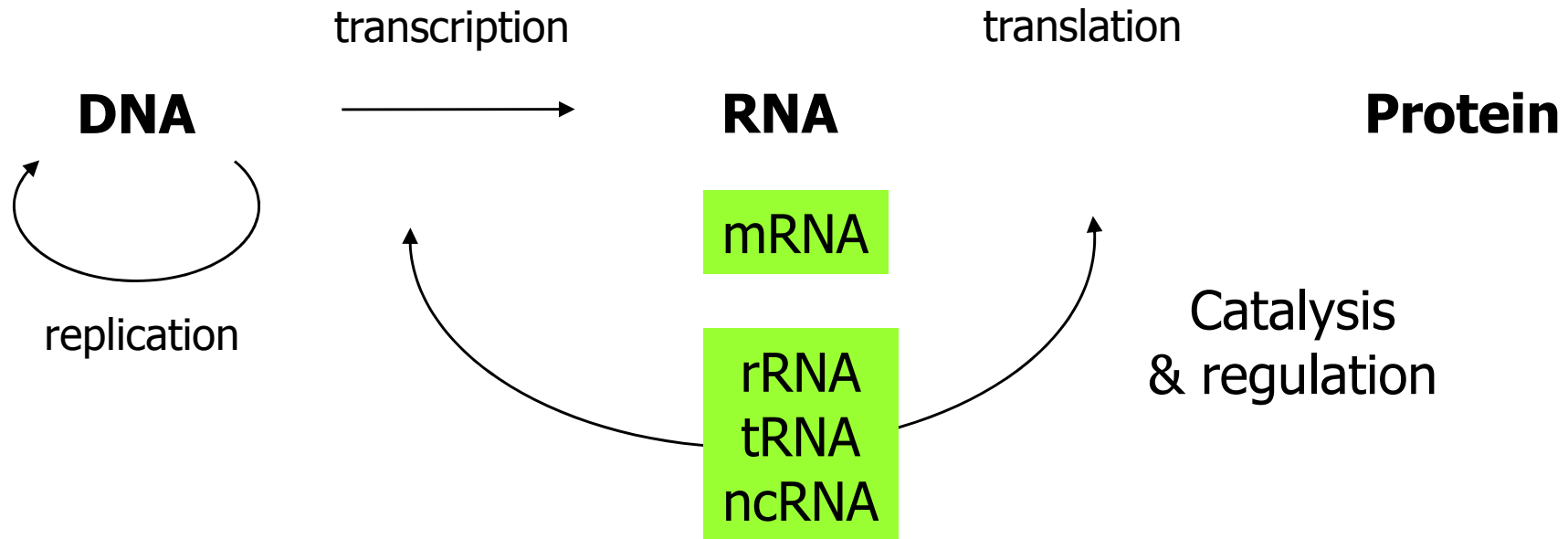
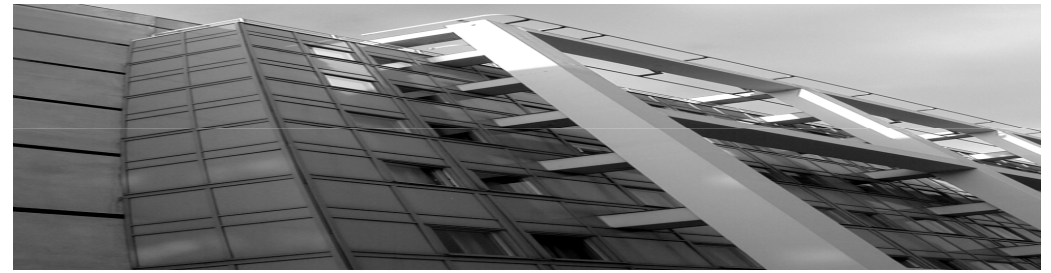


-
- ✓ Potential of genomics : fast analysis of gene mutations and changes in gene expression (at the mRNA level)
 - ⇒ detection of inherited disorders, pathogens, genetic manipulations, molecular oncology...
 - ✓ Novel DNA sequencing platforms
 - ✓ cDNA microarrays



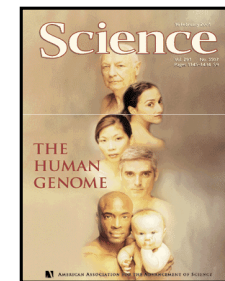
- ✓ Why **PROTEOMICS**?
- ✓ Only limited repertoire of events directly depends on DNA sequence
(25 000 genes × several millions proteins)
1 organism \Rightarrow 1 genome \times many proteomes





Genotype

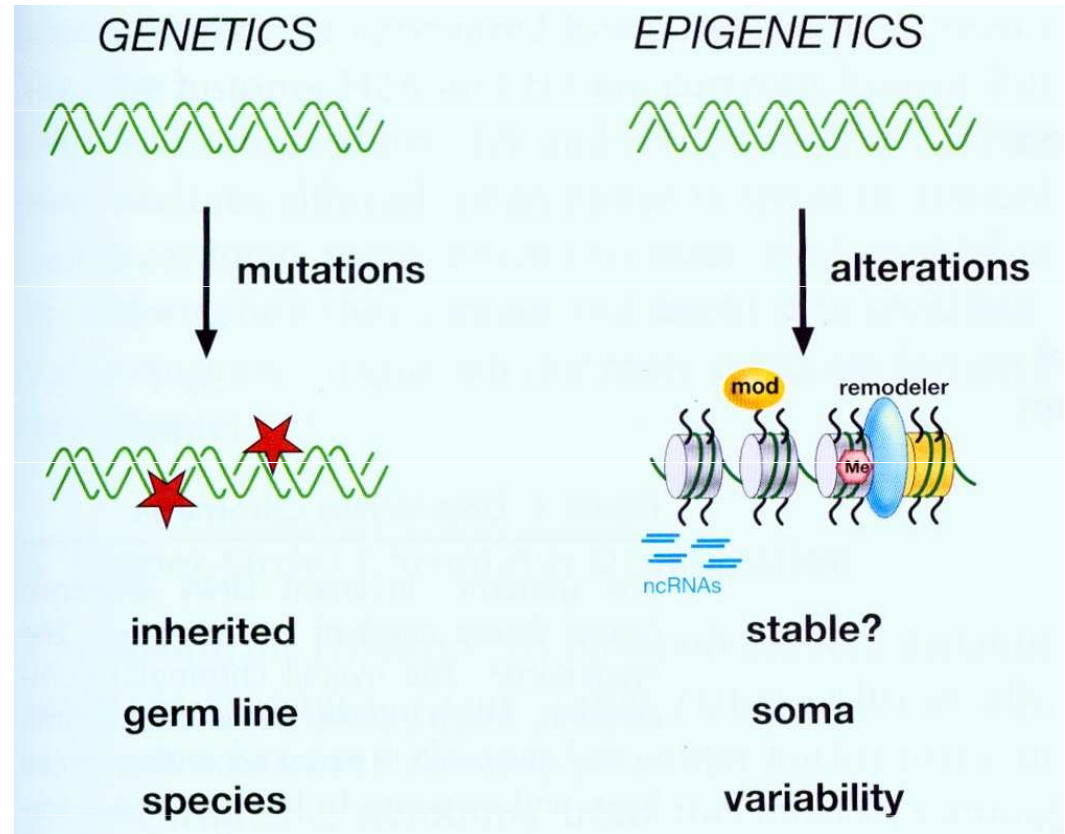
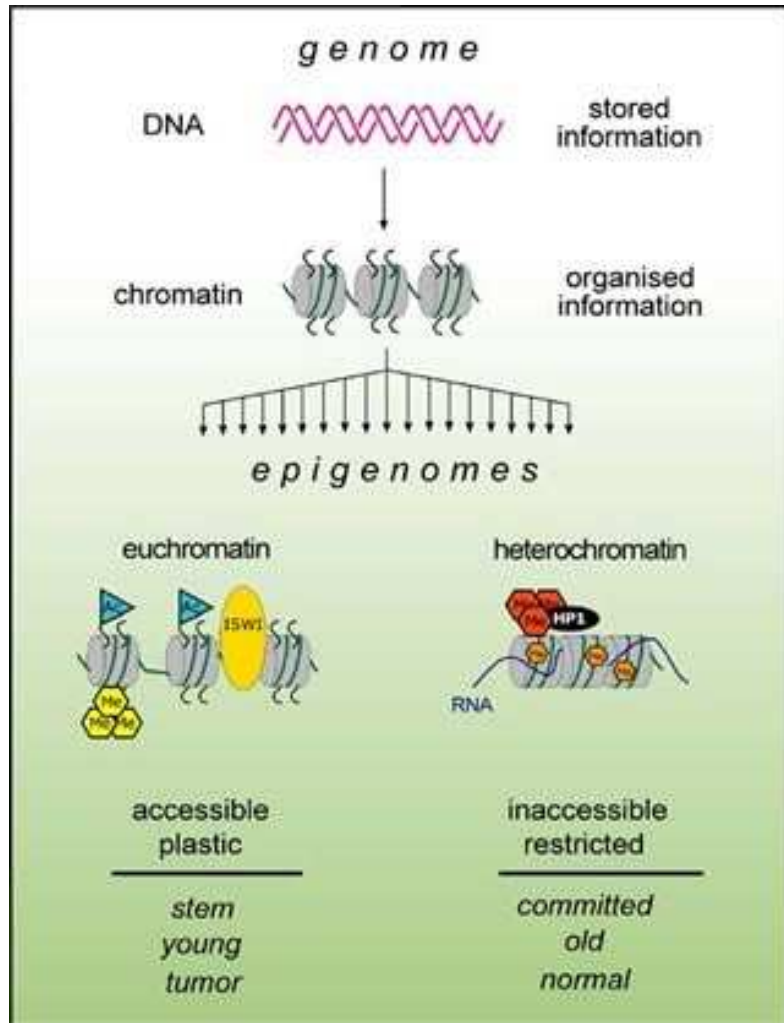
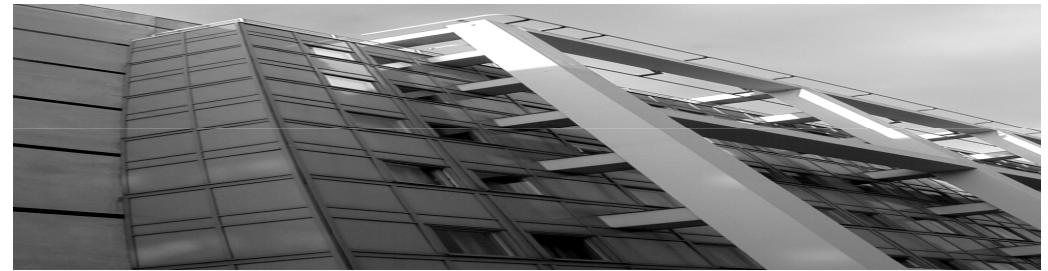
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Phenotype

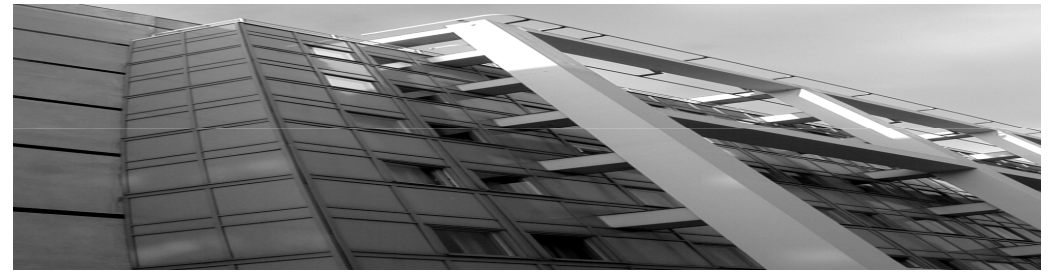
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Core facility “Genomics and **Proteomics**”

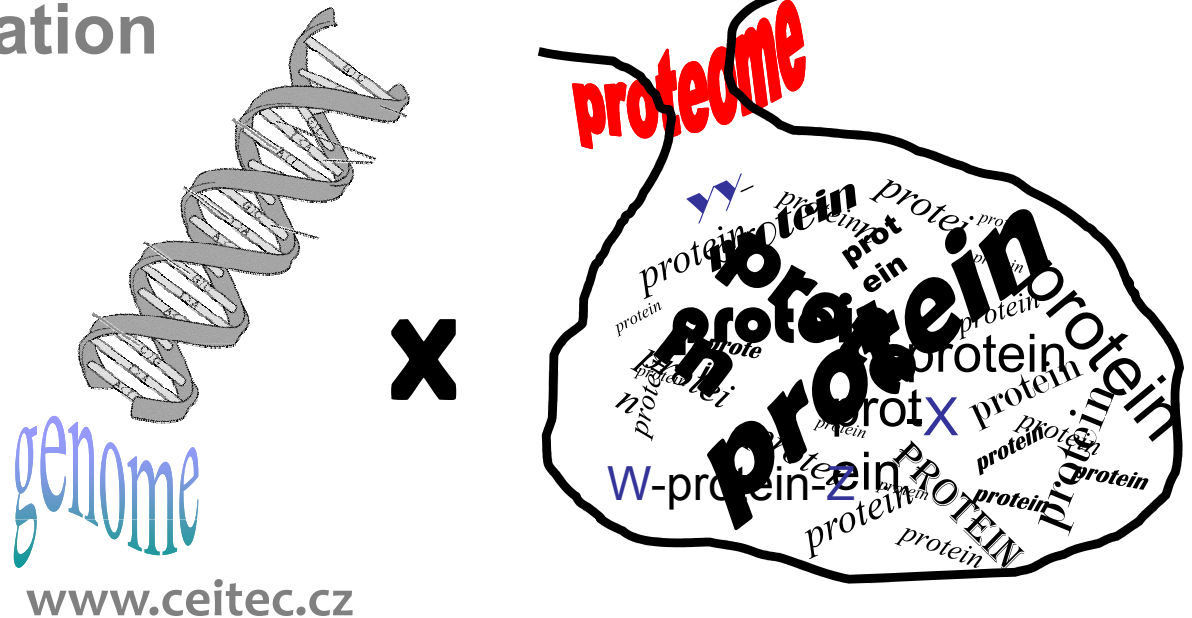
- ✓ **proteome analysis**

bacteria, plants, animals, human, stem cells, etc.

- ✓ **protein characterization**

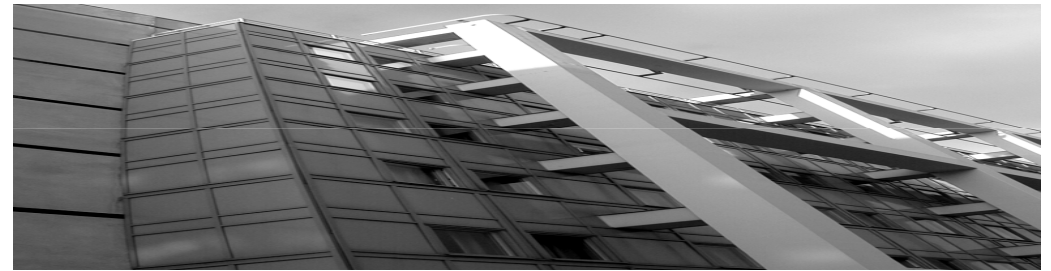


The Desperate Man,
Gustave Courbet, 1844-45



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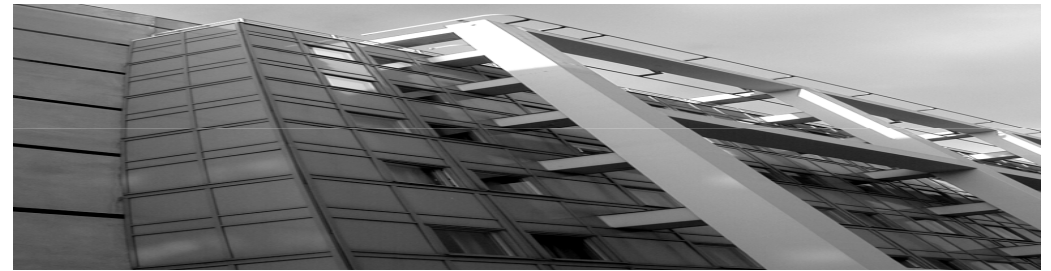


Core facility “Genomics and **Proteomics**”: integration of sophisticated technologies

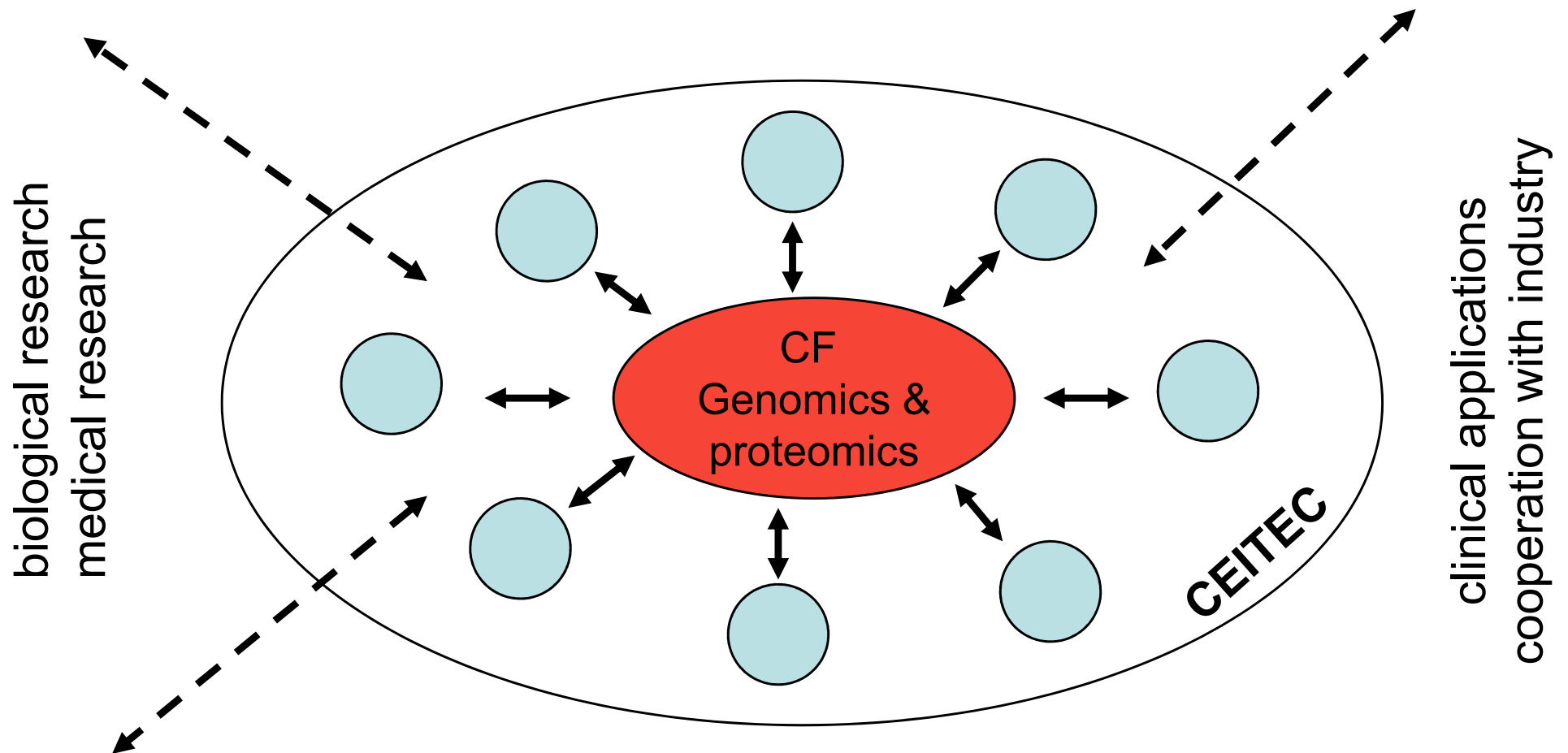
- ✓ isolation, separation of proteins
- ✓ identification of proteins, posttranslational modifications
- ✓ analysis of protein complexes
- ✓ **mass spectrometry – major proteomic tool**

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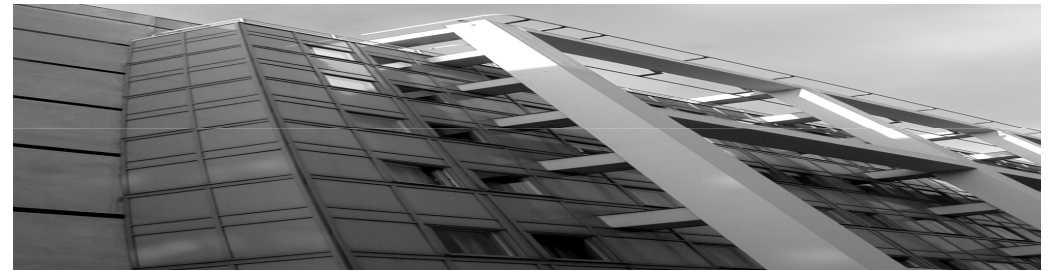
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Core facility “Genomics and Proteomics”

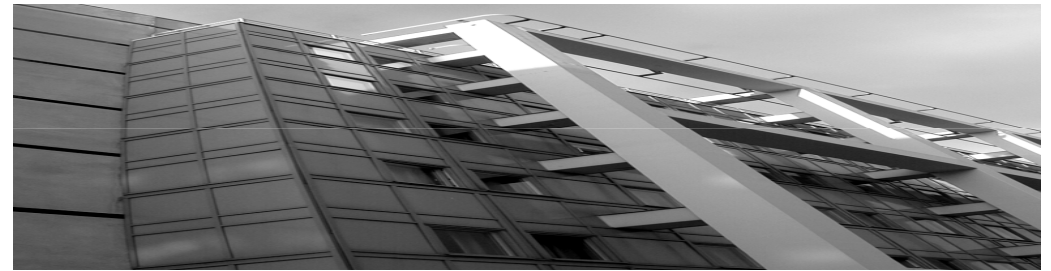


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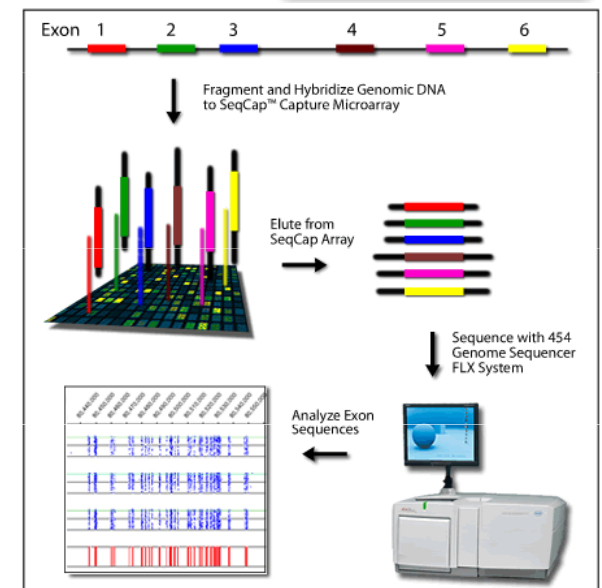
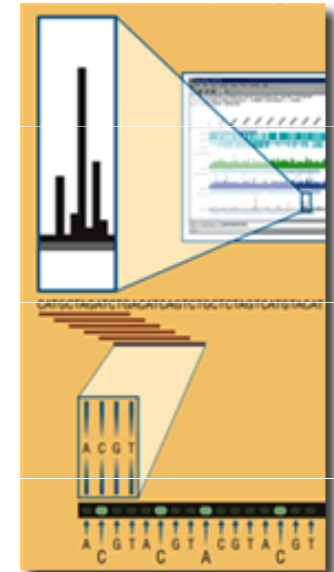
Examples of present scientific projects

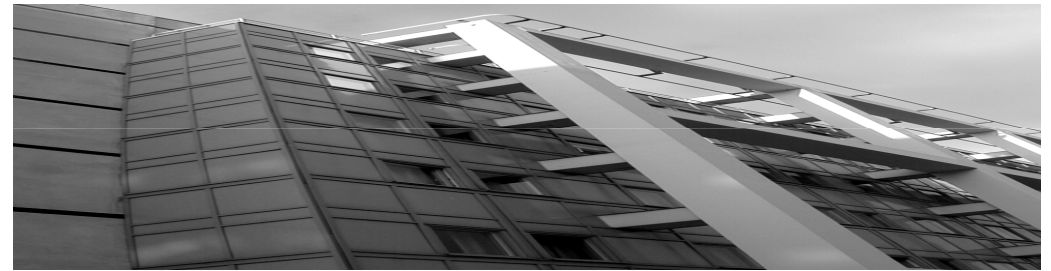
- ✓ Bacterial genetics and genomics
- ✓ Plant cytogenomics
- ✓ Molecular analysis of plant development
- ✓ Biology of telomeres
- ✓ Molecular diagnostics and therapy (collab. UH Brno, UH S.A.)



Bacterial genetics and genomics

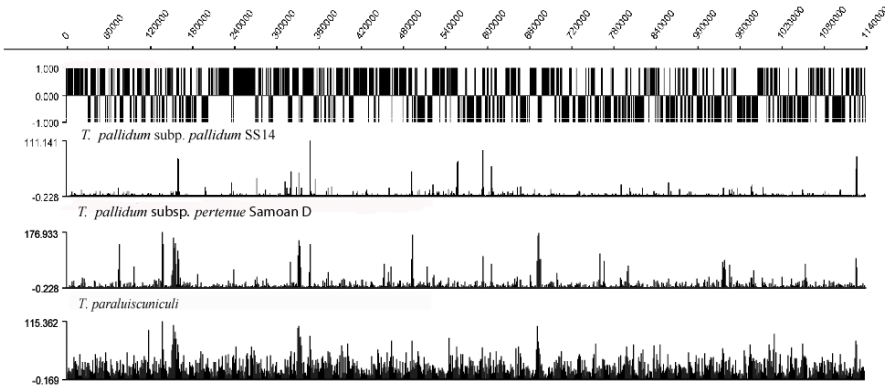
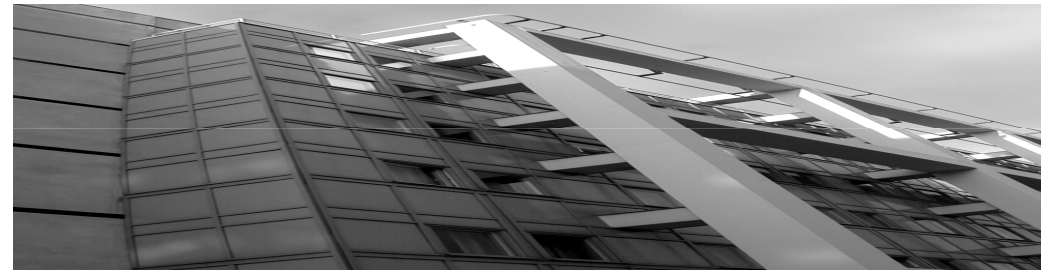
- ✓ Human, emerging and re-emerging pathogens
- ✓ Whole genome sequencing strategies
 - ✓ Whole genome fingerprinting (physical mapping)
 - ✓ Comparative genome sequencing (microarray)
 - ✓ Pyrosequencing, Solexa sequencing, SOLiD sequencing, Sanger sequencing
- ✓ Analyses of bacterial transcriptome
 - ✓ Gene annotations
 - ✓ Analyses of gene regulatory networks



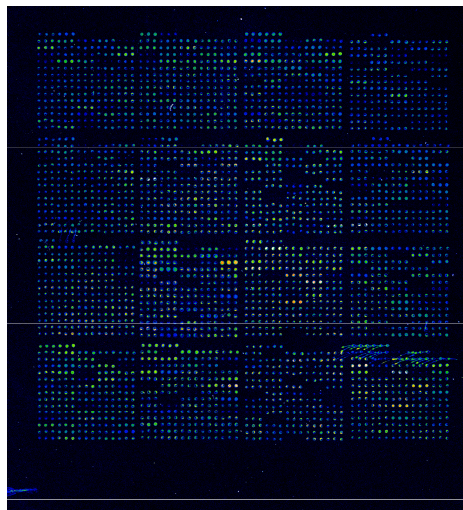


Goals of whole-genome sequencing

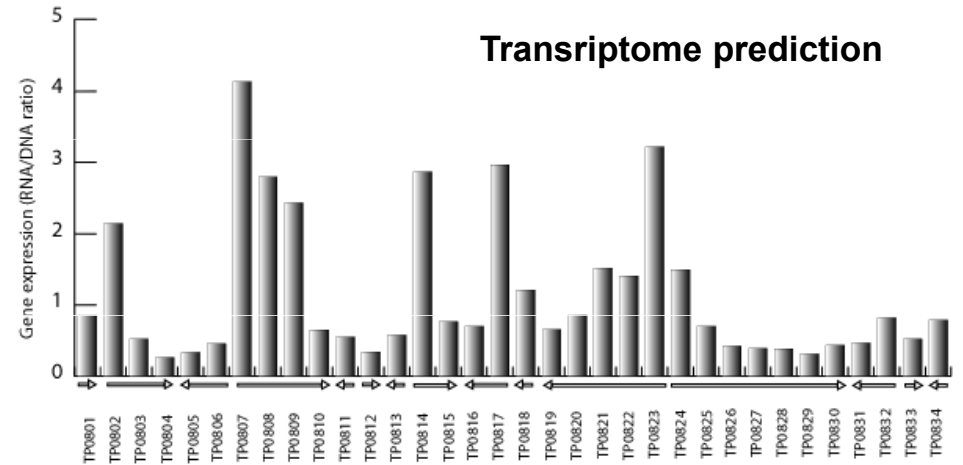
- ✓ Identification of **virulence factors** (better treatment of infectious diseases)
- ✓ Identification of prominent bacterial **antigens** (development of new vaccines)
- ✓ Identification of **unique** genomic sequences (better diagnostics)
- ✓ **Metagenomic** sequencing (definition of human microbiome)
- ✓ **Epidemiological** studies (better preventive measures)



CGS sequencing

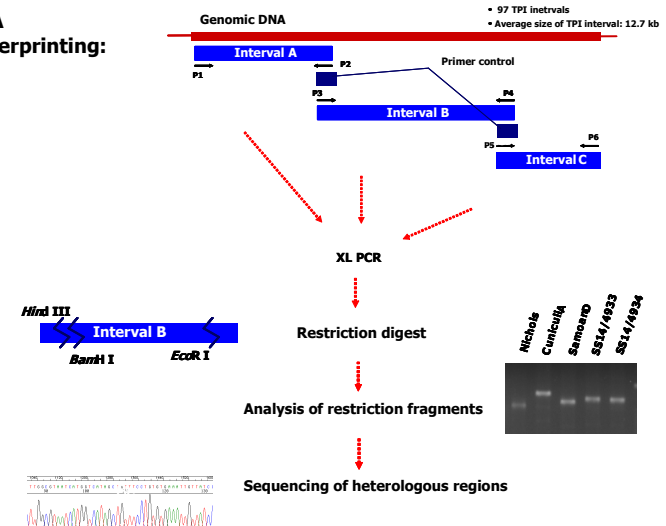


DNA microarray



Transcriptome prediction

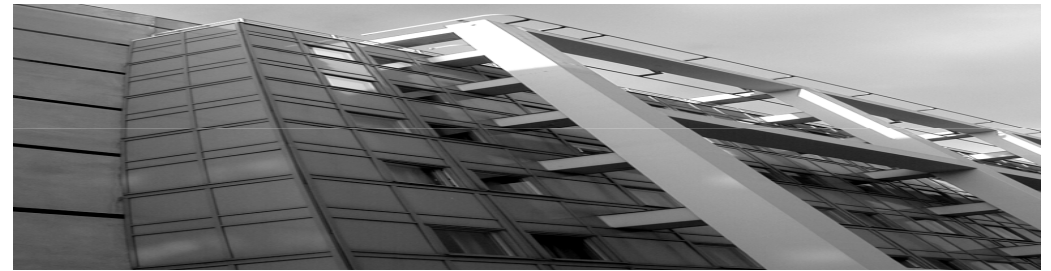
DNA fingerprinting:



Physical mapping of the genome

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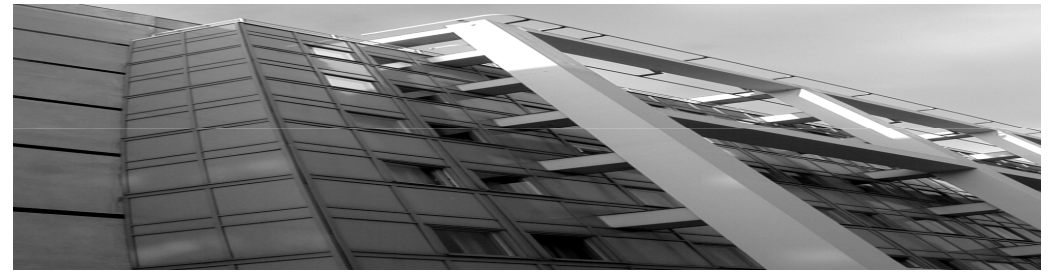
Plant Sciences at MU - Why plants?

- ✓ Scientific reasons: unique developmental model
- ✓ Political and economical reasons: Plants as the only sustainable and self-renewable tool of energy conservation on Earth; Plants as a multipurpose and low-cost production system



GO GREEN

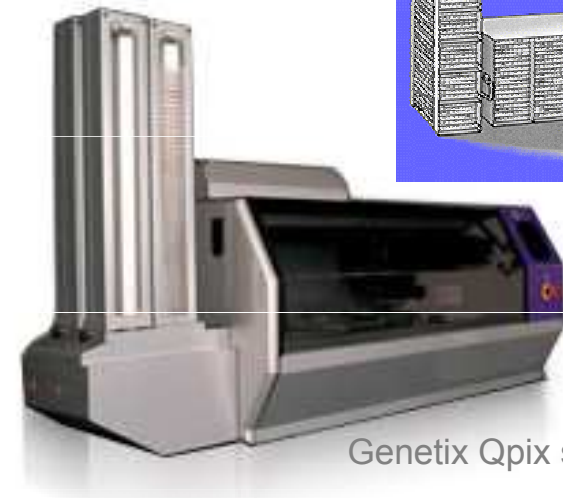
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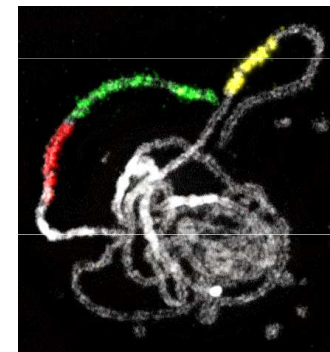
Laboratory of Plant Cytogenomics

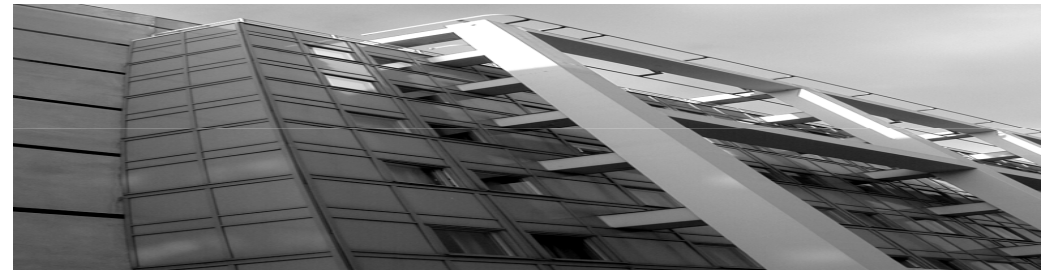
Methodology

- ✓ construction of large insert DNA libraries
- ✓ high-throughput DNA sequencing
- ✓ genome comparisons on a sequence and chromosomal level
 - bioinformatics
 - molecular cytogenetics
 - comparative phylogenomics



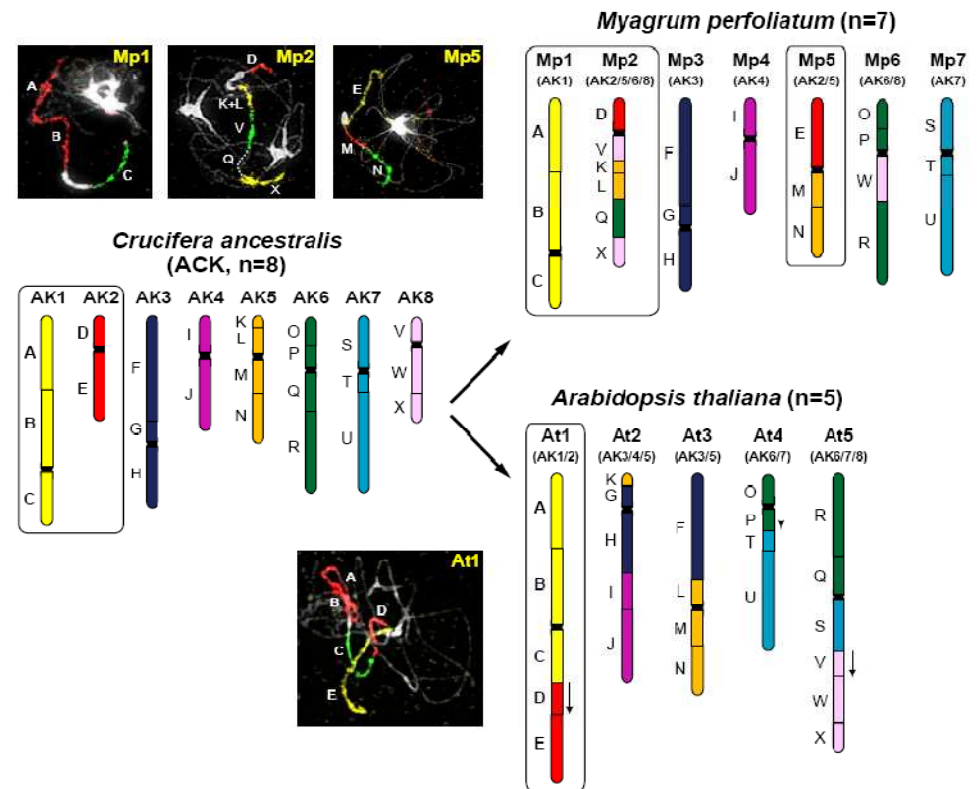
Genetix Qpix system

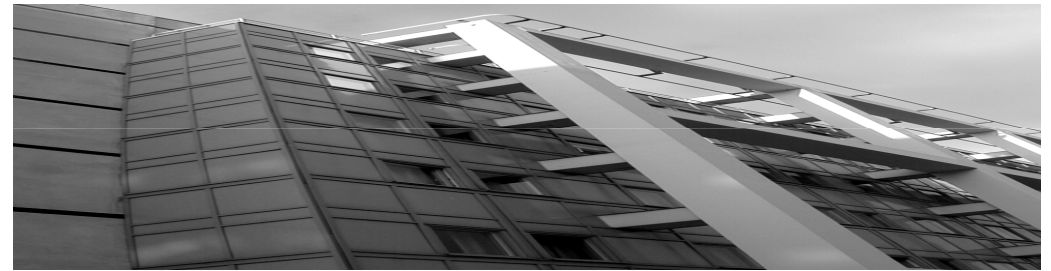




Laboratory of Plant Cytogenomics

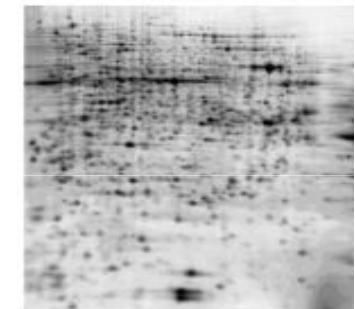
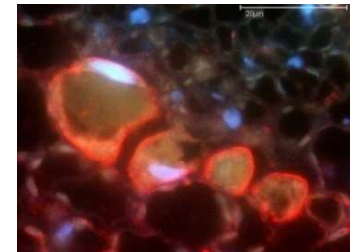
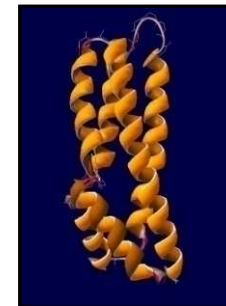
- ✓ analysis of inter-species chromosome and genome collinearity
- ✓ karyotype and genome evolution within phylogenetic frameworks (phylogenomics)
 - ✓ evolution of repetitive DNA elements and structure of plant genomes
 - ✓ karyotype evolution and speciation

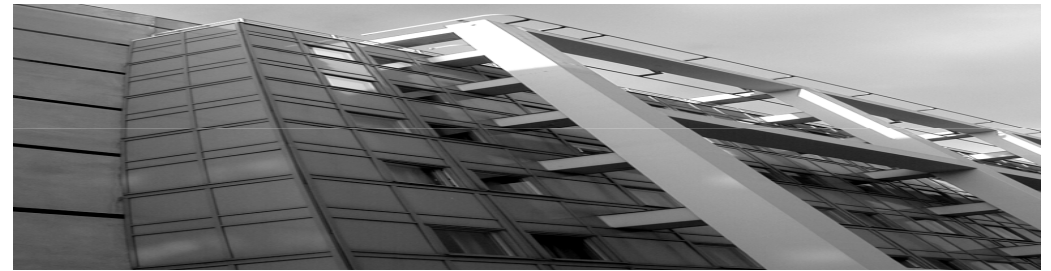




✓ Molecular analysis of plant growth and development

- ✓ Functional genomics and proteomics of model plants (*Arabidopsis*) and crop plants (oil-seed rape) as a low-cost production systems for e.g. pharmaceutically active proteins (antibodies) and biomass production
- ✓ Analysis of the protein structure and protein engineering
- ✓ Identification of Proteins Regulating Plant Biomass Production - cytokinins and their receptors regulate biomass production in plants (in frame of collaboration with Korean colleagues) - application for patent cooperation treaty (PCT) submitted by MU and Korean partner.

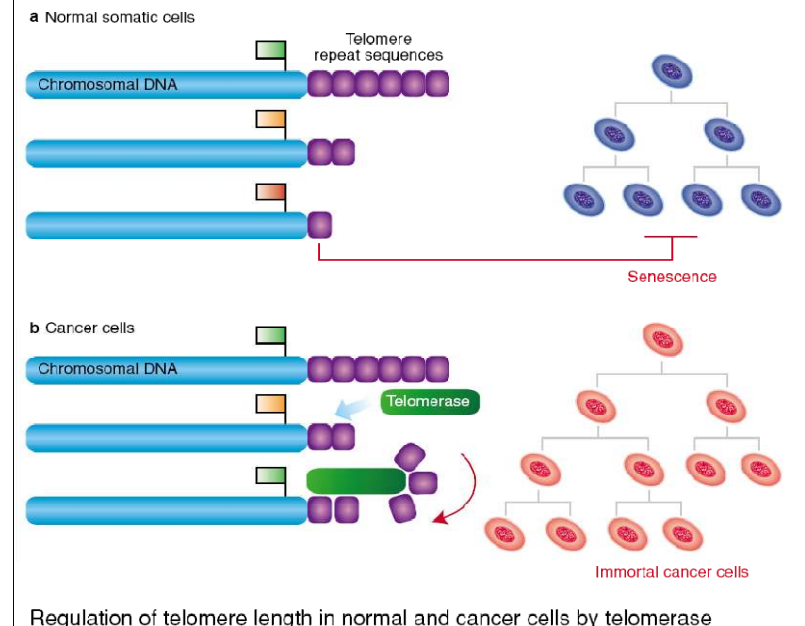
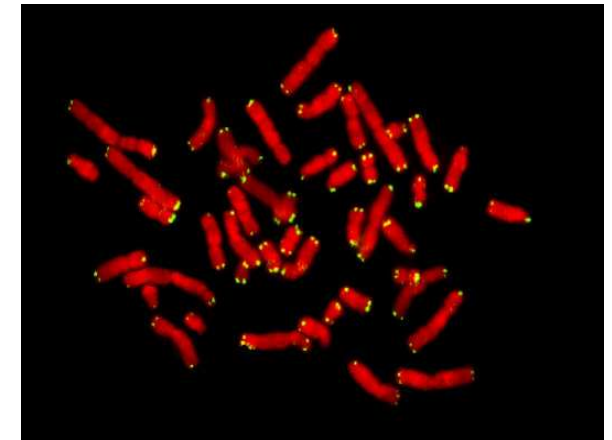


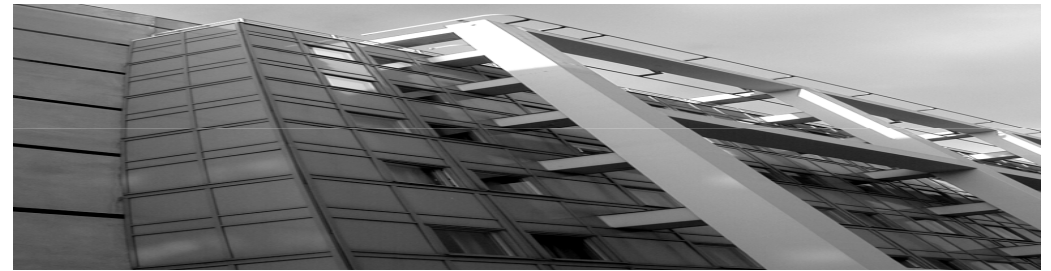


✓ Biology of telomeres

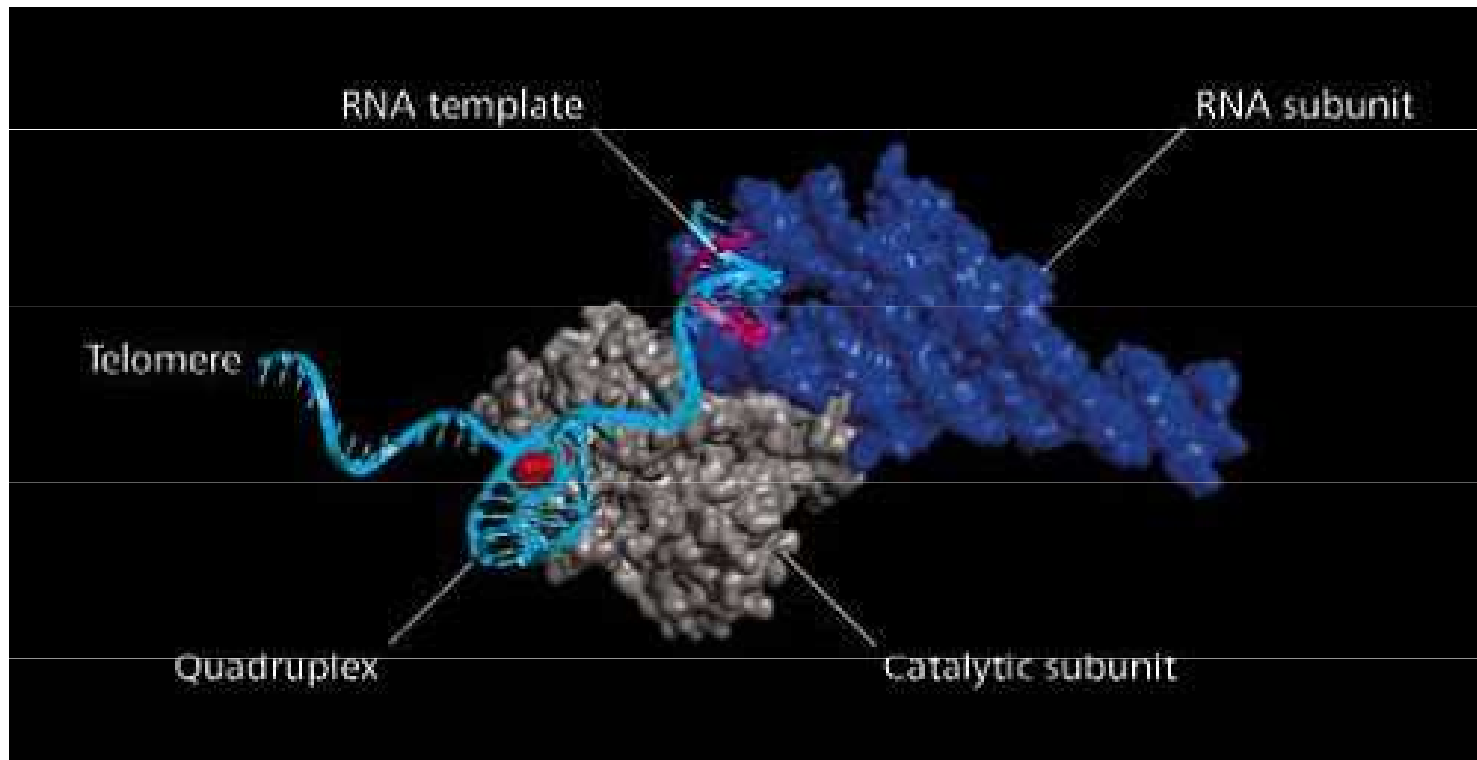
✓ Structure, evolution and maintenance of plant telomeres (DNA, proteins, chromatin structure, epigenetics)

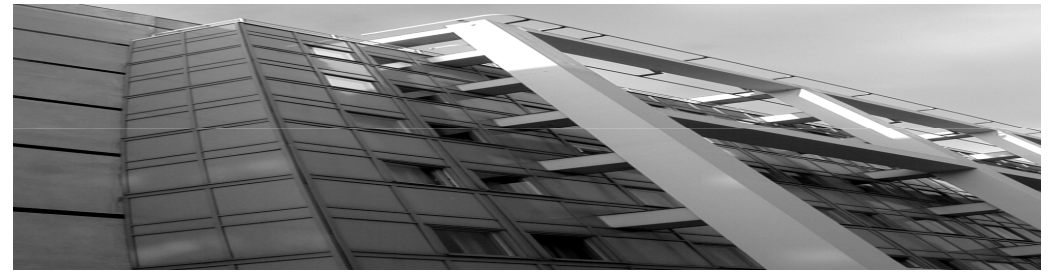
✓ Telomeres and telomerase in oncology diagnostics and therapy





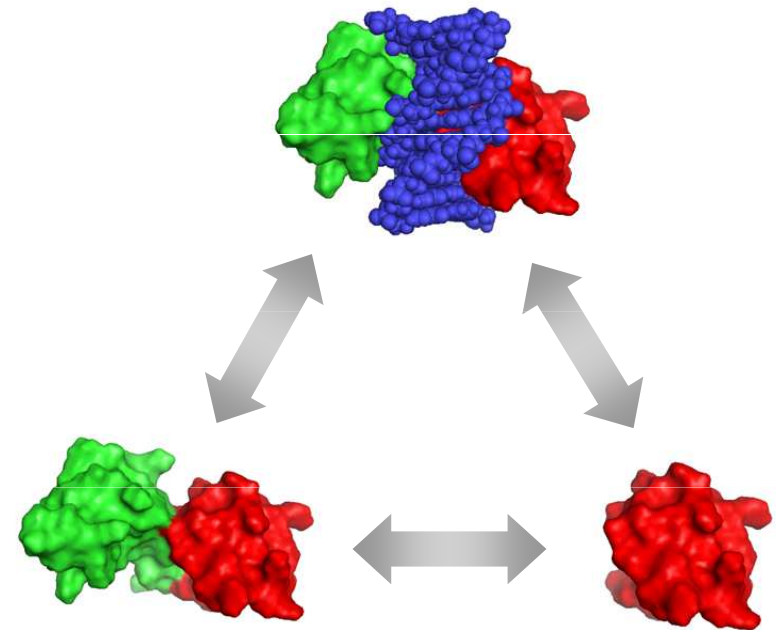
- ✓ Key processes in telomere biology (and in living cell, in general): interaction networks of proteins, DNA and RNA

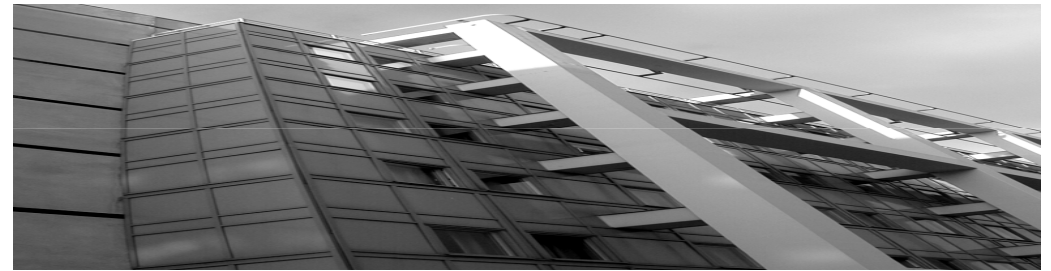




Laboratory of separation and analysis of proteins and their complexes

- ✓ **description** of important protein complexes and their compositions
- ✓ **kinetics and thermodynamics** of protein-protein and protein-DNA interactions
- ✓ study of **mechanisms of function** and action of biomolecular complexes





SUMMARY – Genomics and proteomics

- ✓ Concentration of “universal” and sophisticated genomic and proteomic equipment and expertise in core facility – optimum cost-efficiency
- ✓ Potential for synergistic interactions among research groups, capability to solve complex projects
- ✓ Higher competitive strength and attractiveness to international R&D community ⇒ raising of funds for science
- ✓ Emphasis on current internationally competitive research groups, yet flexibility in routing of future development
- ✓ Connection to major medical institutions (university hospitals, res. institutes), biotechnology incubators and institutes of Czech Academy of Sciences