



生物信息学

第1讲 绪论及常用数据库介绍(1)

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总体授课安排（36理论课时）

第一章 绪论

1理论课时（张高川）

第二章 常用数据库介绍

3理论课时（张高川）

第三章 转录组学与调控网络分析

6理论课时（张高川）

第四章 基因组学与序列分析

8理论课时（黄茉莉）

第七章 代谢组学与个性化用药

8理论课时（杨晓勤）

第五章 蛋白质组学与系统药物设计

8理论课时（肖 飞）

过程考核1
【1课时】

过程考核2
【1课时】

过程考核3
【1课时】

过程考核3
【1课时】



纲 要

生物信息学基本概念

生物信息学的诞生和发展

人类基因组计划（HGP）

生物信息学的研究内容和方向

生物信息学在生命科学研究中的应用

系统生物学的理念

生物信息学的自主学习方法 【带着问题来学习】

Proteins perform many of life's most essential functions. To carry out their specific roles, they often work together in the cell as protein machines.

goal
CHARACTERIZE GENE
REGULATORY NETWORKS

URL: DOEGenomesToLife.org

10/02



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生物信息学的研究内容和方向及其应用

三大数据库介绍

NCBI-Genbank-Entrez-PubMed使用介绍

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GENOMES to LIFE

BIOLOGICAL SOLUTIONS FOR ENERGY CHALLENGES

Protect workers and the public
Clean up the environment
Sequester excess carbon
Produce and use energy
Apply knowledge of microbial functional capabilities

什么是生物信息学 (Bioinformatics) ?

Genes and other DNA sequences contain instructions on how and when to build proteins



Proteins perform many of life's most essential functions. To carry out their specific roles, they often work together in the cell as protein machines.

goal
IDENTIFY PROTEIN MACHINES

CAPABILITIES TO UNDERSTAND COMPLEX BIOLOGICAL SYSTEMS

goal
CHARACTERIZE GENE REGULATORY NETWORKS

WORKING CELL

Many protein machines interact through complex interconnected pathways. Analyzing these dynamic processes will lead to models of life processes.

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什么是生物信息学（Bioinformatics）？

百度百科

生物信息学(Bioinformatics)是研究**生物信息**的采集、处理、存储、传播，分析和解释等各方面的学科，也是随着生命科学和计算机科学的迅猛发展，**生命科学**和**计算机科学**相结合形成的一门新学科。它通过综合利用生物学，计算机科学和信息技术而揭示大量而复杂的**生物数据**所赋有的生物学奥秘。





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360百科

生物信息学（Bioinformatics）是在生命科学的研究中，以**计算机**为工具对**生物信息**进行储存、检索和分析的科学。它是当今生命科学和自然科学的重大前沿领域之一，同时也将是**21世纪**自然科学的核心领域之一。其研究重点主要体现在基因组学（Genomics）和蛋白质组学（Proteomics）两方面，具体说就是从核酸和蛋白质序列出发，分析序列中表达的结构功能的生物信息。





什么是生物信息学（Bioinformatics）？

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搜狗百科

生物信息学(Bioinformatics)利用应用**数学**、**信息学**、**统计学**和**计算机科学**的方法研究**生物学**的问题。生物信息学基本上只是分子生物学与信息技术（尤其是互联网技术）的结合体。生物信息学的研究材料和结果就是各种各样的**生物学数据**，其研究工具是**计算机**，研究方法包括对生物学数据的搜索（收集和筛选）、处理（编辑、整理、管理和显示）及利用（计算、模拟）。主要的研究方向有：序列比对、基因识别、基因重组、蛋白质结构预测、基因表达、蛋白质反应的预测，以及建立进化模型。

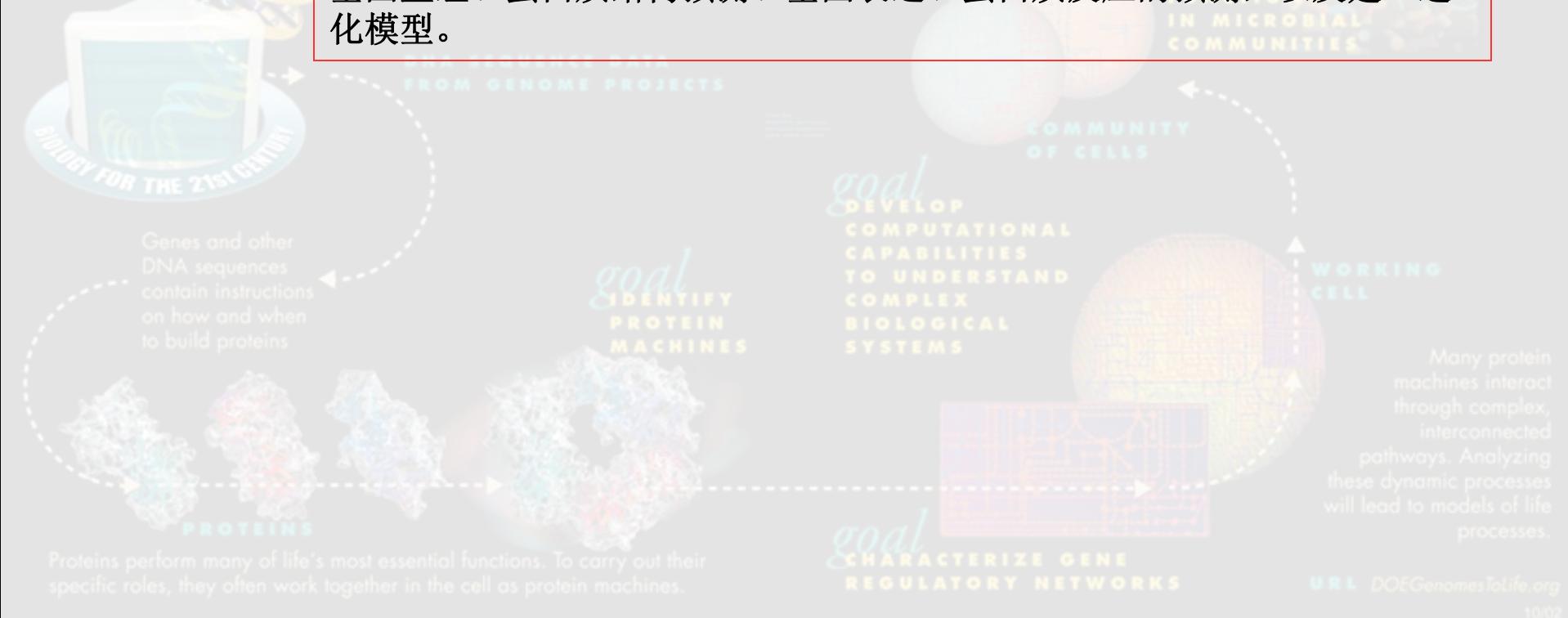




什么是生物信息学（Bioinformatics）？

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Wikipedia

Bioinformatics is an interdisciplinary field that develops methods and software tools for understanding biological data.

As an interdisciplinary field of science, bioinformatics combines Computer Science, Biology, Mathematics, and Engineering to analyze and interpret biological data.

Bioinformatics has been used for *in silico* analyses of biological queries using mathematical and statistical techniques. More broadly, bioinformatics is applied statistics and computing to biological science.

Proteins perform many of life's specific roles; they often work together in the cell as protein machines.

U.S. DOE Genomes to Life.org

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什么是生物信息学（Bioinformatics）？





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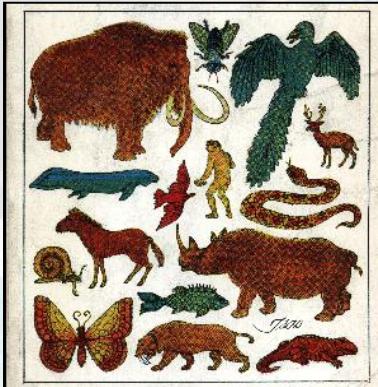
GENOMES to LIFE

BIOLOGICAL SOLUTIONS
FOR ENERGY CHALLENGES

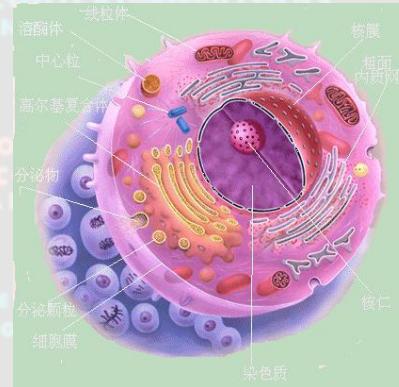


生命科学研究的三重层次(4)

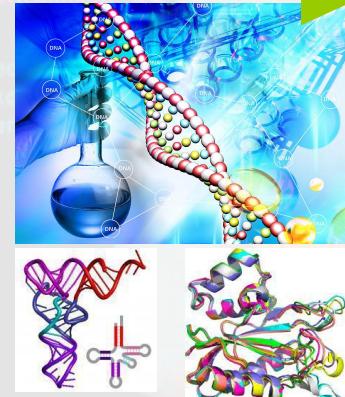
宏观 >>> 微观



个体

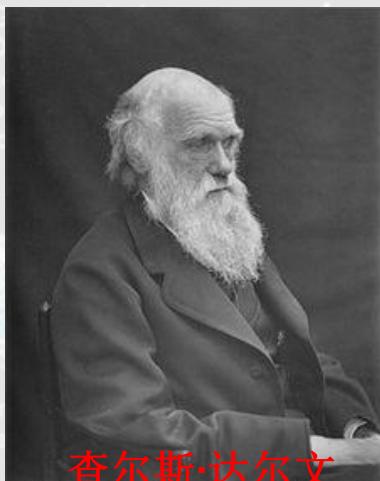


细胞



分子

生命的奥秘



查尔斯·达尔文
(1809-1882)



列文·虎克
(1632-1723)



沃森和克里克
DNA双螺旋, 1953

Apply knowledge of microbial functional capabilities

生命的奥秘



WORKING CELL

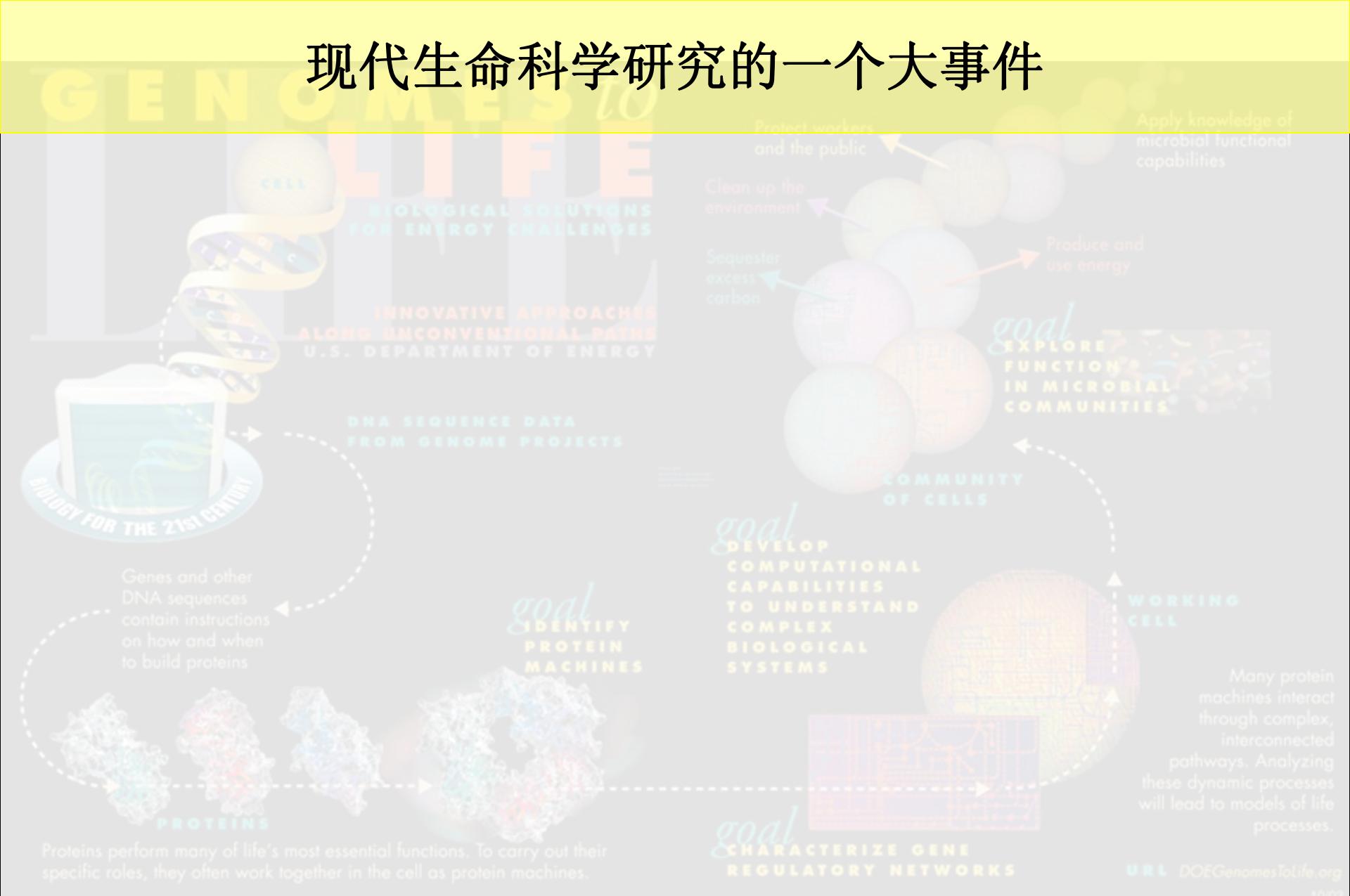
Many protein machines interact through complex interconnected pathways. Analyzing these dynamic processes will lead to models of life processes.

URL: DOEGenomesToLife.org

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现代生命科学研究的一个大事件



现代生命科学研究的一个大事件



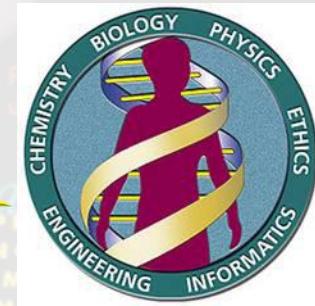
National Institutes
of Health (NIH)

人类基因组计划
(Human Genome Project, HGP)
(30亿个碱基对)

1990-2005; 30亿美元

Protect workers
and the public

Apply knowledge of
microbial functional
capabilities



美国能源部人类基
因组计划徽标

Genes and other
DNA sequences
contain instructions
on how and when
to build proteins



Proteins perform many of life's most essential functions. To carry out their specific roles, they often work together in the cell as protein machines.

goal
IDENTIFY
PROTEIN
MACHINES

goal
DEVELOP
COMPUTATIONAL
CAPABILITIES
TO UNDERSTAND
COMPLEX
BIOLOGICAL
SYSTEMS

goal
CHARACTERIZE GENE
REGULATORY NETWORKS

WORKING
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英国、日本、法国、德国、中国、印度

国际人类基因组组织
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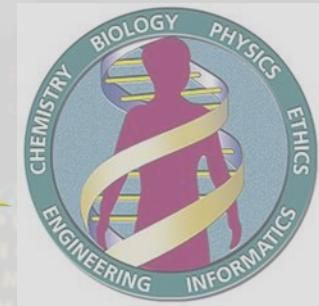
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1998



国家人类基因组南方研究中心
Chinese National Human Genome Center at Shanghai



1999

国家人类基因组北方研究中心
CHINESE NATIONAL HUMAN GENOME CENTER, BEIJING



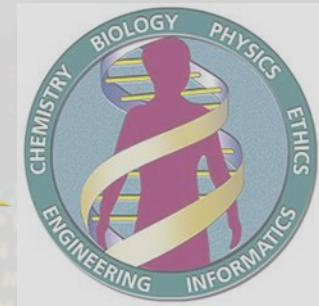
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Chinese National Human Genome Center at Shanghai



1999年9月，中国正式加入HGP；
人类第3号染色体的短臂区域3000万
个碱基对（1%）。

1999

国家人类基因组北方研究中心
CHINESE NATIONAL HUMAN GENOME CENTER, BEIJING



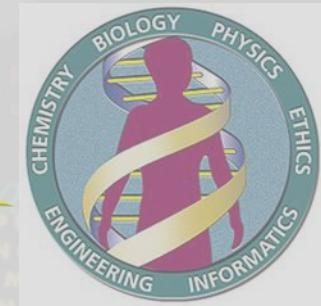
现代生命科学研究的一个大事件



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1998

美国科学家克莱格·凡特
塞雷拉基因组公司
(Celera Genomics)

2000.6.26, 克林顿

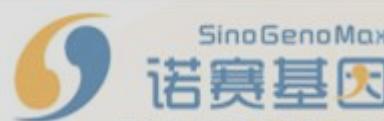
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Chinese National Human Genome Center at Shanghai



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CHINESE NATIONAL HUMAN GENOME CENTER, BEIJING



HGP-生物信息学发展和壮大的契机



人类基因组计划 (Human Genome Project, HGP)



HGP-生物信息学发展和壮大的契机



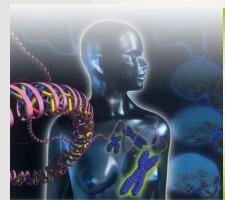
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30亿个碱基对

接下来，该怎么办？



HGP-生物信息学发展和壮大的契机



人类基因组计划 (Human Genome Project, HGP)

30亿个碱基对

数学方法
计算机技术

基因组注释

新基因发现

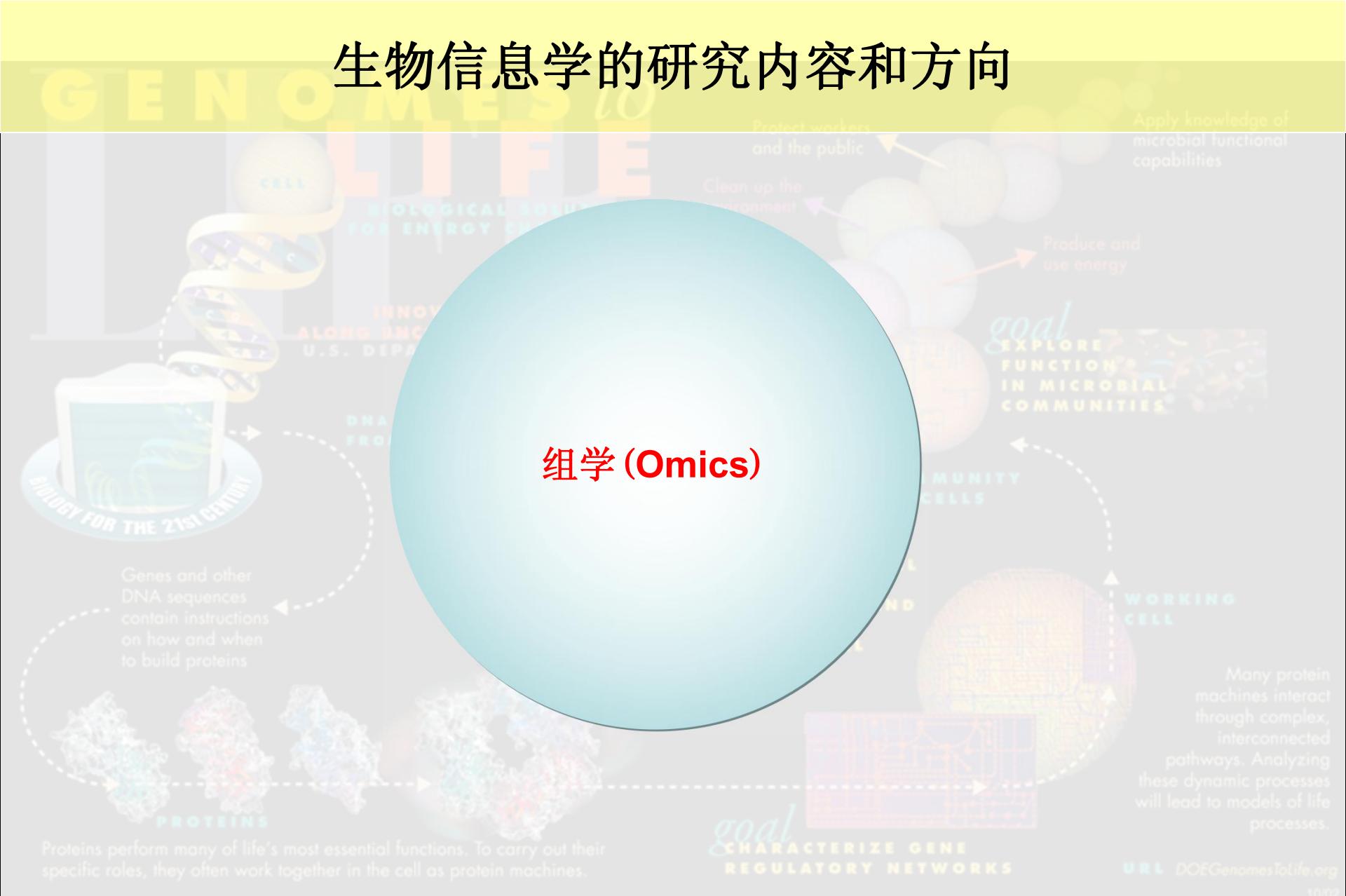
基因组比较

接下来，该怎么办？

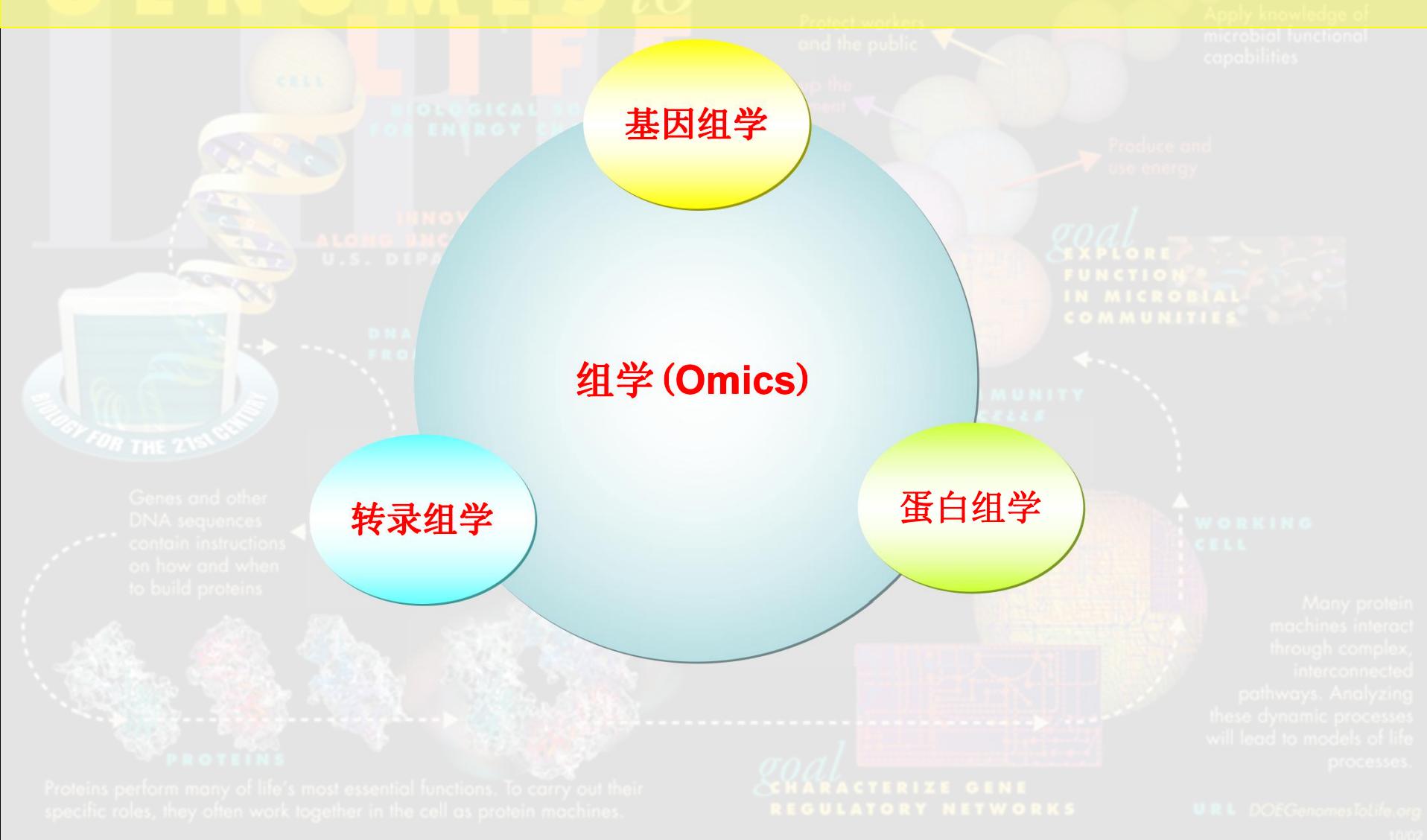


生物信息学的研究内容和方向

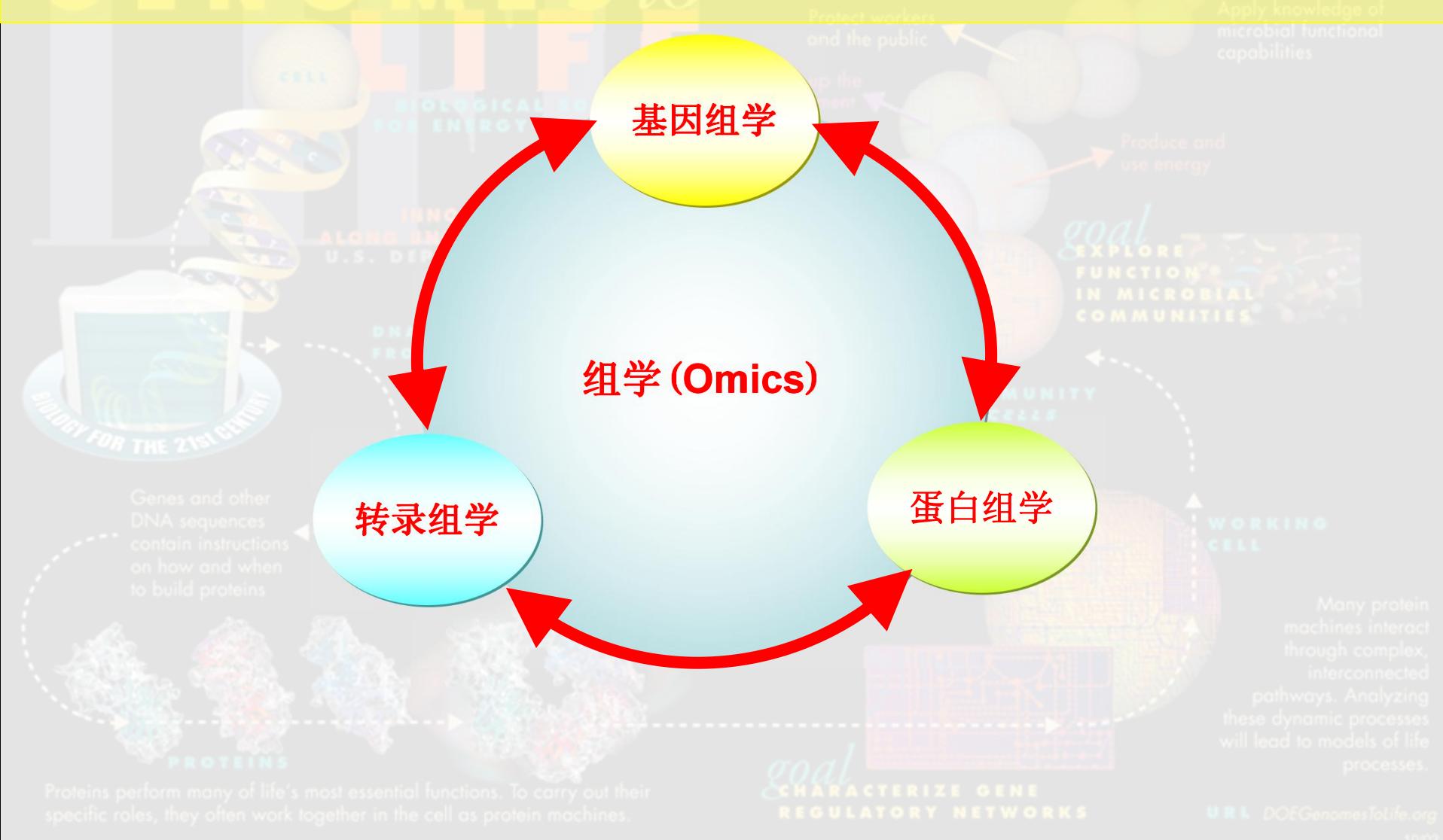
组学 (Omics)



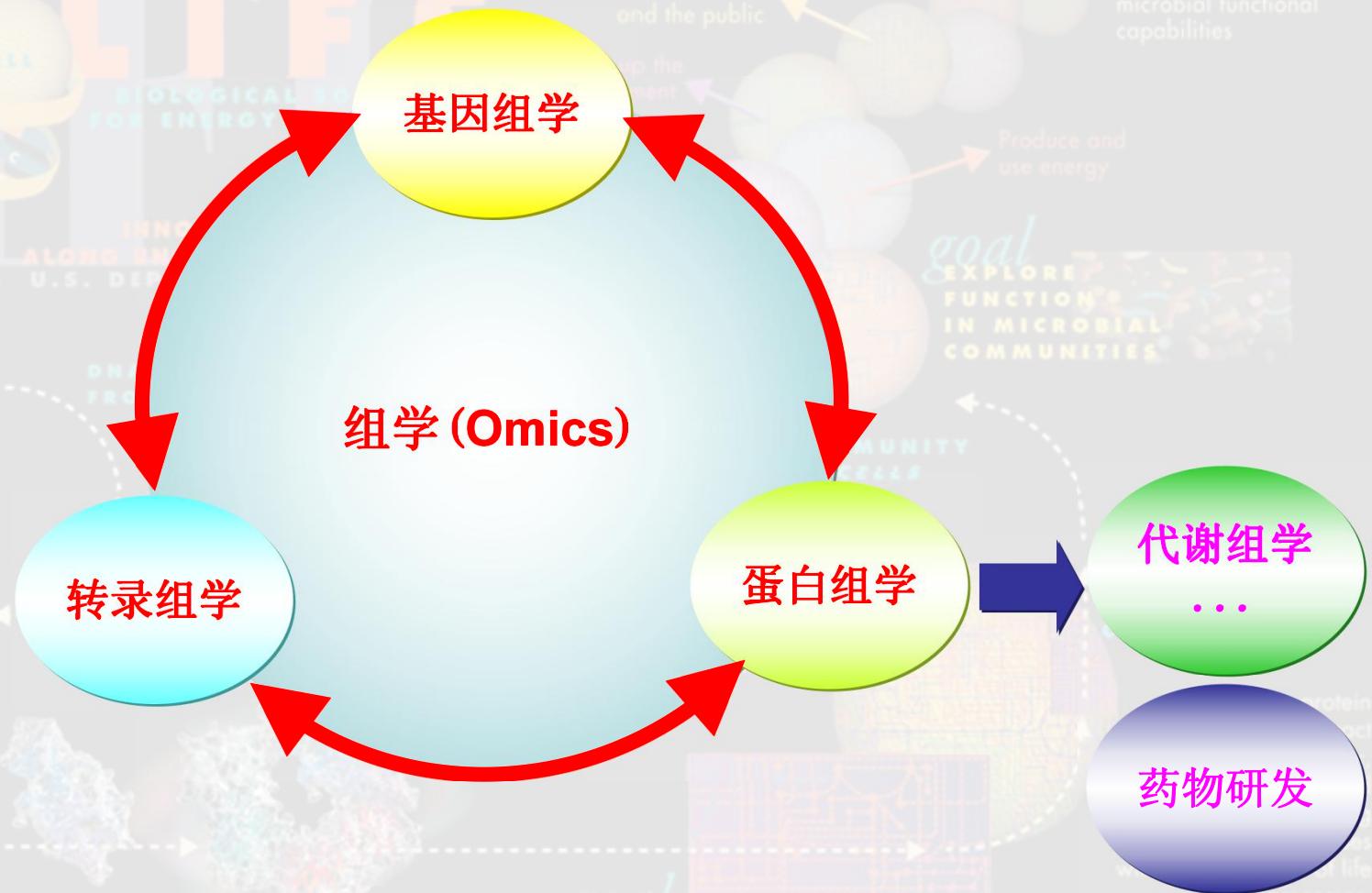
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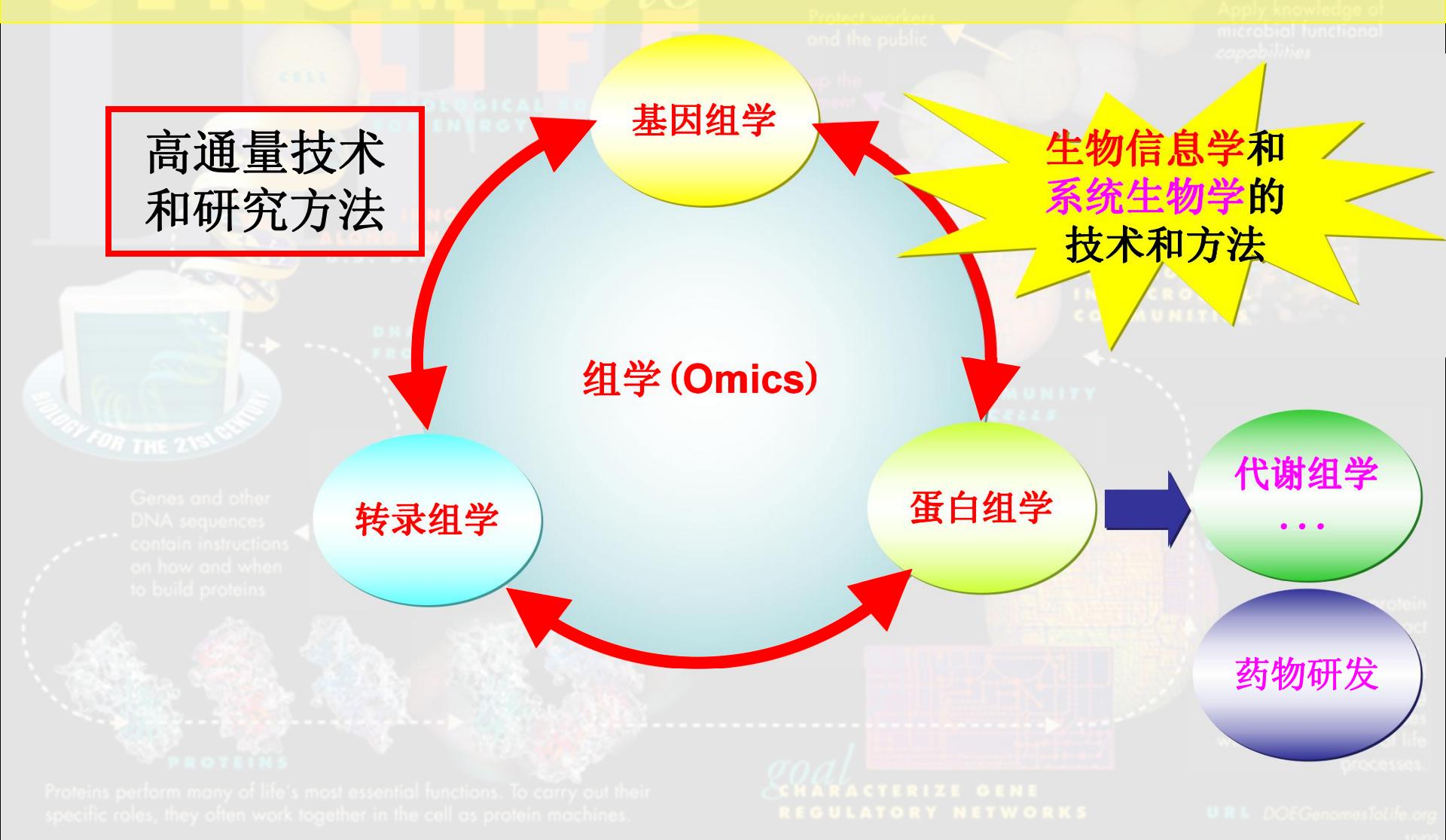
生物信息学的研究内容和方向



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生物信息学的研究内容和方向



生物信息学的研究内容和方向(2)

1. 序列分析 (Sequence alignment, databases)

2. 基因组注释 (Gene finding)

3. 计算进化生物学、比较基因组学



生物信息学的研究内容和方向(2)

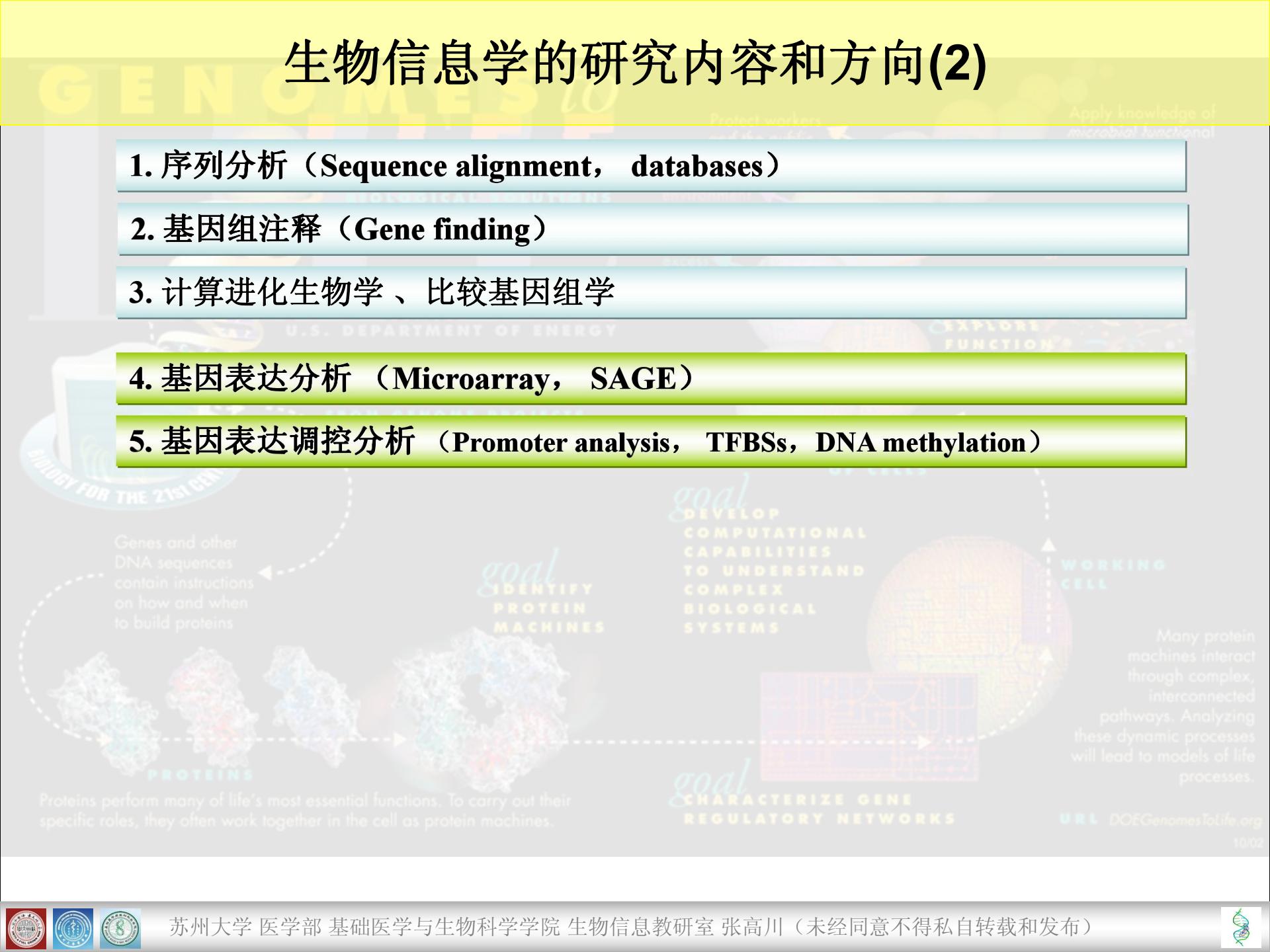
1. 序列分析 (Sequence alignment, databases)

2. 基因组注释 (Gene finding)

3. 计算进化生物学、比较基因组学

4. 基因表达分析 (Microarray, SAGE)

5. 基因表达调控分析 (Promoter analysis, TFBSS, DNA methylation)



生物信息学的研究内容和方向(2)

1. 序列分析 (Sequence alignment, databases)

2. 基因组注释 (Gene finding)

3. 计算进化生物学、比较基因组学

4. 基因表达分析 (Microarray, SAGE)

5. 基因表达调控分析 (Promoter analysis, TFBSS, DNA methylation)

6. 蛋白质表达分析 (2D PAGE, Mass spectrometry-MS)

7. 结构生物信息学：蛋白质结构预测、分子相互作用

8. 计算机辅助药物研发



生物信息学的研究内容和方向(2)

1. 序列分析 (Sequence alignment, databases)

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8. 计算机辅助药物研发

9. 多组学数据的整合分析

10. 生物系统模拟 (Computational systems biology)

11. 文献分析，文本挖掘 (Text mining)



生物信息学在生命科学研究中的应用(1)



Protect workers
and the public

Apply knowledge of
microbial functional
capabilities

GENOMES TO LIFE
BIOLOGY FOR THE
21ST CENTURY
GENOME
COMPUTER
TOOLS
PROTEINS

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goal
CHARACTERIZE GENE
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URL: DOEGenomesToLife.org

10/02



生物信息学在生命科学研究中的应用(1)



你这是怎
么啦？



goal
CHARACTERIZE GENE
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10/02

Protect workers
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Apply knowledge of
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BIOLOGY FOR THE
BIOECONOMY

o

Many protein
machines interact
through complex
interconnected
pathways. Analyzing
these dynamic processes
will lead to models of life
processes.

Proteins per
specific role



生物信息学在生命科学研究中的应用(1)



生物信息学在生命科学研究中的应用(2)

The collage consists of several panels:

- Top Left:** A computer monitor displays a molecular model of a protein-DNA complex. Below it, a person is seen working at a computer in a lab setting. A blue banner at the bottom reads "计算机辅助药物设计实验室".
- Top Right:** A diagram showing a green protein structure with various colored tubes (yellow, pink, blue) representing signal transduction pathways. A red arrow points to a central yellow tube. Text above the diagram includes "Protect workers and the public", "Clean up the environment", and "Apply knowledge of microbial functional capabilities".
- Bottom Left:** A yellow vertical box contains the Chinese characters "药物研发" (Drug Development). To its left is a circular graphic with the text "BIOLOGY FOR THE 21ST CENTURY" and "Genes and DNA sequences contain the information on how to build proteins". Below this is a small image of a protein structure.
- Bottom Center:** A large green protein structure with internal pathways. A yellow banner at the bottom reads "goal CHARACTERIZE GENE REGULATORY NETWORKS".
- Bottom Right:** A URL "URL: DOEgenomes2life.org" and the number "10/02".

Text at the bottom left of the collage states: "Proteins perform many of life's most essential functions. To carry out their specific roles, they often work together in the cell as protein machines."



生物信息学在生命科学研究中的应用(3)



遗传育种



生物信息学在生命科学研究中的应用(4)



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Protect workers
and the public

Apply knowledge of
microbial functional



any protein
interact
in complex
connected
Analyzing
processes:
models of life
processes.

REGULATORY NETWORKS

URL: DOEgenomes2life.org

10/02

遗传与进化分析

生物信息学在生命科学研究中的应用(4)



遗传与进化分析



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Protect workers
and the public

Apply knowledge of
microbial functional

REGULATORY NETWORKS

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生物信息学在生命科学研究中的应用(4)



遗传与进化分析



生物信息学理论知识和技术方法的更新

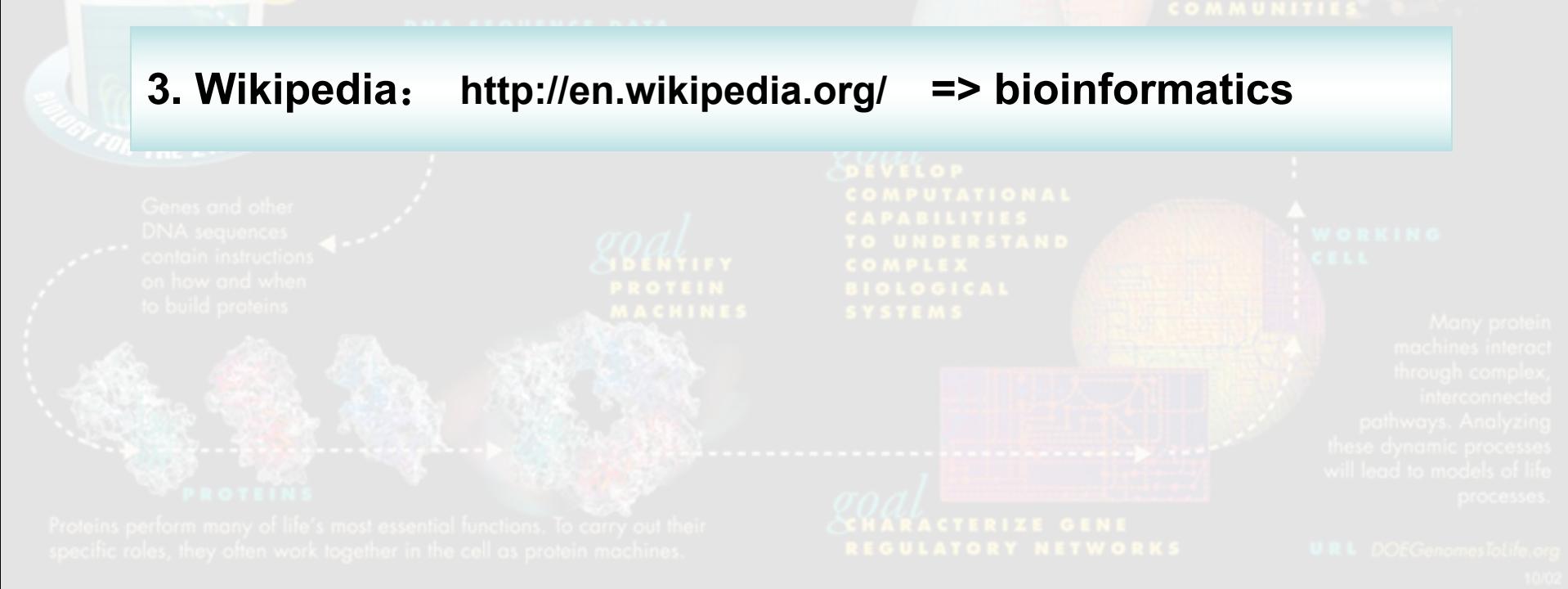
Protect workers
and the public

Apply knowledge of
microbial functional
genomics

1. 百度百科: <http://www.baidu.com/> => 生物信息学

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生物信息学理论知识和技术方法的更新

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生命医学的
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Proteins perform many of life's most essential functions. In specific roles, they often work together in the cell as protein

Many protein machines interact through complex interconnected pathways. Analyzing these dynamic processes will lead to models of life processes.

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带着问题来学习

生物学问题的提出



?



带着问题来学习

根据讲授的生物信息学的技术和方法：

(1) 理论知识

(2) 数据库资源

(3) 分析工具

生物学问题的提出

生物信息学
的解决方案
和思路

?

Proteins perform many of life's most essential functions. To carry out their specific roles, they often work together in the cell as protein machines.

Apply knowledge of microbial functional capabilities

Produce and use energy

Many protein machines interact through complex interconnected pathways. Analyzing these dynamic processes will lead to models of life processes.

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带着问题来学习

根据讲授的生物信息学的技术和方法：

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生物学问题的提出

生物信息学
的解决方案
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生物学问题的解决

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machines interact
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【结合专业知识：选定自己感兴趣的生物学问题】

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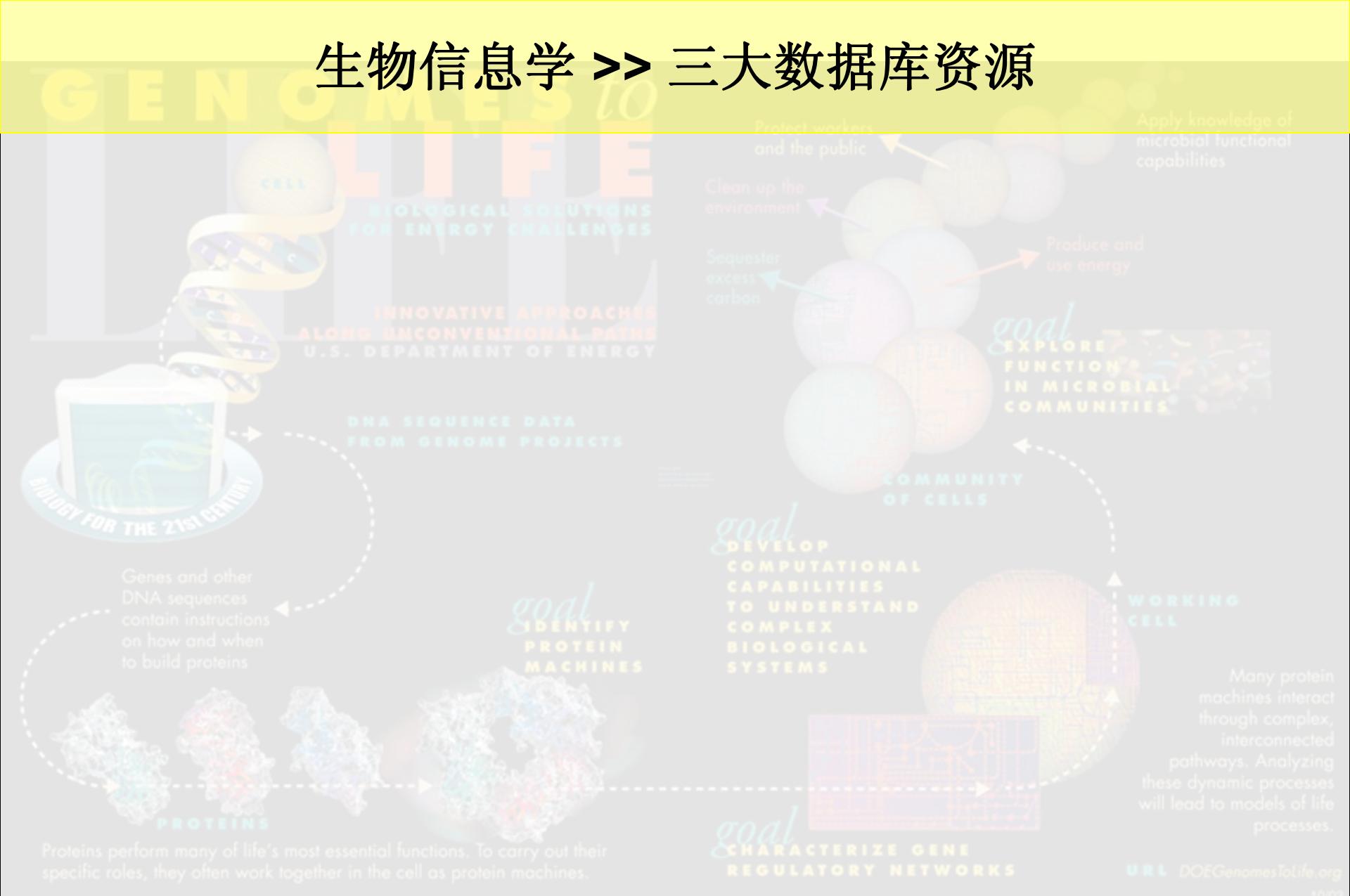
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CHARACTERIZE GENE
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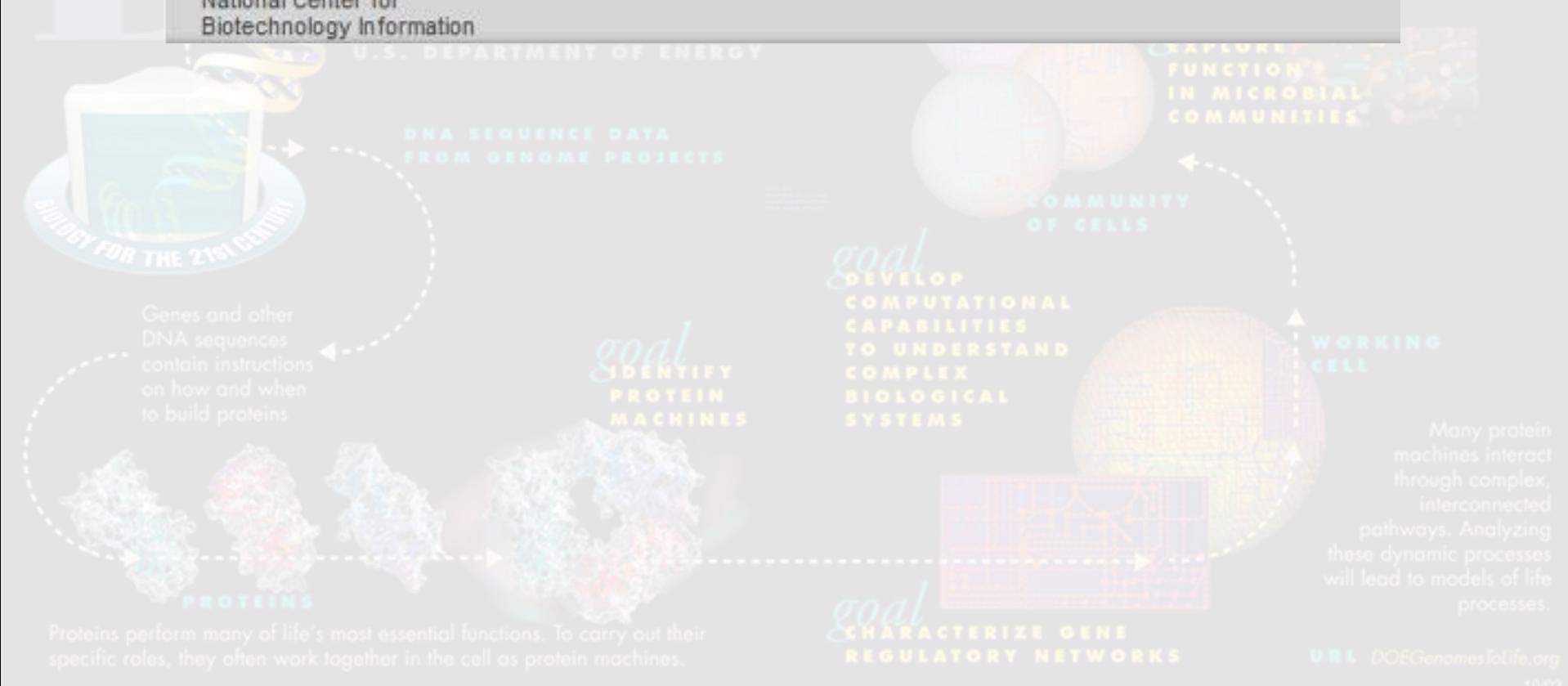


生物信息学 >> 三大数据库资源



生物信息学 >> 三大数据库资源

The screenshot shows the NCBI homepage with the URL <http://www.ncbi.nlm.nih.gov/> highlighted in yellow. The page features the NCBI logo and navigation links for Resources and How To. A search bar labeled "All Databases" is present, along with the word "Entrez" in large red letters.



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<http://www.ncbi.nlm.nih.gov/>

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SRS

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DNA sequences contain instructions on how and when to build proteins



Proteins perform many of life's most essential functions. To carry out their specific roles, they often work together in the cell as protein machines.

goal
IDENTIFY
PROTEIN
MACHINES

TO UNDERSTAND
COMPLEX
BIOLOGICAL
SYSTEMS

WORKING
CELL

Many protein machines interact through complex, interconnected pathways. Analyzing these dynamic processes will lead to models of life processes.

goal
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Search NCBI databases

Help

vasculogenesis

Search

Results found in 21 databases for "vasculogenesis"

Literature

Books	527	books and reports
MeSH	4	ontology used for PubMed indexing
NLM Catalog	13	books, journals and more in the NLM Collections
PubMed	3,188	scientific & medical abstracts/citations
PubMed Central	14,155	full-text journal articles

Health

ClinVar	2	human variations of clinical significance
dbGaP	0	genotype/phenotype interaction studies
GTR	0	genetic testing registry
MedGen	3	medical genetics literature and links
OMIM	50	online mendelian inheritance in man
PubMed Health	110	clinical effectiveness, disease and drug reports

Genomes

Assembly	0	genome assembly information
BioCollections	0	museum, herbaria, and other biorepository collections
BioProject	35	biological projects providing data to NCBI
BioSample	0	descriptions of biological source materials
Clone	0	genomic and cDNA clones
dbVar	0	genome structural variation studies
Genome	0	genome sequencing projects by organism
GSS	0	genome survey sequences
Nucleotide	280	DNA and RNA sequences
Probe	2	sequence-based probes and primers
SNP	1	short genetic variations
SRA	0	high-throughput DNA and RNA sequence read archive
Taxonomy	0	taxonomic classification and nomenclature catalog

Genes

EST	0	expressed sequence tag sequences
Gene	456	collected information about gene loci
GEO DataSets	48	functional genomics studies
GEO Profiles	555,900	gene expression and molecular abundance profiles
HomoloGene	0	homologous gene sets for selected organisms
PopSet	0	sequence sets from phylogenetic and population studies
UniGene	0	clusters of expressed transcripts

Proteins

Conserved Domains	8	conserved protein domains
Protein	253	protein sequences
Protein Clusters	0	sequence similarity-based protein clusters
Structure	22	experimentally-determined biomolecular structures

Chemicals

BioSystems	88	molecular pathways with links to genes, proteins and chemicals
PubChem BioAssay	67	bioactivity screening studies
PubChem Compound	0	chemical information with structures, information and links
PubChem Substance	0	deposited substance and chemical information



Search NCBI databases

Help

vasculogenesis

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Results by year

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Role and regulation of growth plate vascularization during coupling with osteogenesis in tibial dyschondroplasia of chickens.

Huang SC, Zhang LH, Zhang JL, Rehman MU, Tong XL, Qiu G, Jiang X, Iqbal M, Shahzad M, Shen YQ, Li JK. Sci Rep. 2018 Feb 27;8(1):3680. doi: 10.1038/s41598-018-22109-y. PMID: 29487404 Free PMC Article Similar articles

Resveratrol protects late endothelial progenitor cells from TNF- α -induced inflammatory damage by upregulating Krüppel-like factor-2.

Chu H, Li H, Guan X, Yan H, Zhang X, Cui X, Li X, Cheng M. Mol Med Rep. 2018 Feb 20. doi: 10.3892/mmr.2018.8621. [Epub ahead of print] PMID: 29484436 Similar articles

Evidence of cardiac involvement in the fetal inflammatory response syndrome: disruption of gene networks programming cardiac development in nonhuman primates.

Mitchell T, MacDonald JW, Srinouanprachanh S, Bammler TK, Merillat S, Boldenow E, Coleman M, Agnew K, Baldessari A, Stencel-Baerenwald JE, Tisoncik-Go J, Green RR, Gale MJ Jr., Rajagopal L, Adams Waldorf KM. Am J Obstet Gynecol. 2018 Feb 21. pii: S0002-9378(18)30009-7. doi: 10.1016/j.ajog.2018.01.009. [Epub ahead of print] PMID: 29475580 Similar articles

Neovasculature can be induced by patching an arterial graft into a vein: A novel in vivo model of spontaneous arteriovenous fistula formation.

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The screenshot shows the PubMed search results for the term "vasculogenesis". The search interface includes a sidebar with filters like "Text availability" and "Species". The main results page displays a list of 3188 items, with the first few results highlighted by yellow starburst annotations:

- 1. [Role and regulation of growth plate vascularization during coupling with osteogenesis in tibial dyschondroplasia of chickens.](#)
Huang SC, Zhang LH, Wang JL, Rehman MU, Liang XL, Qiu J, ... [et al.]
Sci Rep. 2018 Feb 27;8(1):3680. doi: 10.1038/s41598-018-23220-w.
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Mitchell T, MacDonald JW, Srinivasanprachary S, Agnew K, Baldessari A, Stencel-Baerenwald EM, Adams Waldorf KM.
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Neovasculature can be induced by patching an arterial graft into a vein: A novel in vivo model of spontaneous arteriovenous fistula formation.

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1. Kinetic Analysis of **Vasculogenesis** Quantifies Dynamics of **Vasculogenesis** and Angiogenesis In Vitro.

Varberg KM, Winfree S, Dunn KW, Haneline LS.
J Vis Exp. 2018 Jan 31;(131). doi: 10.3791/57044.
PMID: 29443032
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2. Mouse Metanephric Mesenchymal Cell-Derived Angioblasts Undergo **Vasculogenesis** in Three-Dimensional Culture.

Patel M, Velagapudi C, Burns H, Doss R, Lee MJ, Mariappan MM, Wagner B, Arar M, Barnes VL, Abboud HE, Barnes JL.
Am J Pathol. 2018 Mar;188(3):768-784. doi: 10.1016/j.ajpath.2017.10.022. Epub 2017 Dec 19.
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Wang S, Yin Z, Zhao B, Qi Y, Liu J, Rahimi SA, Lee LY, Li S.
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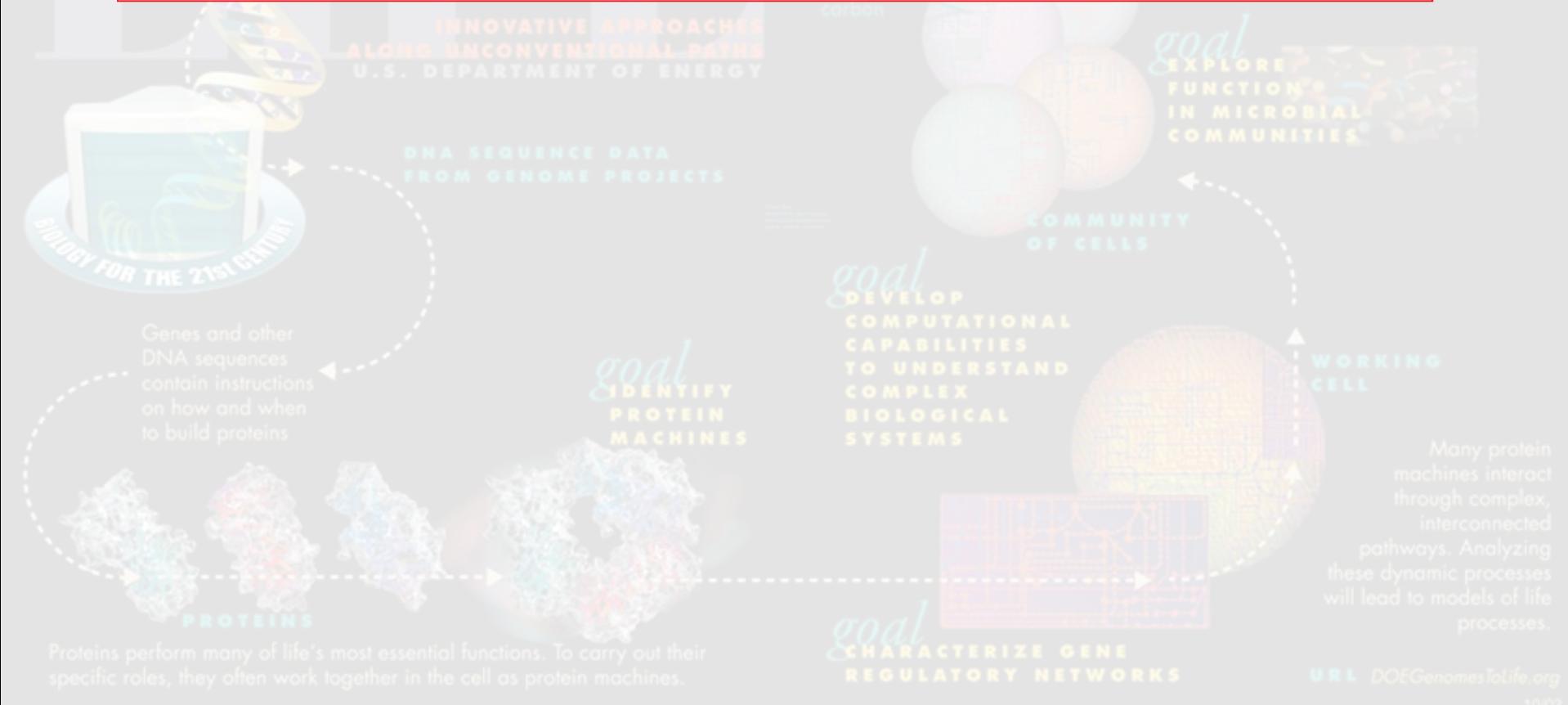
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DP - 2012 Jul 10
TI - A novel function of lycorine hydrochloride in the inhibition of metastatic melanoma C8161 cell-dominant vasculogenic mimicry.
LID - 10.1111/j.1755-148X.2012.01036.x [doi]
AB - Melanoma cells actively participate in tumor angiogenesis and vasculogenic mimicry. However, Moreover, our study provides a new cut-in point for exploring novel anti-melanoma therapeutics and suggests that LH is a novel potential candidate drug for anti-melanoma therapy. (c) 2012 John Wiley & Sons A/S.
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