

Molecular and Cellular Biology (MCB)

BB101

LECTURE-1

Introduction to Biology

Sanjeeva Srivastava, Ph.D.

Associate Professor
Biosciences and Bioengineering, IIT Bombay

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Course Overview

Module	Faculty	Quiz	Mid-sem	End-sem	Total
Molecular & Cell Biology (MCB)	Prof. Sanjeeva Srivastava	15	10	0	25
Molecular & Cell Biology (MCB)	Prof. Subramahnyam G	0	25	0	25
Physical Biology	Prof. Ambarish Kunwar	10	0	20	30
Biomedical Engineering	Prof. Soumyo Mukherji	0	0	20	20

Module-I	50 marks
Module-II	30 marks
Module-III	20 marks
	100 marks

Mid-sem	35 marks
End-sem	40 marks
Quiz	25 marks
	100 marks

Quiz 1 + Mid sem. + Quiz 2 + End sem.

Minimum 30%

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Class Schedule

Two 1.5-hour lectures per week; 1 H Tutorial

	Class	Venue	Slot	Student
D3.	Tuesday 3:30 pm to 5:00 pm	LA101	11A	ME, EP, CH, BS
	Friday 3:30 pm to 5:00 pm	LA101	11B	
D1.	Tuesday 11.35 am to 1.00 pm	LA101	3B	CS, EE
	Thursday 8.00 am to 9.30 am	LA101	3C	
T	Monday 8:30 am to 9:30 am	LT – 301, 302, 303, 202, 203	Slot 1A	
T	Wednesday 2:00 pm to 3:30 pm	LT – 001, 002, 003, 102, 103	Slot X1	

Attendance policy

Mandatory – in addition to biometric, random hard copy attendance

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Contact Information

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Associate Professor
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Biosciences & Bioengineering
sanjeeva@iitb.ac.in
Phone: 7779

Handouts: <http://moodle.iitb.ac.in/>

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Teaching Assistants

#	Name (mobile)	E-mail(@iitb.ac.in)	Remarks
1	Eshant Bhatia(8828291215)	15I300001@	PhD, RB Lab [MSc, Biotechnology]
2	Nikita Jain (8899917924)	15i300004@	PhD, RPur [B.Tech,M.Sc, Biotechnology]
3	Komal Patel (164300008)	komalpatel@	PhD, S.Maji [M.Sc, Microbiology]
4	Sravanti K.(8291291624)	164300003@	PhD, PPLab [MSc, Biotechnology]
5	Vijendra Kavatalkar (9669192160)	vijendrak@	Ph.D, [M.Sc., Microbiology]
6	Sukhjeet Kaur(9888463480)	Sukhjeetkaur622@	PhD, NSP Lab (M.Sc., Biotechnology)
7	Rituparna saha	164300004@	PhD, PT Lab [MSc, Microbiology]
8	Chhaminder Kaur (9871477981)	Chhaminder.kaur@	PhD, SP Lab [B.Tech, Biotechnology]
9	Brijesh Gada (7600800816)	164303002@	PhD, S Sen lab [MSc, Biotechnology]
10	Shalini Aggarwal	shalini010293@	PhD, SS lab [MSc, Biotechnology]
11	Shivangi Shukla (9545314467)	164303005@	PhD, AKumar lab(Msc, Biotechnology)

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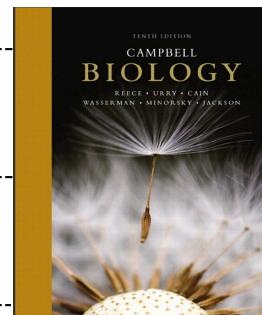
Lecture Schedule (For Prof. Sanjeeva Srivastava)

- 1. Introduction to biology, Cell
- 2. Cell and Cell cycle
- Tutorial-1

- 3. Development
- 4. Genetics
- Tutorial-2

- 5. Chromosomal & Molecular basis of Inheritance
- 6. DNA tools & Biotechnology
- Tutorial-3

- 7. Evolution & Biological Diversity
- Tutorial-4



Campbell Biology, 10th edition
by Reece, Urry, Cain,
Wasserman, Minorsky,
Jackson

Pearson publishers

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Teaching Philosophy

Facilitate learning experience of students

Motivate students for exciting areas of research in biology

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Outline

1. Introduction: Why Biology for Engineers?
2. Properties & Processes Associated with Life

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- Why biology for engineers?
- Life and its properties

Why Biology for Engineers?

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- Why biology for engineers? - Basic problems
- Food, Climate, Diseases
- Essential Requirements, Energy

I. Biologist or Engineer:

We Share Same Basic Problems!

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- Why biology for engineers? - Basic problems
- Food, Climate, Diseases
- Essential Requirements, Energy

1. How to Feed Growing World's Population?

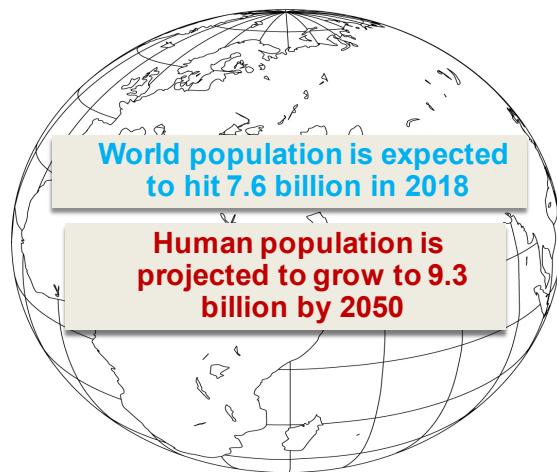
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How to Feed Growing World's Population?



How do we feed the growing world population when most arable land on the planet is already under cultivation?

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Environmental Impact on Food Production

- Abiotic stresses impose major limitations on food production worldwide
- 20% of agricultural land in world under salinity stress
- A third of earth's surface is threatened by desertification
- Crops in 90% of arable land will be subjected to one or more environmental stresses

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Environmental Impact on Food Production



DNA HOME INDIA WORLD BUSINESS TECH SPORTS ENTERTAINMENT PHOTOS VIDEOS

TRENDING# TTV Dhinakaran Kulbhushan Jadav Winter Session of Parliament Bigg Boss 11 Amit Shah

Home > India

Cyclone Ockhi: Mumbai receives highest December rainfall since 1967



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How Genetic Engineering & Biotechnology can help?

- **Recombinant DNA molecule:** a molecule containing DNA from two different sources

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How Genetic Engineering & Biotechnology can help?

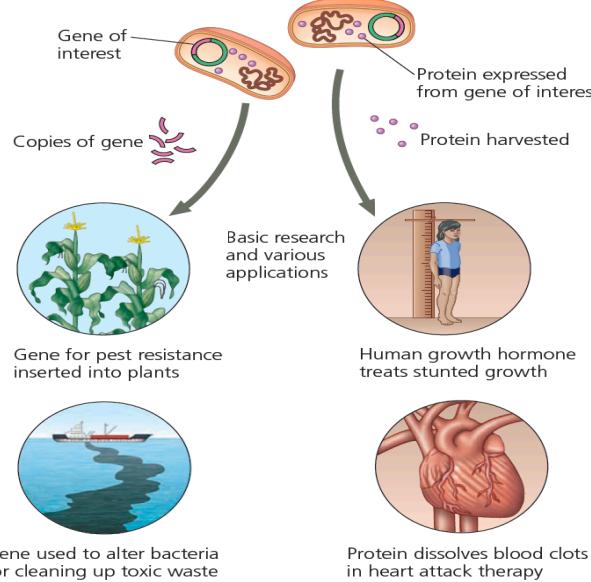


Figure 20.5 17

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- Why biology for engineers? - Basic problems
- Food, Climate, Diseases
- Essential Requirements, Energy

2. Climate Change & Global Warming

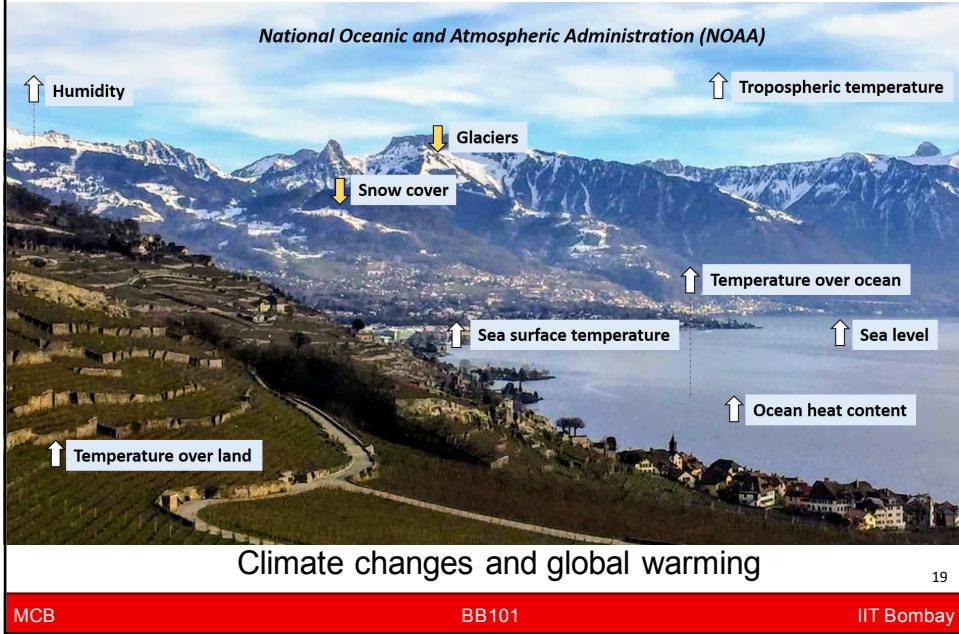
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Climate Changes



- Why biology for engineers? - Basic problems
- Food, Climate, Diseases
- Essential Requirements, Energy

3. How to Treat Deadly Diseases?

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Human Diseases



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Human Diseases: HIV



- HIV continues to be a major global public health issue, having claimed more than 34 million lives so far.
- Millions of people died from HIV-related causes globally.

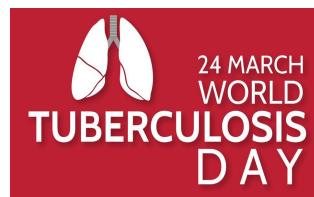
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Human Diseases: TB



- Tuberculosis (TB) is second most deadly disease due to a single infectious agent.
- Over 95% of TB deaths occur in low- and middle-income countries.

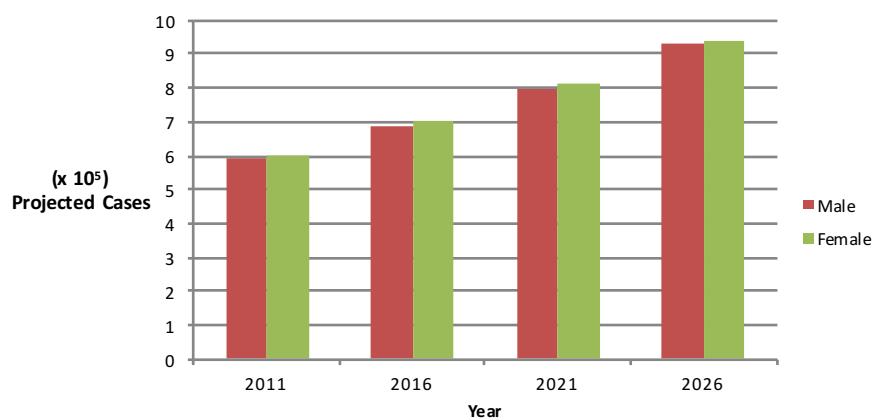
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Cancer: An Indian Scenario



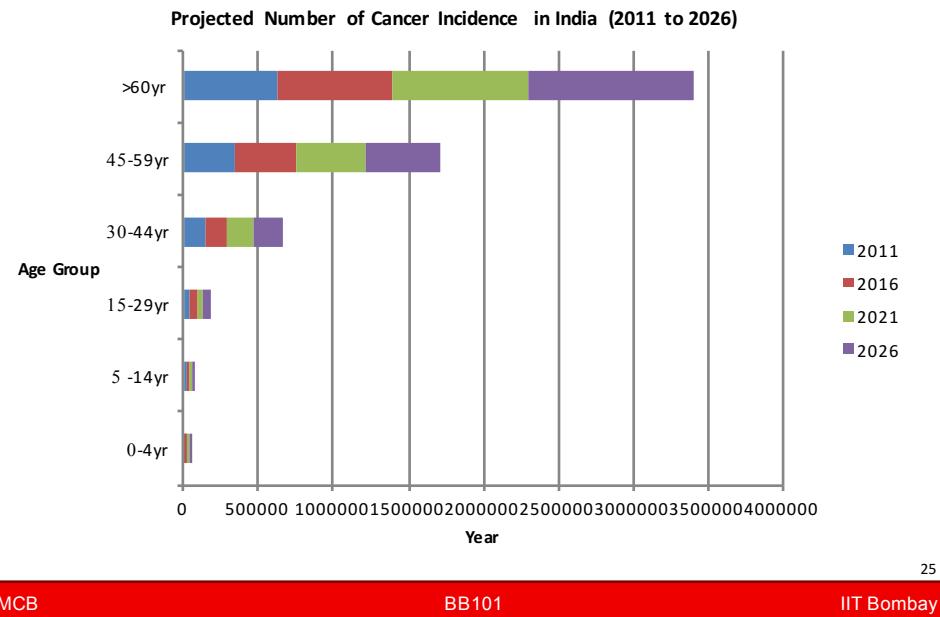
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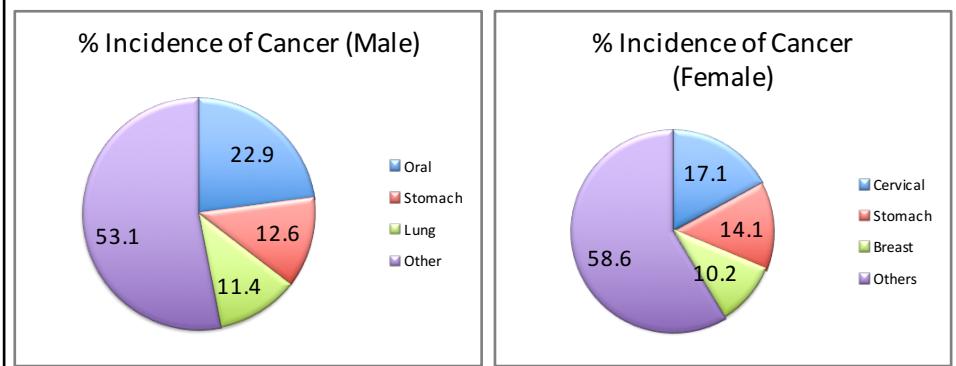
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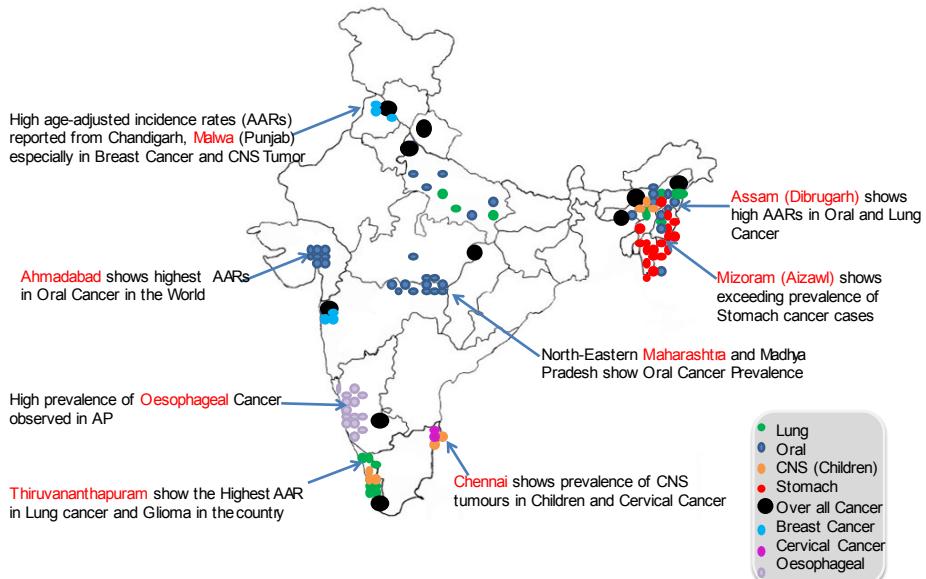
Cancer: An Indian Scenario



Top most Fatal Cancers and Comparison of Cancer Sites in India



Geographic Prevalence of Cancers in India



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THE TIMES OF INDIA | Chandigarh

Malwa zone of Punjab sitting on cancer volcano: Survey

Neel Kamal, TNN Dec 14, 2012, 04:09PM IST

The Telegraph
calcutta, india

MAPPING CANCER
- Aizawl has highest incidence of stomach cancer after Japan

After four years of trying to track down malignancies, the government is ready with a cancer atlas highlighting patterns observed never before in India. G.S. Mudur reports

THE TIMES OF INDIA | Kochi

You are here: Home > City > Kochi > Crime > Civic Issues > Politics > Schools & Colleges

Is Kerala cancer's own country?

P Sudhakaran, TNN May 15, 2013, 08:57 AM IST

THE HINDU

Stomach cancer incidence set to rise, say experts

Eso India organising awareness run on Nov. 26

THE TIMES OF INDIA | Ahmedabad

Oral cancer doubles in Ahmedabad in two decades

TNN Feb 3, 2013, 04:38AM IST

THE TIMES OF INDIA | Guwahati

Stats reveal oesophageal cancer common among NE women

Anangsha Patra, TNN Aug 26, 2013, 10:46AM IST

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- Why biology for engineers? - Basic problems
- Food, Climate, Diseases
- **Essential Requirements**, Energy

4. Essential Requirements of Life

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Essential Requirements of Life

- Clean air
 - pollution control, microorganism testing
- Clean and adequate water
 - water level low, polluted due to chemical & fertilizers
- Food and nutritional security

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- Why biology for engineers? - Basic problems
- Food, Climate, Diseases
- Essential Requirements, Energy

5. Energy: Exploring Alternate Resources

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Energy: Alternative Energy Resources

- Biofuel
- Wind power
- Photovoltaic
- Geothermal

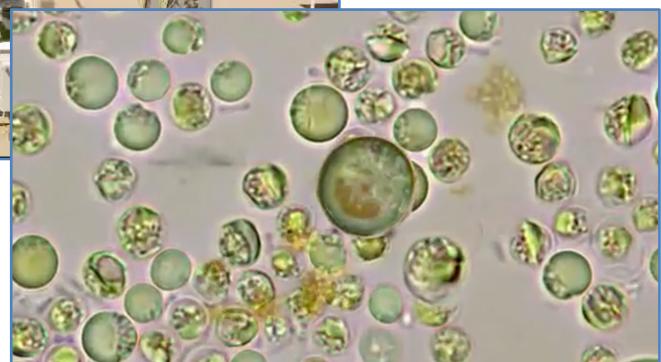
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Energy: Biofuel

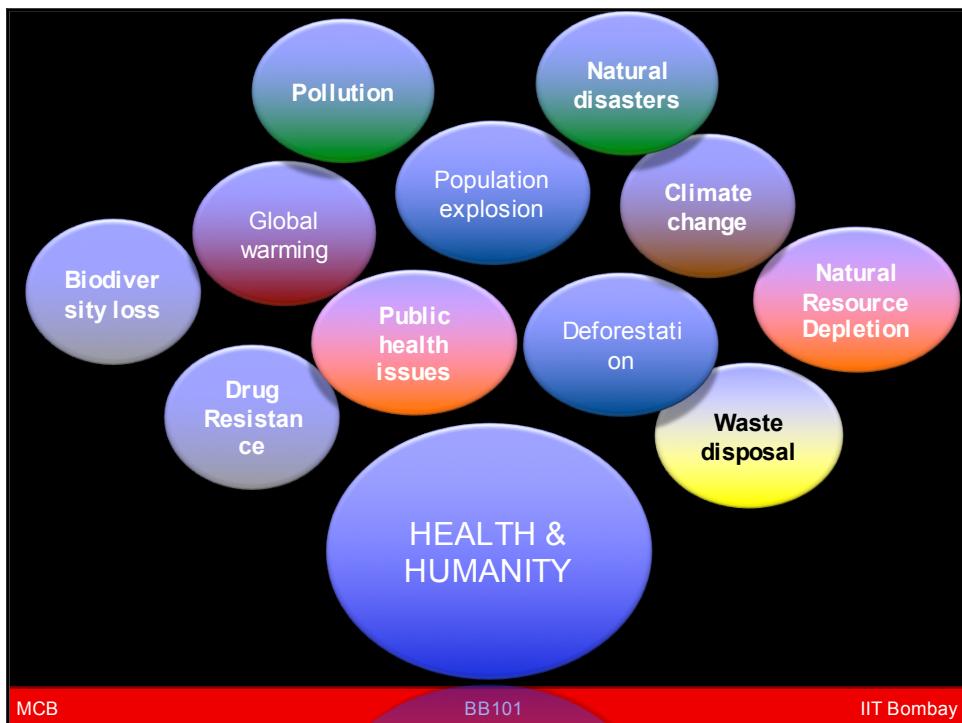


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Why Biology for Engineers!

- Major life problems require inter-disciplinary skills for effective solutions
- Genetic engineering & biotechnology aims to provide promising solutions

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- Why biology for engineers?
- Basic problems
- Bio-inspired engineering

II. Bio-inspired Engineering

Studying nature's creation & elements, and from such inspiration develop designs and models to solve complex human problems.

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Bio-inspired Engineering: Waterproofing



Lotus, crevices of microscopic rough leaf surface traps air upon which water droplets float.

Lotus: lessons for waterproofing

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THE ORIGINAL
TEXTILE FINISH
**INSPIRED BY
NATURE.**

GreenShield is a multi-functional technology providing water and oil repellency and stain resistance in a single finish.

PRODUCT APPLICATIONS >

GET GREENSHIELD >

URL: <https://greenshieldfinish.com>

- *Green Shield Construction Chemicals, used “lotus effect” in waterproofing. Result - achieved water & stain repellency*

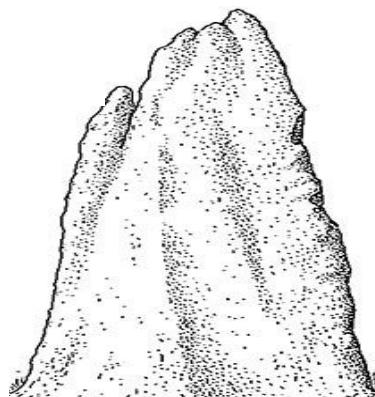
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Bio-inspired Engineering: Architecture



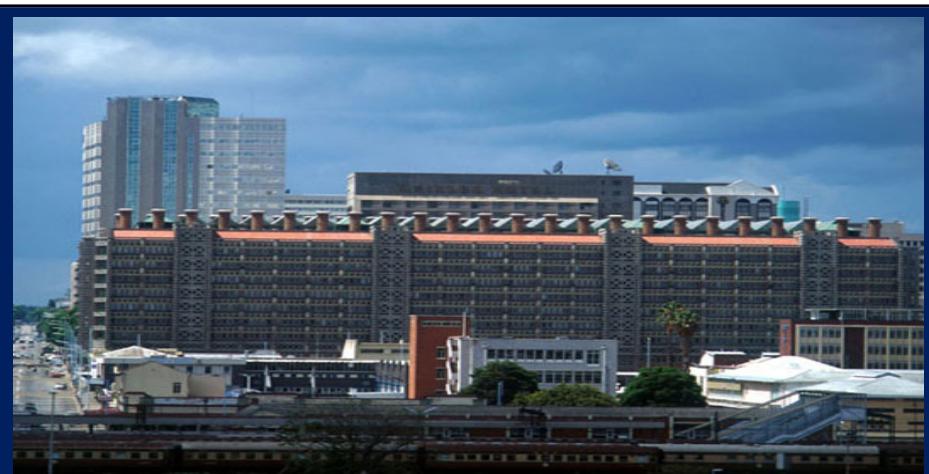
Termite mounds maintain stable temp by passive cooling
Creation of sustainable buildings: Lessons from Termites

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URL: <https://inhabitat.com/building-modelled-on-termites-eastgate-centre-in-zimbabwe/>

Eastgate Building, Zimbabwe - Air conditioning system modeled on self-cooling mounds termites

Result – mechanical or passive cooling system used 10% energy for ventilation than conventional building

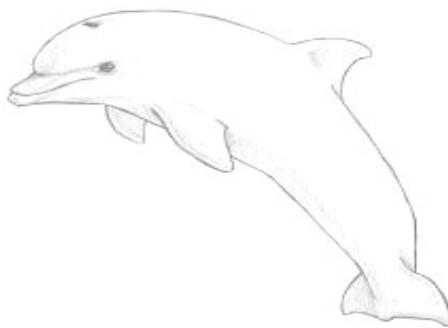
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Bio-inspired Engineering: TSUNAMI ALERT SYSTEM



*Lessons from Dolphins: Warning people about Tsunamis
Dolphins recognize calls ~25 kms away, cope with sound scattering behavior of high frequency*

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EvoLogics

Products > Underwater Acoustic Modems > Underwater Acoustic Modems

Scroll and click to view Product Information

UNDERWATER ACOUSTIC MODEMS

S2CM HS S2CM MODEMS S2CR 48/78 S2CR 42/65

M-Series Underwater Acoustic Modems

The S2C M-series offers the full benefits of the company's patented S2C (Sweep-Spread Carrier) communication technology in a light and compact design.

The S2C M-series is fully compatible with EvoLogics standard S2C R and S2C R USBL series and includes a selection of directional and non-directional short- and mid-range devices for various application scenarios, especially those where size and weight are critical. These modems use EvoLogics' S2C technology and communication technology to overcome the challenges of dynamic underwater environments and offer a great improvement in various operating conditions. S2C M-series modems are smaller and lighter than standard EvoLogics R-series devices, but deliver the uncompromising performance of the full-sized product line.

Device	Application
S2C M HS	Ultra-high-speed device for fast short-range transmissions in shallow waters
S2C M 48/78	High-speed device for short-range applications in shallow waters
S2C M 42/65	High-speed device for short- and medium-range applications, wide-angle beam pattern for communication in vertical, slant and horizontal channels
S2C M 18/34	All-round performer for medium-range applications

Underwater Acoustic Modems Key Features S2C Technology Gallery Research

URL: <https://www.evologics.de>

- EvoLogics - high performance underwater sonar, underwater robotics
- Result - high-performance underwater modem for data transmission, currently employed in tsunami early warning system in Indian Ocean

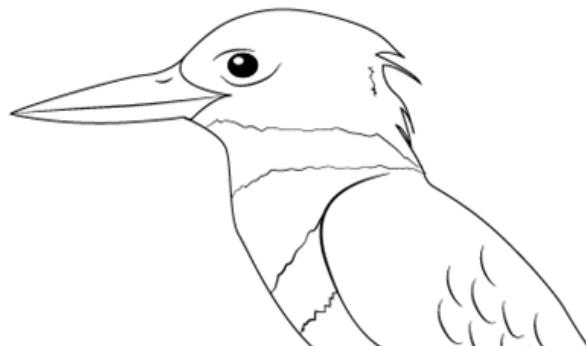
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TRANSPORTATION:



Learning Efficiency from Kingfisher

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JapanStation.com

URL: <https://www.japanstation.com/shinkansen-high-speed-train-network-in-japan/>

- Eiji Nakatsu, chief engineer and bird-watcher
- Modeled front-end of Shinkansen bullet train inspired from beak of kingfisher
- Result - quiet train, less electricity, travels faster

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FOG HARVESTING TECHNOLOGY:



Beetle (*Stenocara gracilipes*)

Technology from an IITB alumnus:

Material Sciences & Engineering, MIT Lessons from Beetle

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URL: <http://news.mit.edu/2011/fog-harvesting-0421>

- Namib Desert beetle (*Stenocara gracilipes*) collects water droplets from morning fog on its back & let moisture roll down into its mouth
- Device consist of fence-like mesh to attract droplet & drip into container

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- Why biology for engineers?
- Basic problems
- Bio-inspired engineering
- **Mega bio projects**

III. Technology Giants Investing in Mega Biology Projects

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Google X Projects: Google Brain



eWEEK

URL: <http://www.ewEEK.com/cloud/10-bold-google-x-projects-aiming-for-tech-breakthroughs>

Advances in artificial intelligence. Google brain aims to build intelligent machines

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Google X Projects: Smart Contact Lens



eWEEK

URL: <http://www.ewEEK.com/cloud/10-bold-google-x-projects-aiming-for-tech-breakthroughs>

Chips and glucose sensors for diabetes

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IBM WATSON

<https://www.ibm.com/watson/>

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- Why biology for engineers?
- Basic problems
- Bio-inspired engineering
- Mega bio projects
- Bio-research at IITB

IV. Bio-research is a reality in IIT Bombay

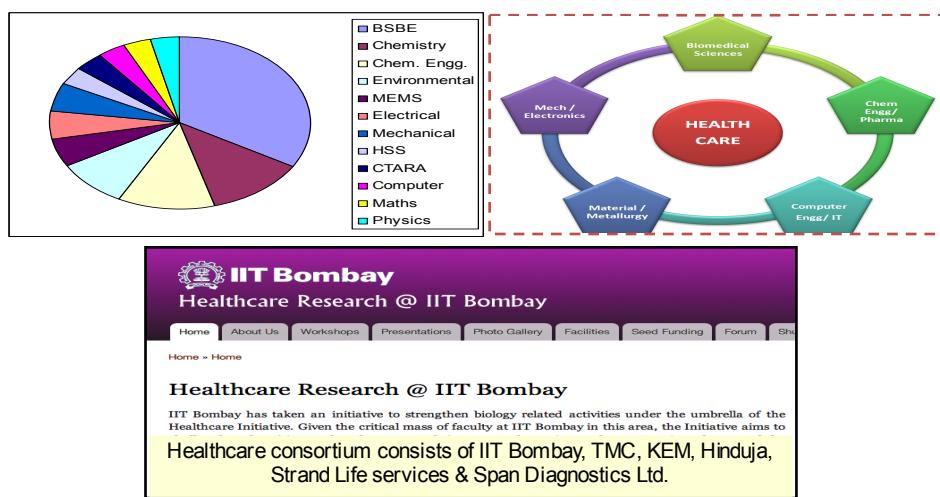
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IIT Bombay: faculty involved in Bioresearch

- 15% faculty of institute actively involved in bio-research
- A wide-spectrum from *basic to applied & translational research*



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IITB Faculty Pursuing Interdisciplinary Bio Research



<http://www.bio.iitb.ac.in/people/faculty/srivastava-r>

Mobile based portable diagnostic system - urine analysis to blood sugar test

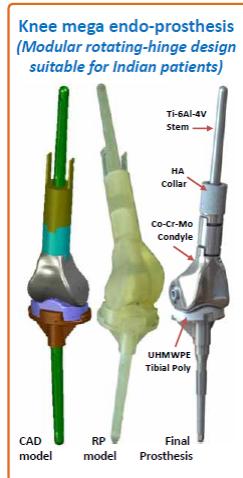
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IITB Faculty Pursuing Interdisciplinary Bio Research



<http://orthocad.iitb.ac.in/betic/>

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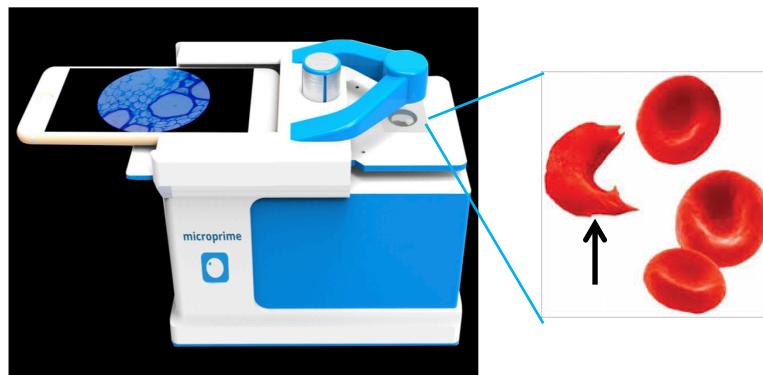
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IITB Faculty Pursuing Interdisciplinary Bio Research

Mobile-phone based diagnostic platform to detect sickle cells in blood at point-of-care



www.bio.iitb.ac.in/~dpaul/research.html

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Several IITB Engineer Alumni Pursue Bio Research

Member of BASIC SCIENCES
MALIK LAB

Projects Lab Members Publications Joining the Lab Lab News Contact Us

HHMI janelia farm research campus

Research& Labs Campus & Community Research Resources Student Programs Conferences & Events Professional Opportunities

Malik Lab Members
Dr. Harmit Malik

Harmit Malik grew up in the Institute of Technology where he was introduced to molecular biology by Prof. S. Rao in the nascent Biotechnology Department. After University of Rochester, under Prof. J. D. Watson, he did his Ph.D. in molecular elements of histones and other proteins from the Helen Hay Whitney Foundation. He then decided to stay at the Hutchins Center for Medical Research and Genetics, Boston, MA, USA.

Harmit is interested in a variety of problems in molecular evolution. He studies the molecular mechanisms that lead to better understand the molecular sources of conflict between the genome and its environment. His work focuses on the molecular basis of adaptation to environmental changes, particularly to retroviruses. Harmit's members include his wife, Chanda, and their two sons, Harsh and Arun.

Harmit is married to Chanda, a graphic designer. They have two sons, Harsh and Arun.

Vivek studied to be an aerospace engineer, but instead pursued numerical simulation softwares and neuroscience courses at Stanford University. He now spends his time working on the ones and zeros of the digital world.

B.Tech., Indian Institute of Technology, Kharagpur
MS, University of Florida
PhD, California Institute of Technology

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Home Department Overview Academic Programs Events Institutes

VIVEK JAYARAMAN

Lab Head Jayaraman Lab Contact Me

Faculty

Chaitan Khosla

Wells H. Rausch and Harold M. Petiprin Professor in the School of Engineering; Professor of Chemical Engineering, Chemistry, and Biochemistry, by courtesy (b. 1964)

Education: B.Tech., 1985, Indian Institute of Technology, Kharagpur; M.S., Indian Institute of Technology, Postdoctoral, John Innes Centre, U.K., 1990-91

Awards: Dreyfus New Investigator Award, 1991; NSF Young Investigator Award, 1994-99; Packard Fellowship for Science and Engineering, 1994-99; AIChE Alton P. Tondre Award, 1995; National Research Service Award in Chemistry, 1999; NSF Alan T. Waterman Award, 1999; ACS Pure Chemistry Award, 2000; Caltech Distinguished Research Award, 2000; Member, American Academy of Arts and Sciences, 2007; Arthur C. Cope Scholar Award, 2009; Member, National Academy of Engineering, 2009

Chemistry Research Area: Bioorganic, Biophysical

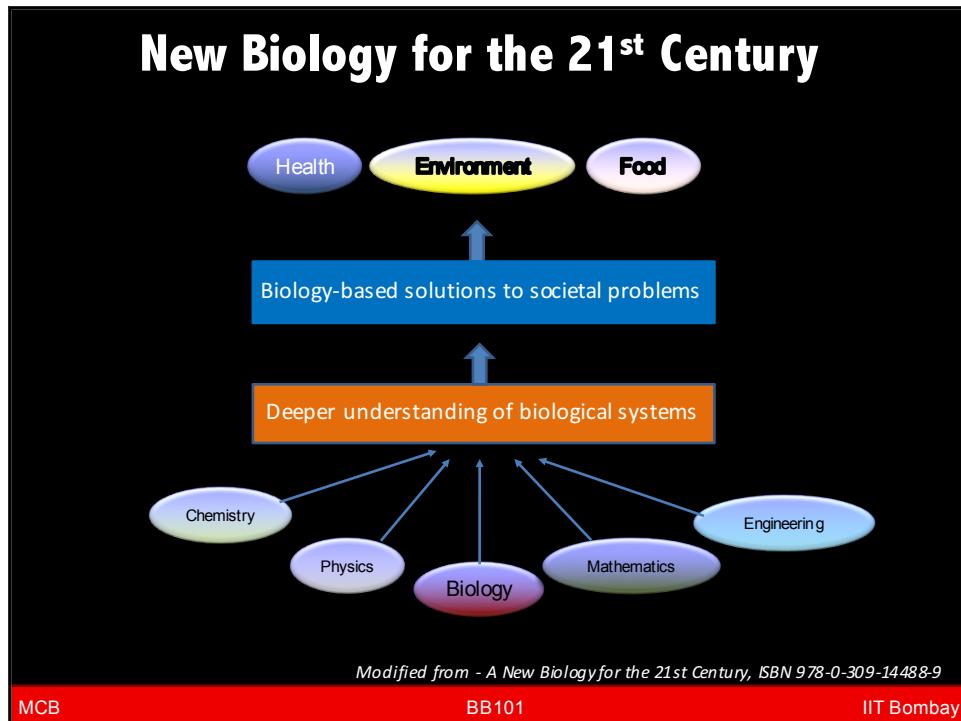
Every engineer of IITB campus should get exposure of Biology

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Why this course?

- To provide good background of biological concepts & issues of societal impacts
- Biology is going to influence you in one or the other way so having a decent understanding of subject will prepare you
- Combination of Biology knowledge with core Engineering, Physics or Chemistry may contribute to biomedical research
- This course may help you understand and appreciate how Biology/ Engineering & Technology are interwoven with each other

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- Why biology for engineers?
- Basic problems
- Bio-inspired engineering
- Mega bio projects
- Bio-research at IITB
- Life and its properties

II. Properties & Processes Associated with Life

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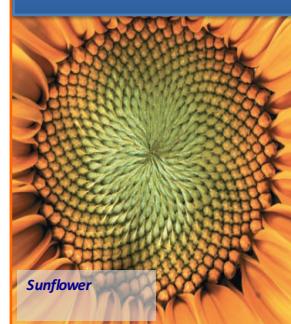
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Properties & Processes Associated with Life (1)

Energy Processing



Order



Regulation



Figure 1.2

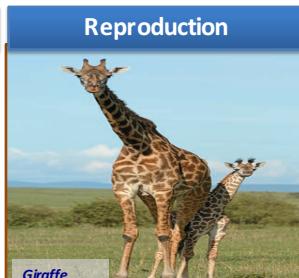
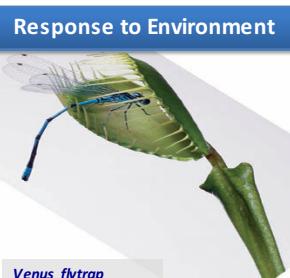
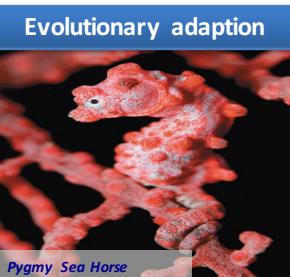
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Properties & Processes Associated with Life (2)



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Unifying themes of life

- **Organization** – levels of biological organization: biosphere-ecosystem-community-population-organism-organs-tissue-cell-organelle-molecules: new properties at systems level
- **Information** – transmitting genetic information – central dogma
- **Energy and matter** - transfer of energy and matter; energy flow in ecosystem
- **Interactions** - interactions are key for biological processes and systems
- **Evolution** – central theme of biology

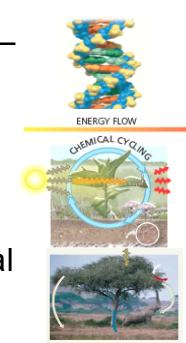


Figure 1.9

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Organisms have distinct morphologies but remarkable biochemical commonality!



Bacterium
Escherichia coli



Fruit fly
Drosophila melanogaster



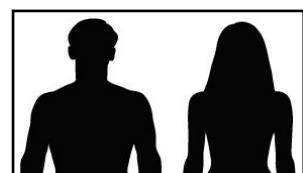
Thale cress
Arabidopsis thaliana



Roundworm
Caenorhabditis elegans



Yeast
Saccharomyces cerevisiae



Human
Homo sapiens

- Remarkable uniformity at molecular level – arisen from a common ancestor?

Figure – Genetics, Second edition 2005 WH Freeman 63

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What is a cell?

- An organism's basic unit of structure and function
- Fundamental to living systems of biology (*like atom to chemistry*)
- Simplest collection of matter that can be alive

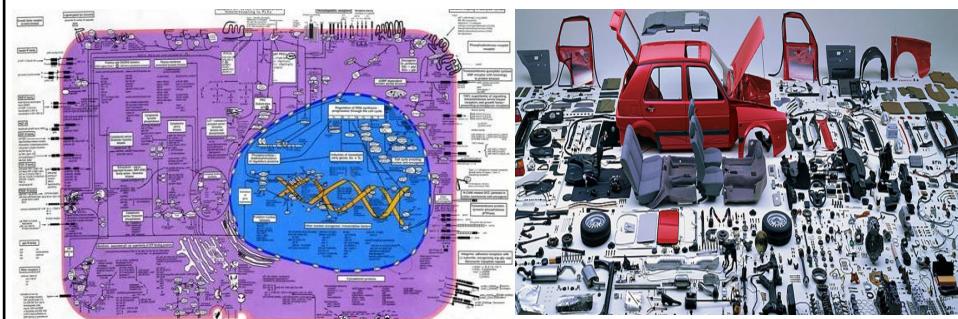
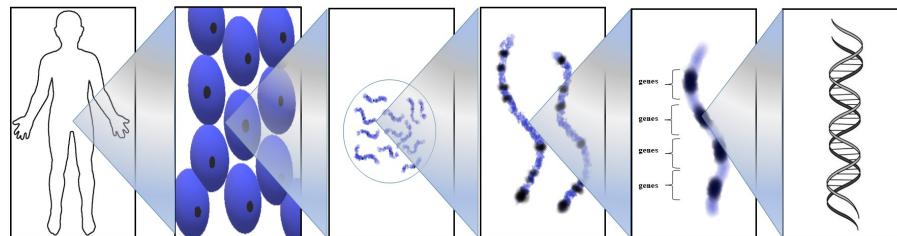
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Basics: An Overview of Cell



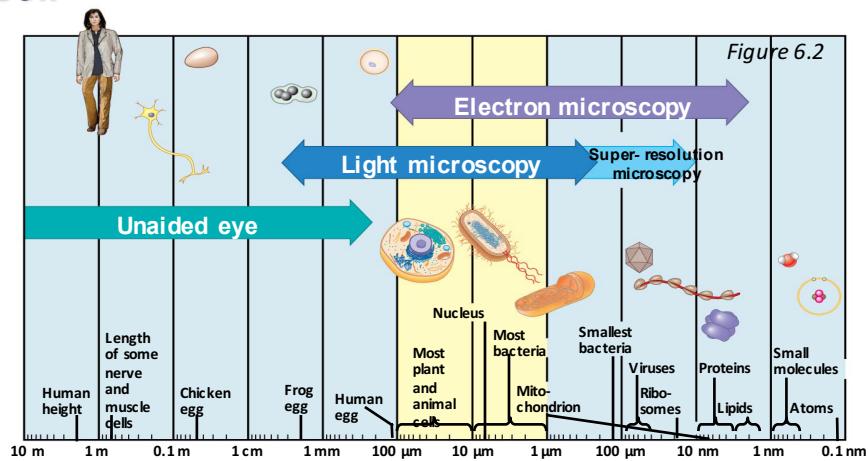
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Cell



- Most cells are between 1 - 100 μm in diameter

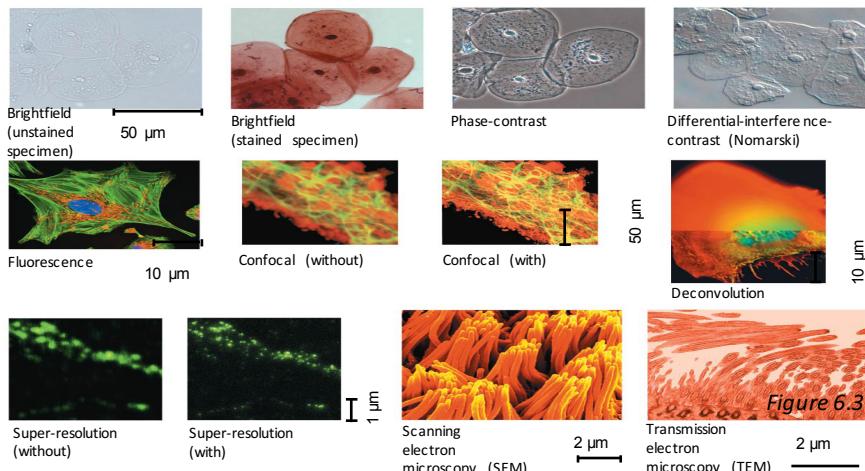
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Studying Cells Using Microscopy



- All are variants of light microscopy except SEM & TEM
- Light microscopy allows imaging of live cells; SEM/TEM: dead cells

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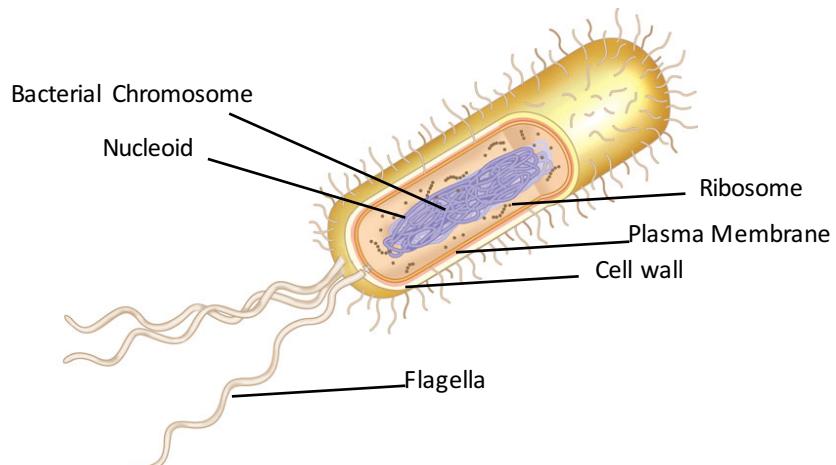
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Prokaryotic Cell

Pro = before, Eu = true, Karyon = nucleus



- Nucleoid - consist of bacterial DNA not enclosed in a membrane

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Eukaryotic Cell

ANIMAL CELL

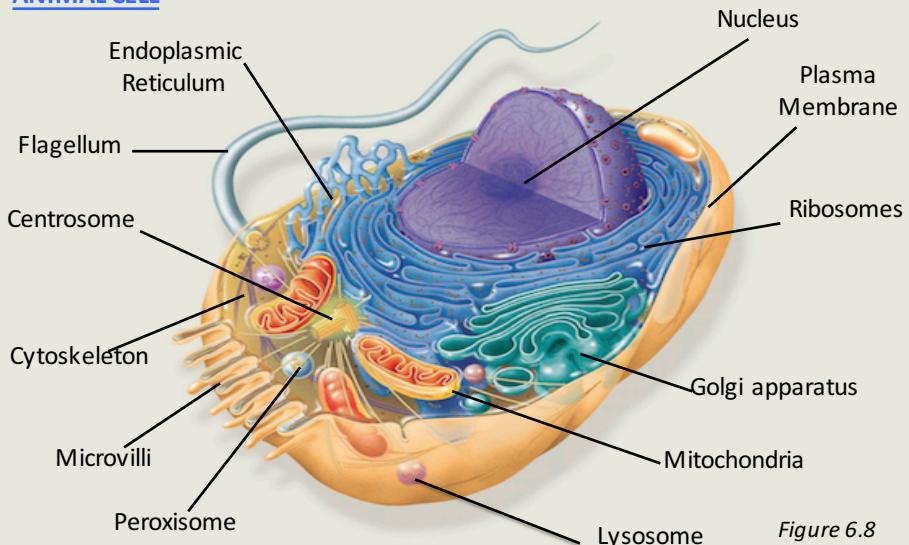


Figure 6.8

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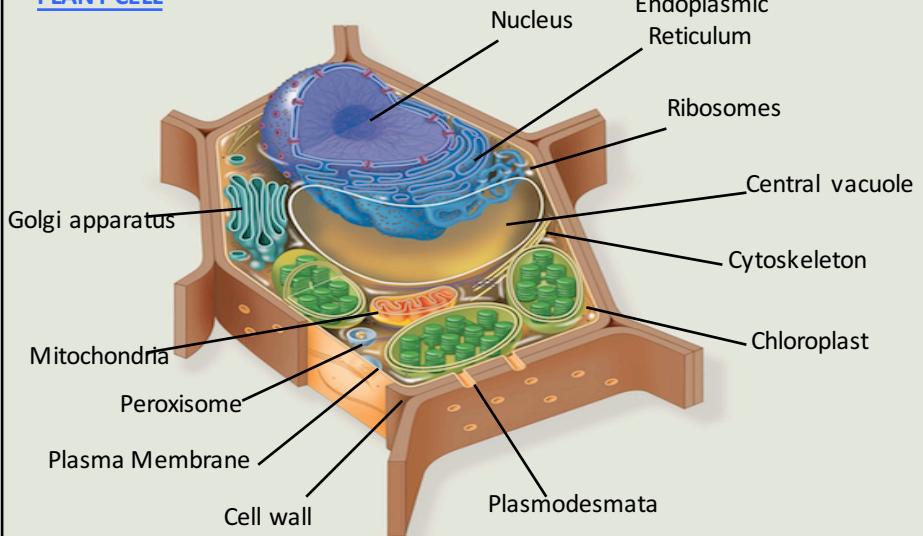
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Eukaryotic Cell

PLANT CELL



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Summary

- We understood the need for a partnership between biologists & engineers
- Properties & processes associated with life were discussed by highlighting several examples, which also displayed the diversity and complexity of living organisms
- We started discussing about cell, which is an organism's basic unit of structure and function

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References

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- Active tails enhance arboreal acrobatics in geckos. Proc Natl Acad Sci U S A. 2008 Mar 18;105(11):4215-9
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http://www.nap.edu/catalog.php?record_id=12764



*Next Lecture....
Cell & Cell Cycle*

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