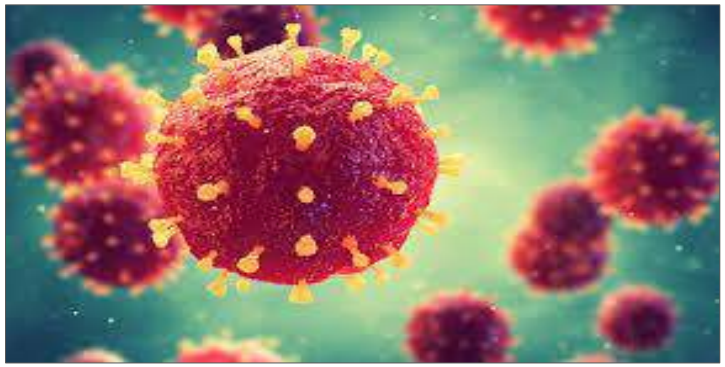
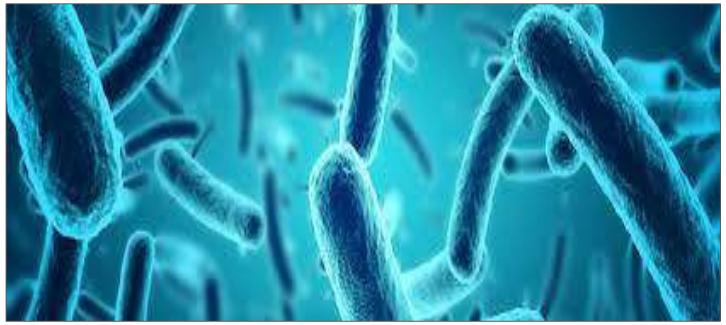
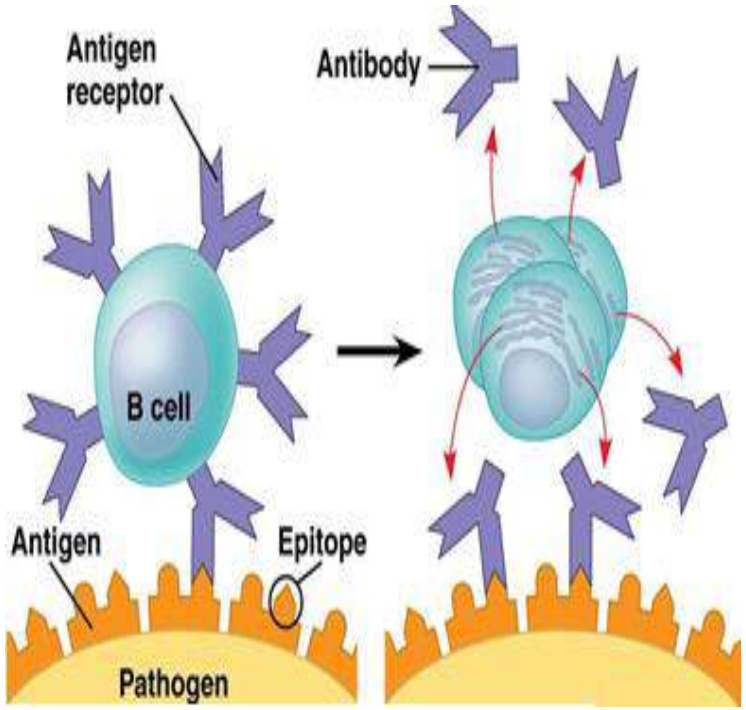
Topic: Antigens







Dr. K. Sravanthi

Lecturer in Microbiology,

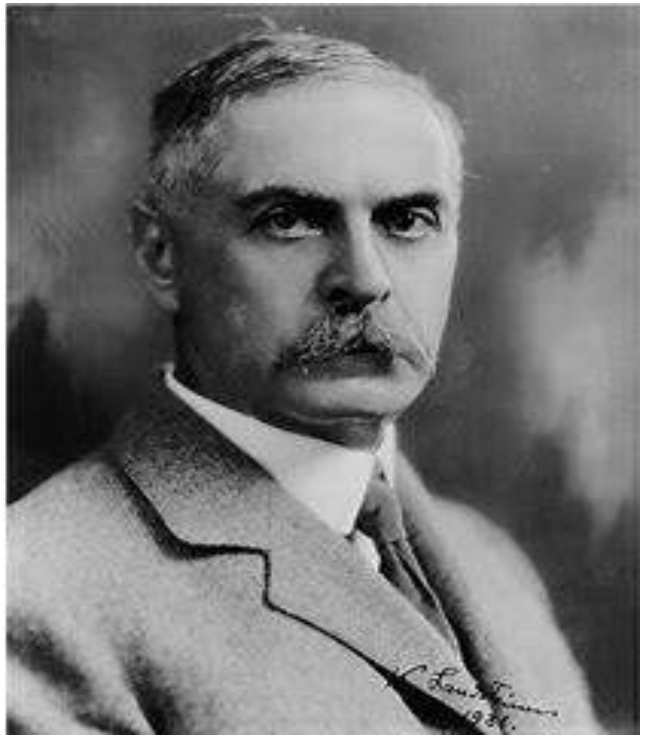
TGSWRAFPDCW, Bhongir

Learning objectives

- Define immunological terms like Antigens, Antigenicity, Haptens etc.
- An understanding of the characteristics of antigens
- An appreciation of the importance of Antigens in inducing immune response

History

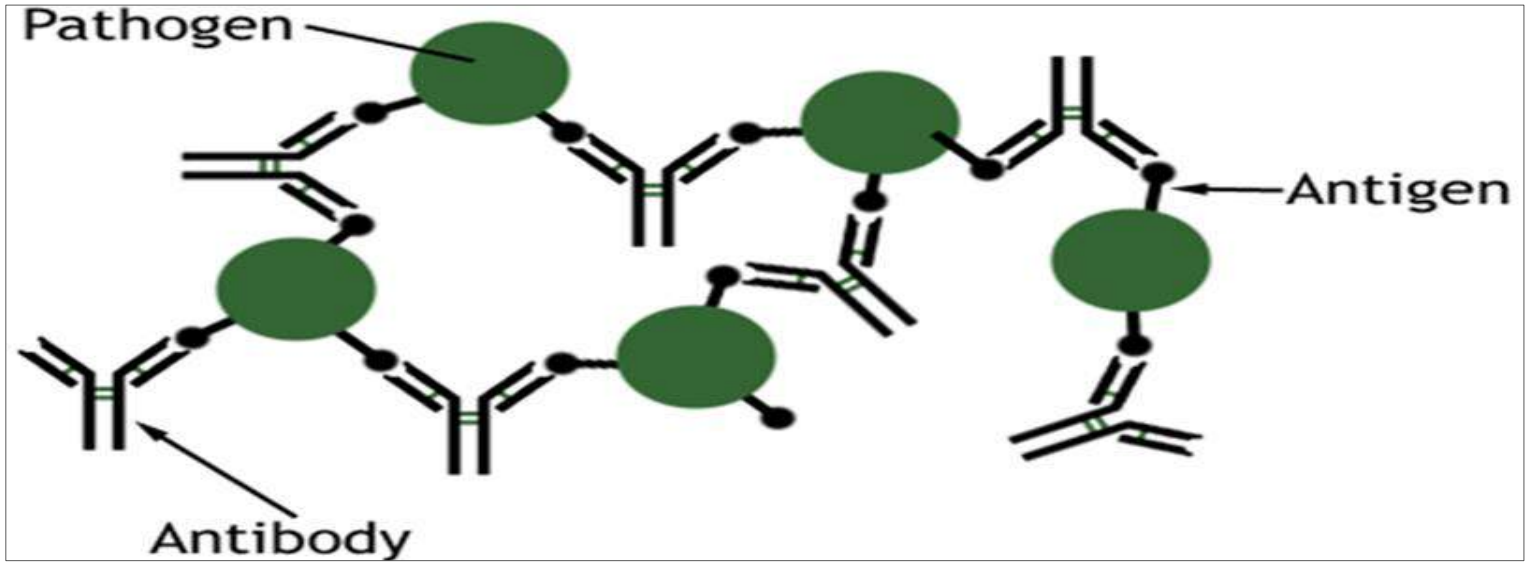
- **Ladislas Deutsch** coined the term “Antigen” in 1899
- **Karl Landsteiner** discovered Blood group antigens A, B, O in 1900



Karl Landsteiner

Definition

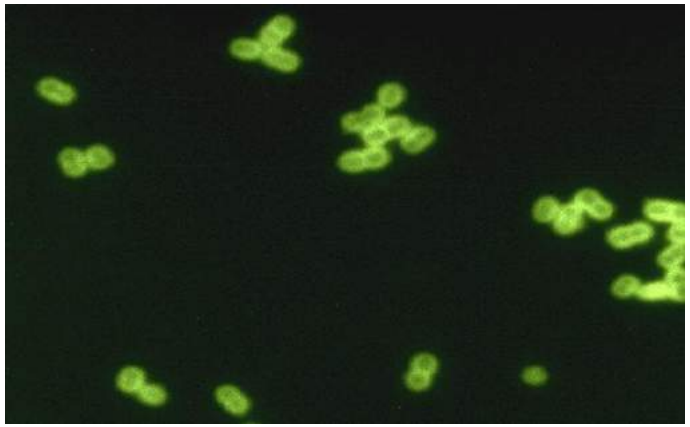
- An antigen can be defined as a foreign substance that induces immune response and bind to the specific antibodies when introduced into the host.
- **Anti**body **gen**eration.

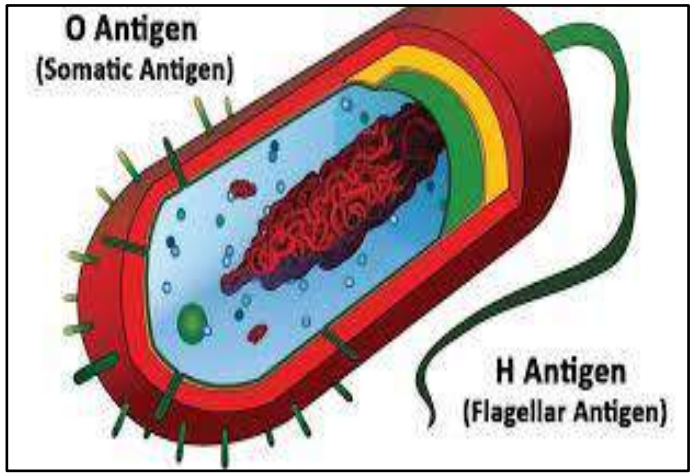


Components of microbes

Bacteria

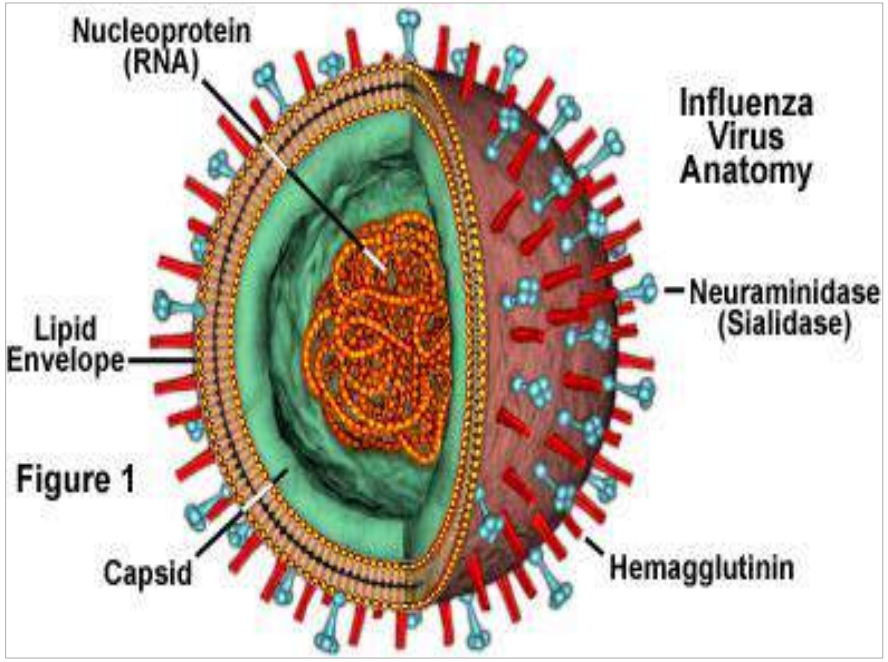
- Capsules
- Cell walls
- LPS – Salmonella ‘O’ antigen
- Flagella
- Toxins from bacteria

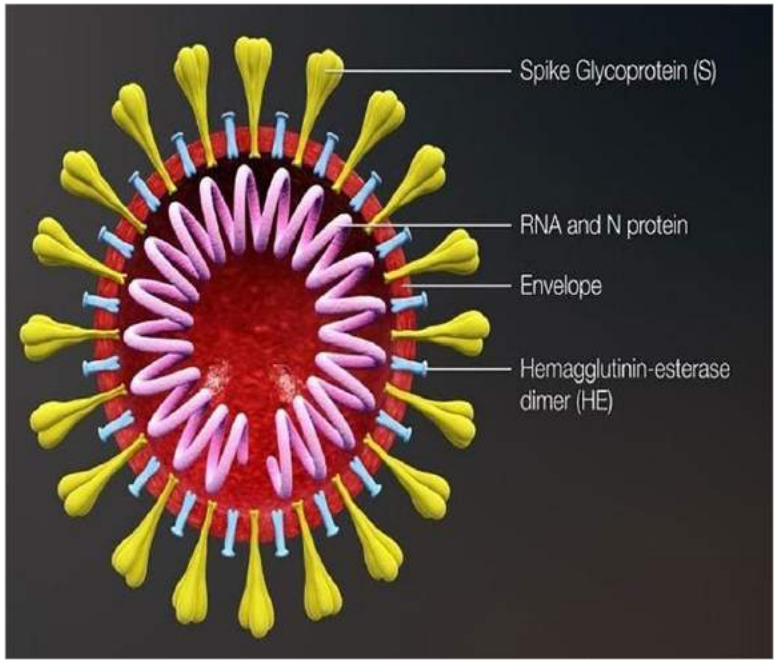




Components of microbes

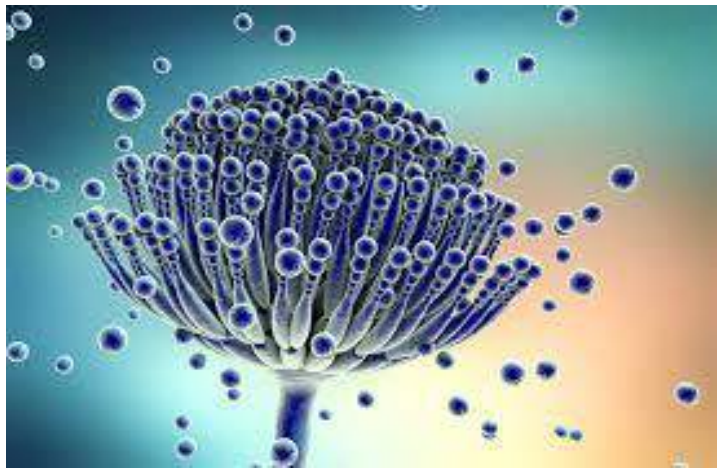
- **Viruses**
  - Nucleoprotein – Influenzae A & B
  - Spike **protein** (**S-protein**) - SARS-CoV-2





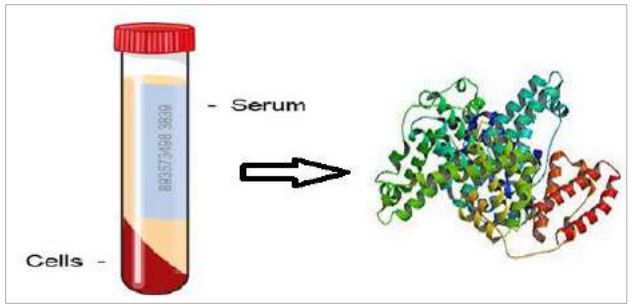
Components of microbes

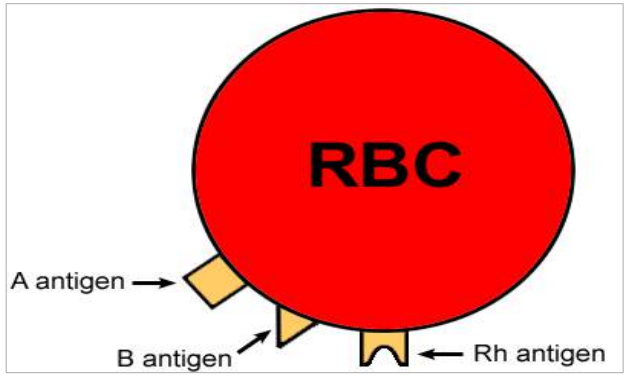
- Fungi
  - Spores of Aspergillus
- Protozoa
  - Glycoprotein receptor in Trypanosoma

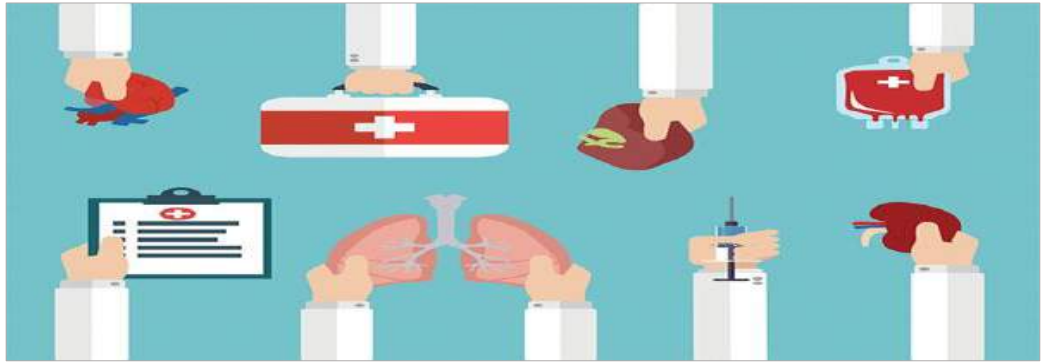


Non-Microbial antigens

1. Pollen
2. Serum proteins
3. RBC surface molecules
4. Egg white
5. Surface molecules of transplants



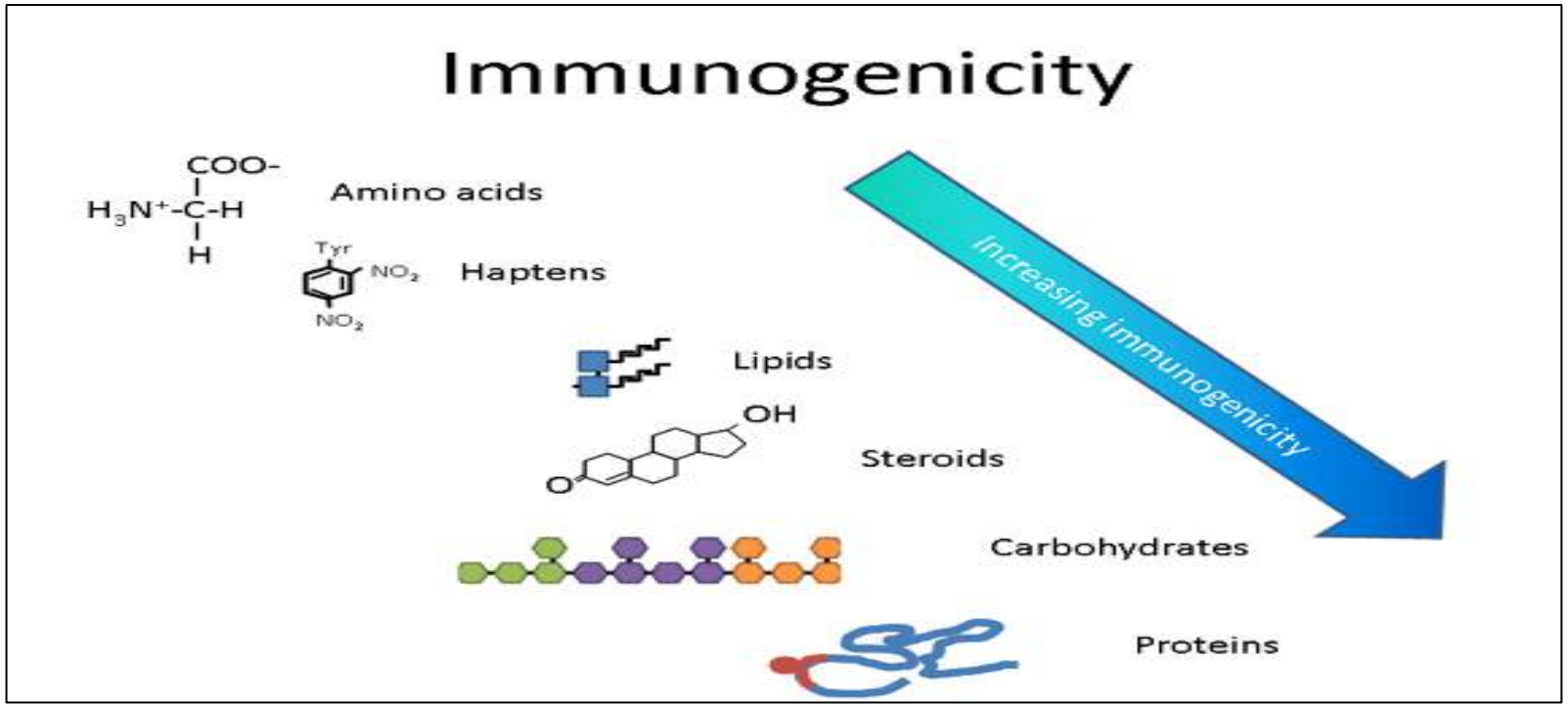




Antigenicity vs Immunogenicity

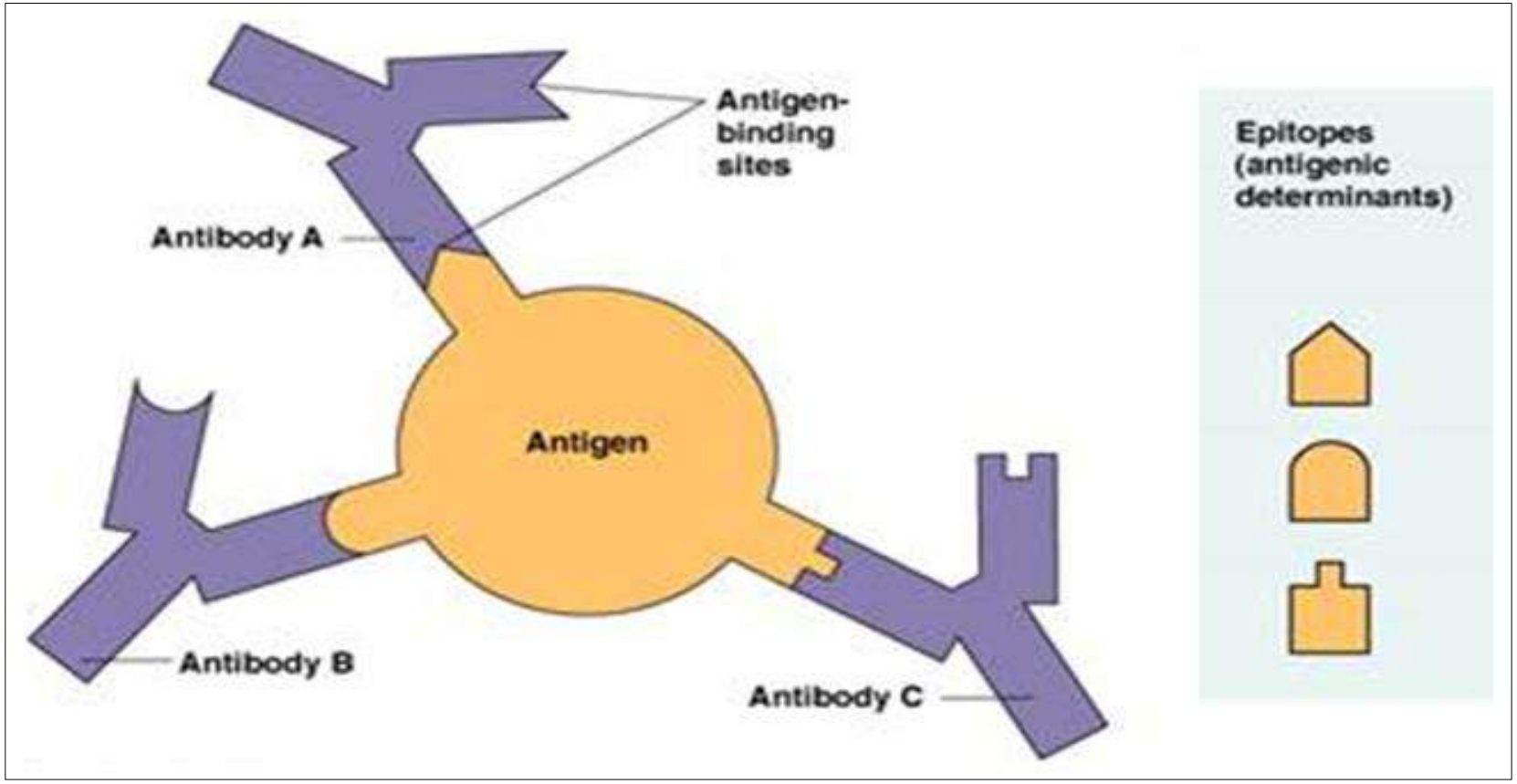
Antigenicity is the ability to combine specifically with the final products of immune response.

Immunogenicity refers to the ability of a substance to induce cellular and humoral immune response.



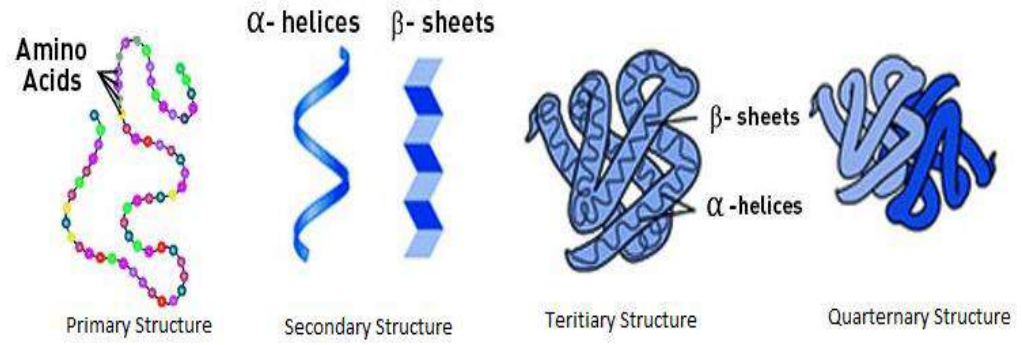
Epitopes

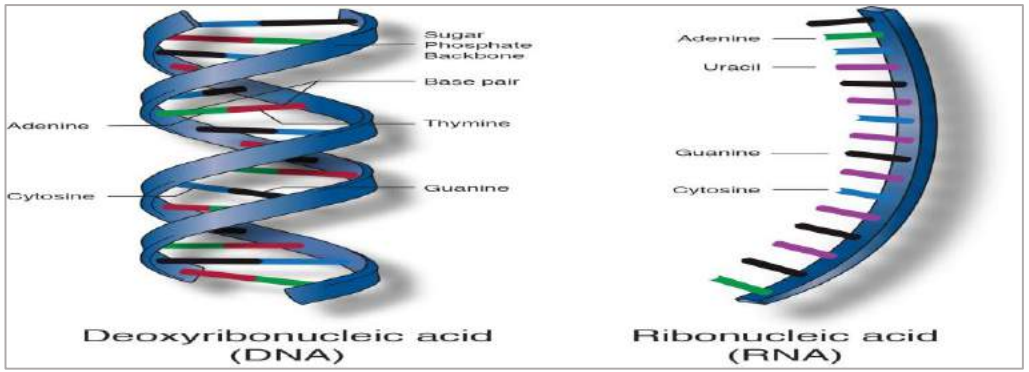
- Immunologically active regions of an Antigen
- Antigenic determinant sites

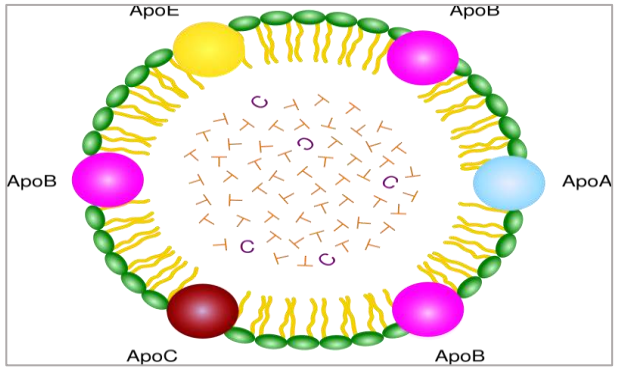


Chemical nature

- Proteins
- Polysaccharides
- Nucleic acids
- Lipids
- Conjugates
- Lipoprteins
- Lipopolysaccharides







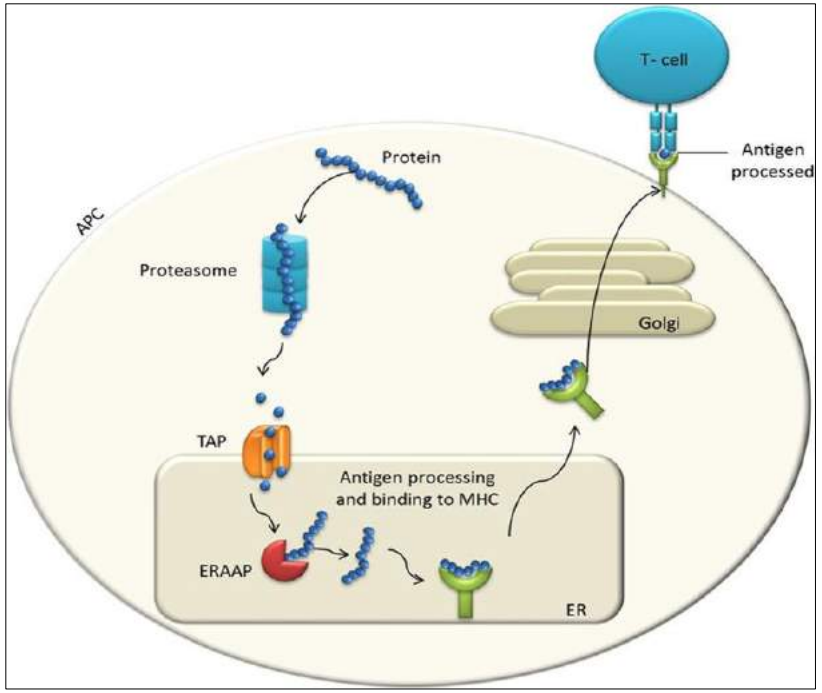
Factors affecting Immunogenicity

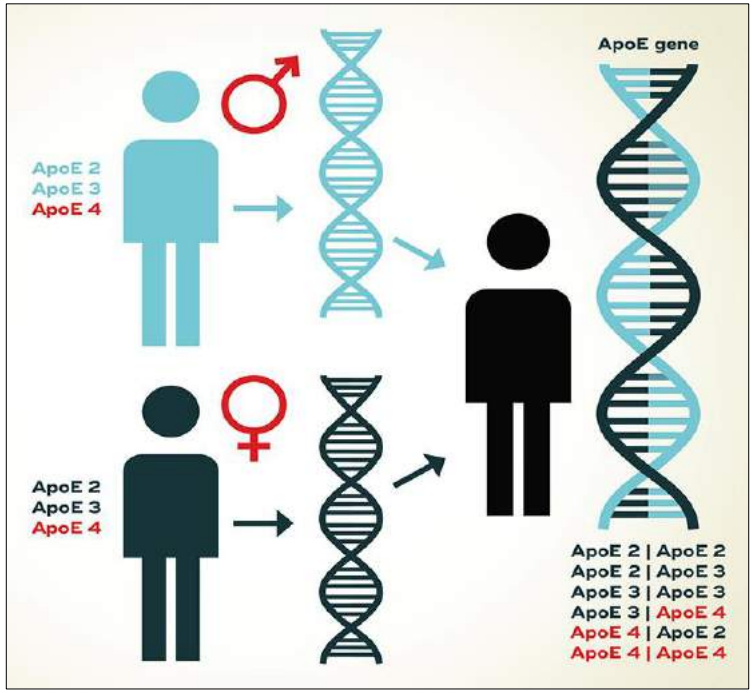
- Foreignness
- Molecular size

Antigen	Approximate Molecular mass (Da)
Bovine Gamma Globulin (BGG)	1,50,000
Tetanus toxoid	1,50,000
Bovine serum albumin (BSA)	69,000
Flagellin (Monomer)	40,000
Ovalbumin	44,000
Hen egg white lysozyme	15,000

Factors affecting Immunogenicity

- Chemical composition
- Physical form
- Degradability
- Genetic factors



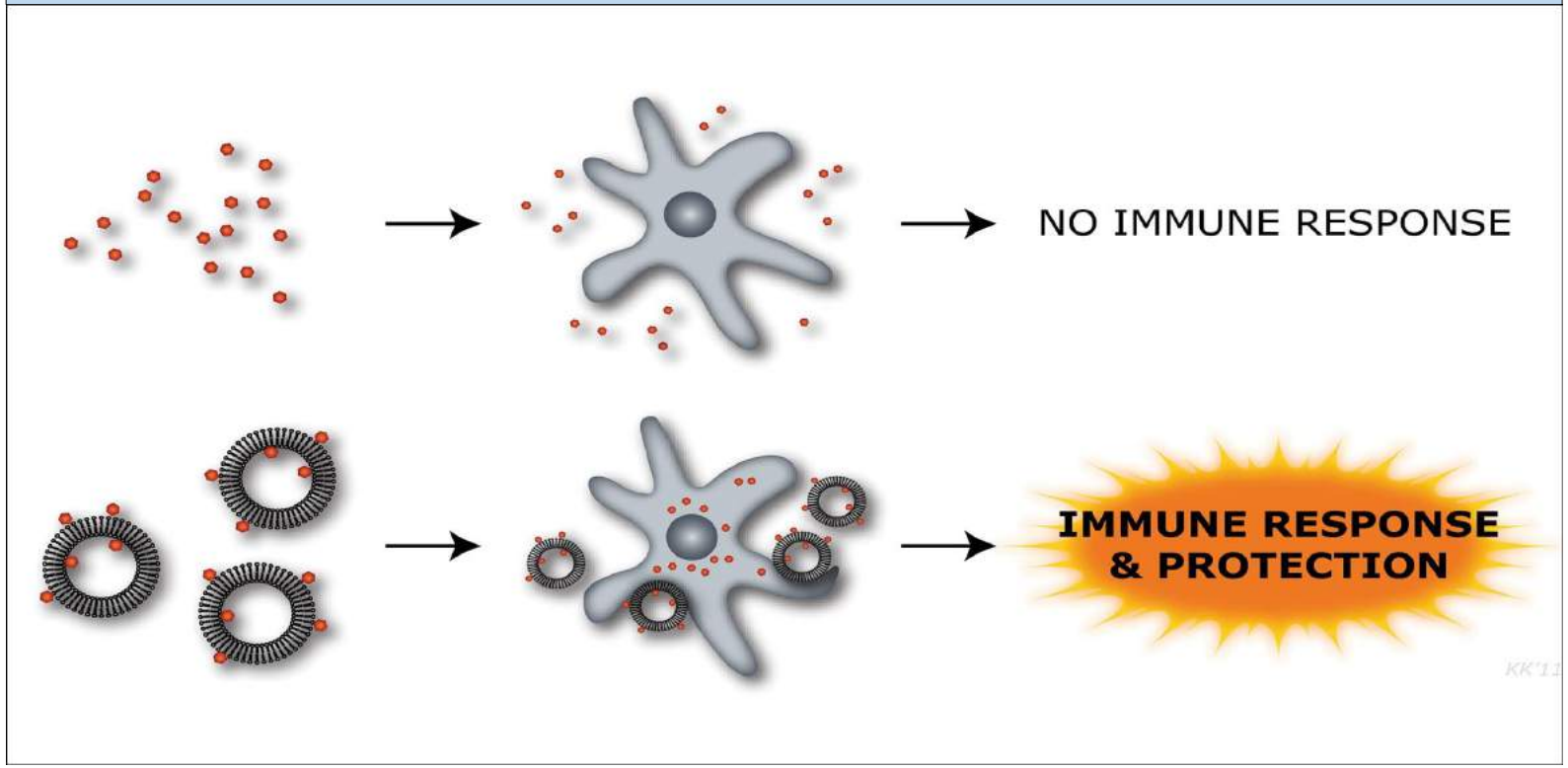


Factors affecting Immunogenicity

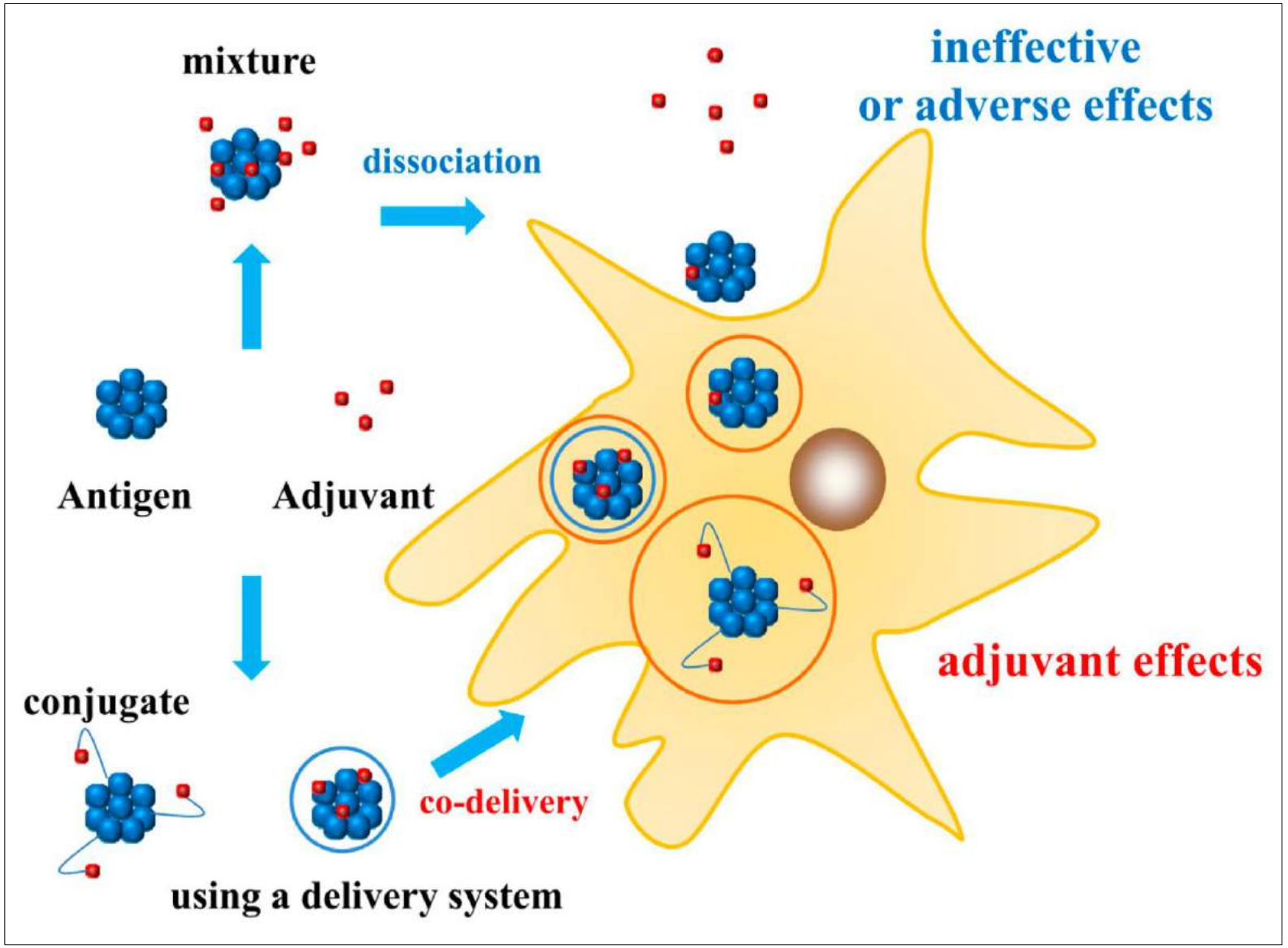
- Age
- Dose
- Route of administration

Adjuvants

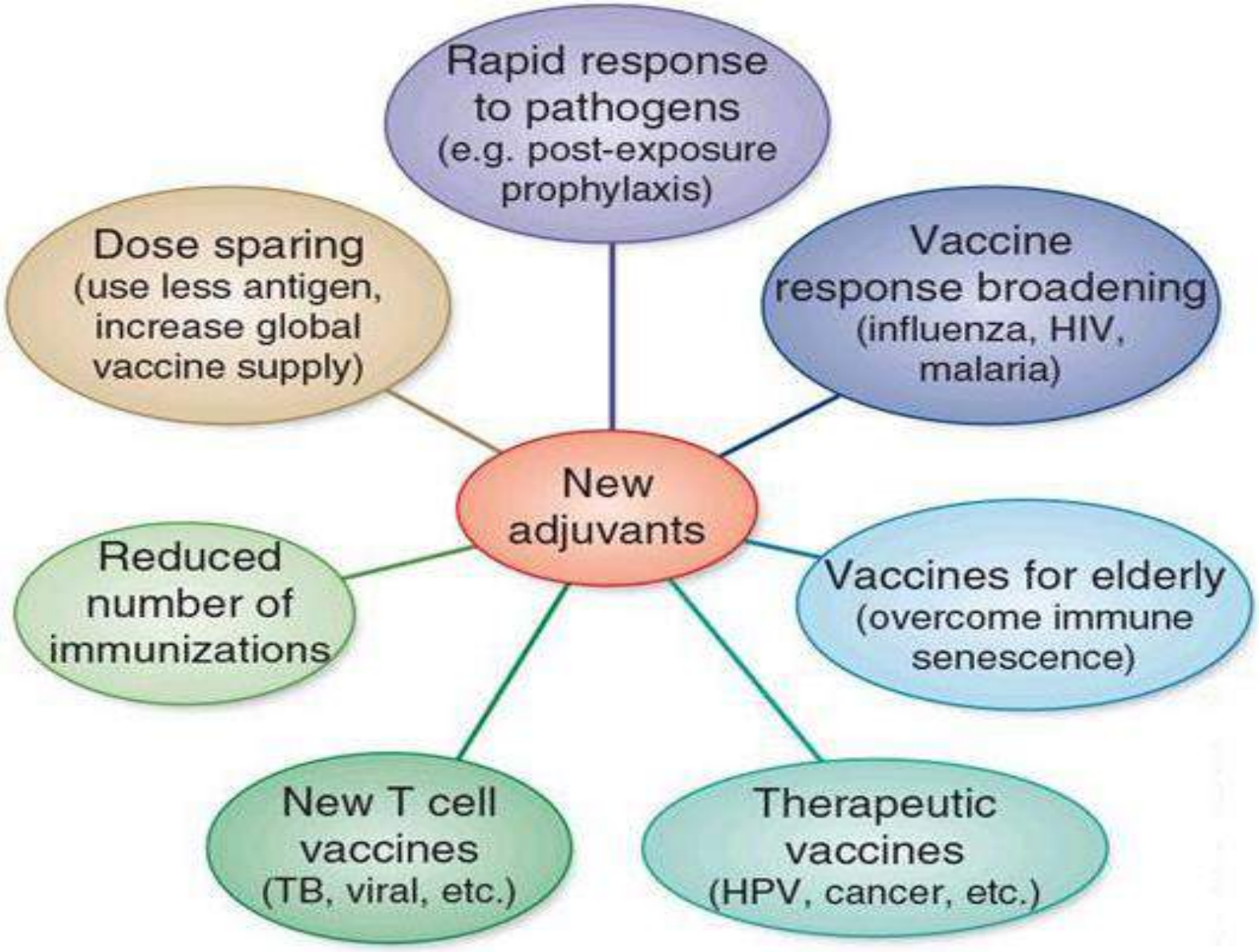
- Enhance immunogenicity of antigen
- Latin word- “Adjuvare”- “To help”



Mechanism

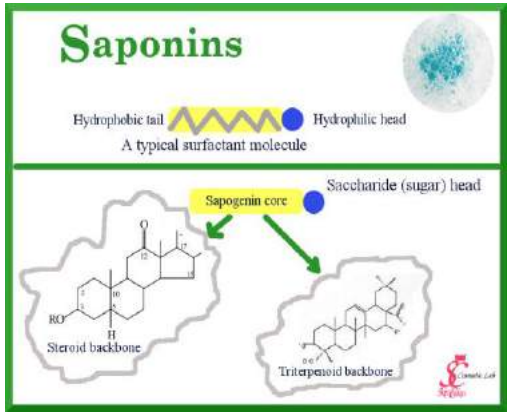

mixture
dissociation
ineffective
or adverse effects
Antigen
Adjuvant
conjugate
co-delivery
using a delivery system
adjuvant effects

Benefits of Adjuvants



Commonly used Adjuvants

1. Aluminium potassium sulphate (Alum)
2. Freund’s incomplete adjuvant
3. Freund’s complete adjuvant
4. Plant saponins
5. Cytokines
6. Squalene
7. Bacterial toxoids
8. Synthetic polynucleotides



Recap 

- The foreign substances that enter and induce immune response are called as **Antigens.**
- Immunologically active regions of an Antigen are **Epitopes.**
- Low molecular weight organic molecules that cannot induce immune response by themselves are **Haptens**.
- The substances that enhance immune response when injected with an antigen are **Adjuvants**.

Classification of Antigens

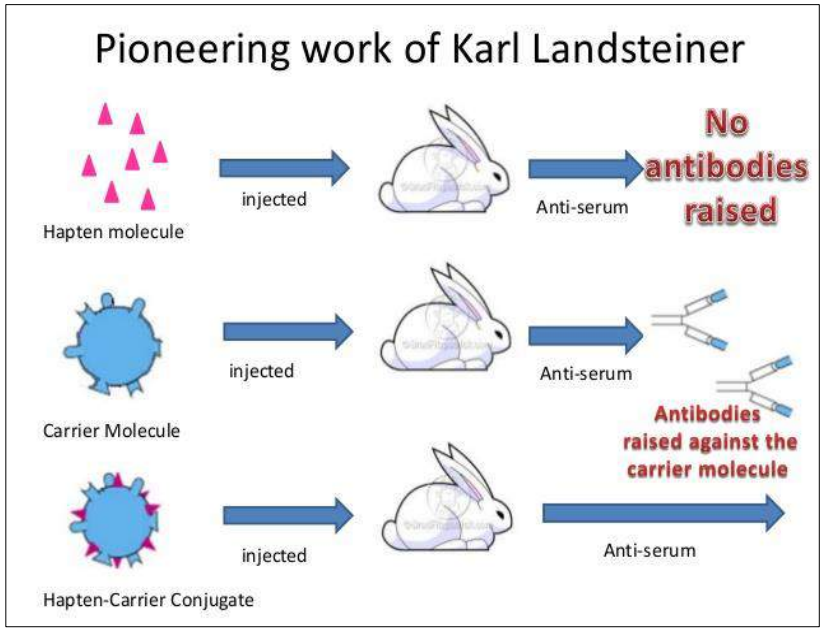
1. **On the basis of origin**
   - Exogenous
   - Endogenous
   - Auto Antigens

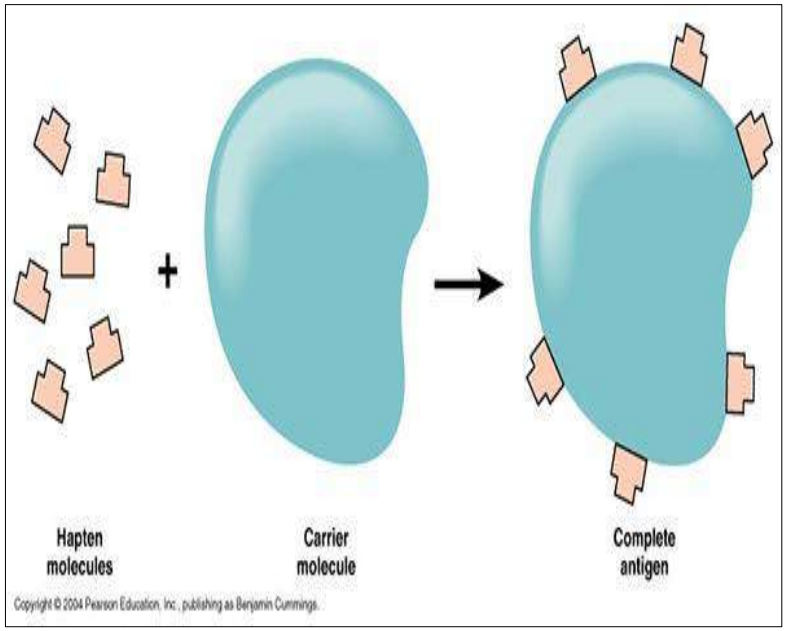
2. **On the basis of Immune response**
   - Complete antigens
     - Posses antigenic properties denovo

Classification of Antigens

Incomplete Antigens or Haptens

- Require carrier molecule
- Eg: Pencillin, Urushiol

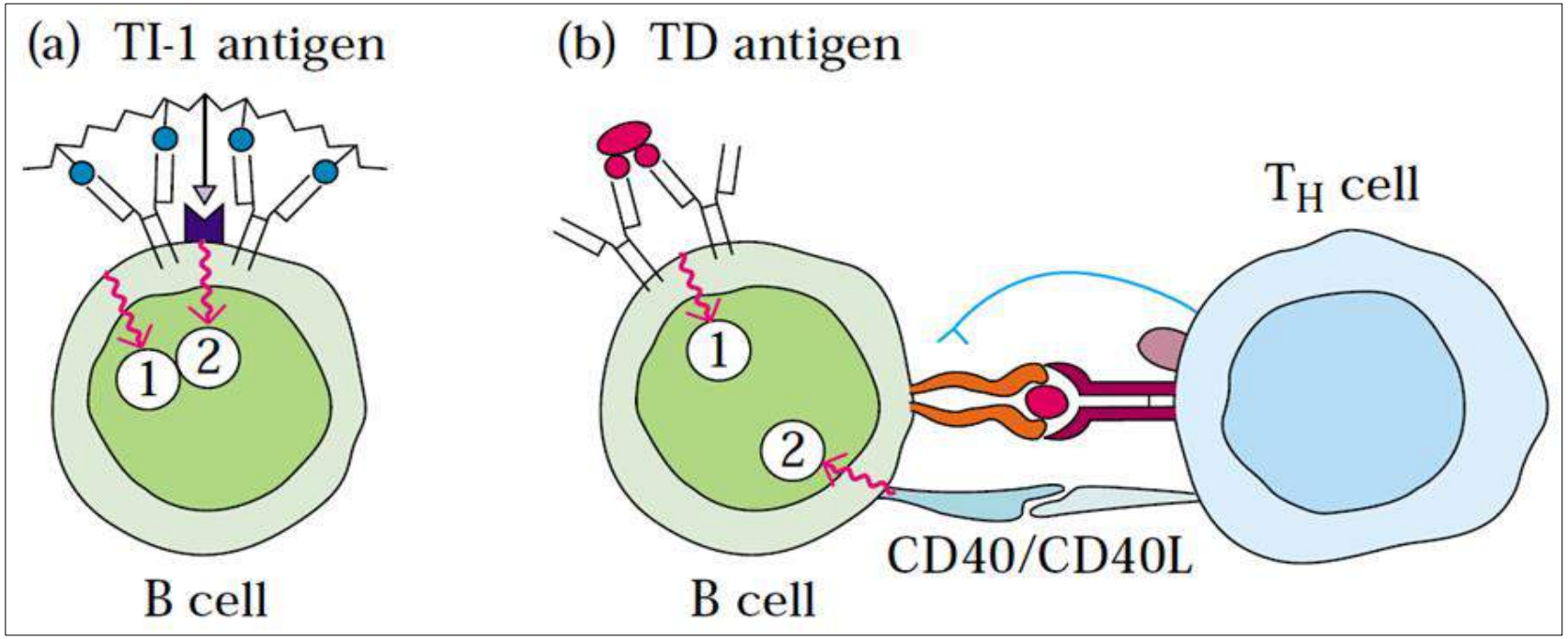




Classification of Antigens

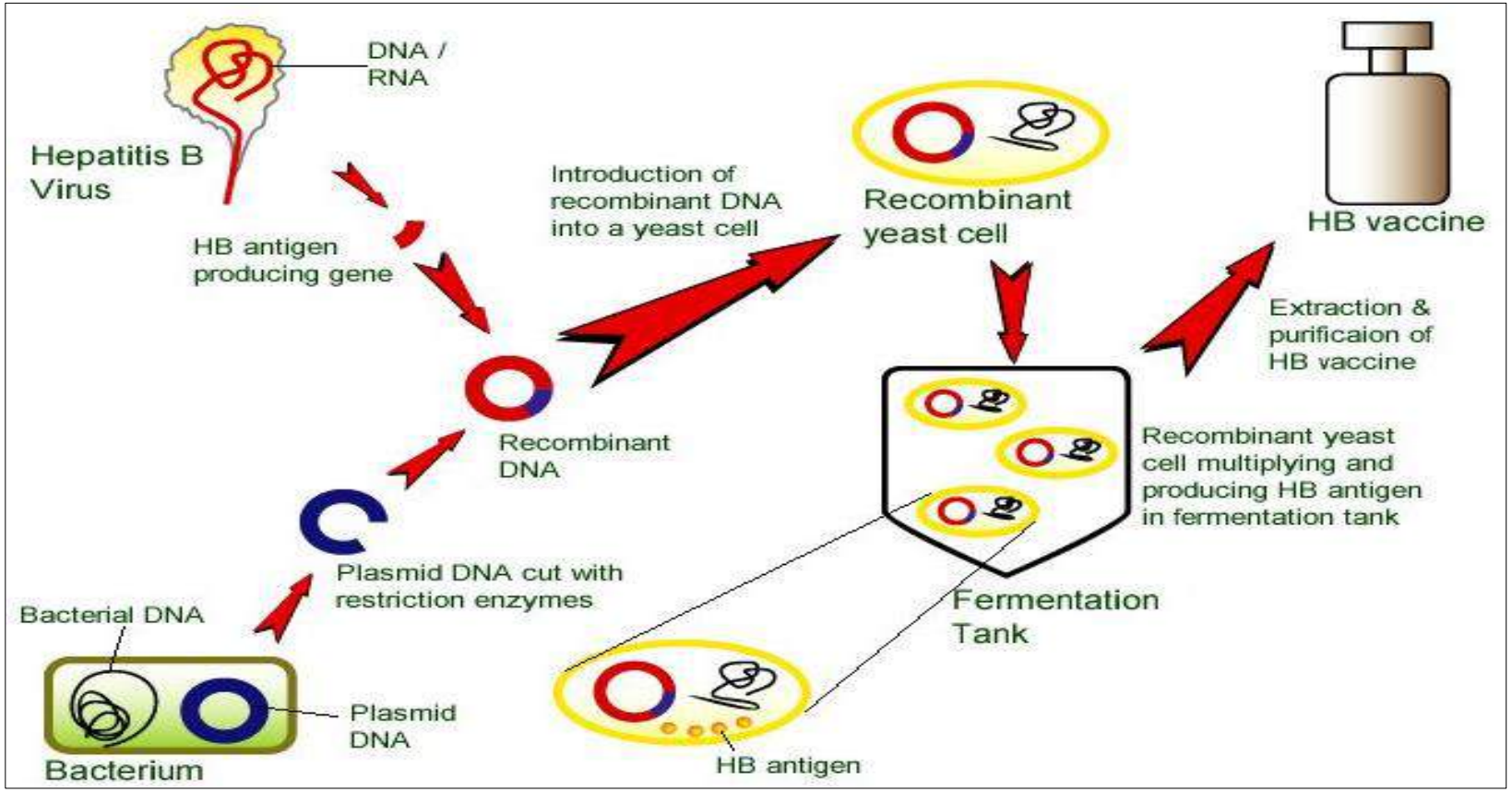
3. Biological classes

- Thymus dependent antigens
- Thymus Independent antigens



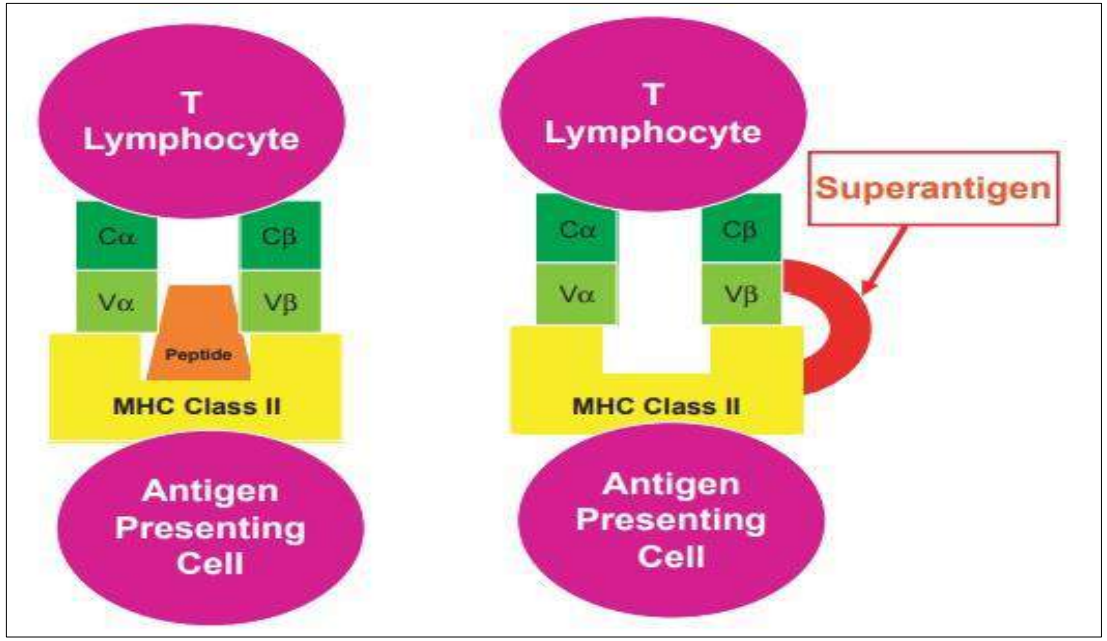
Synthetic Antigens

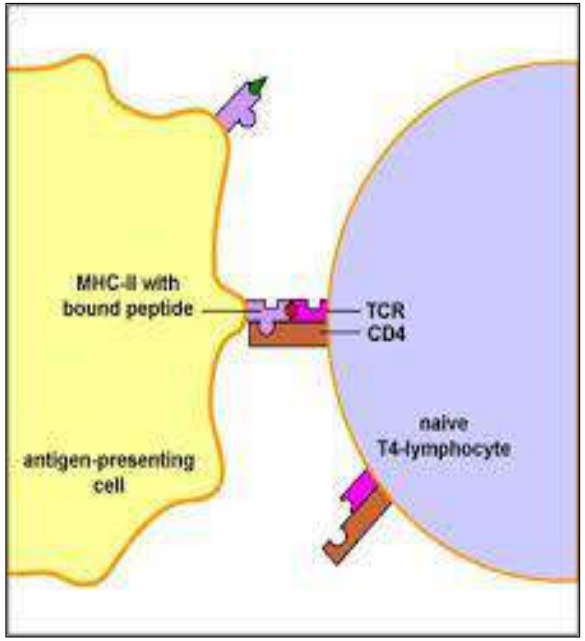
- Invitro synthesis
- Vaccine preparations
- Diagnostics



Super Antigens

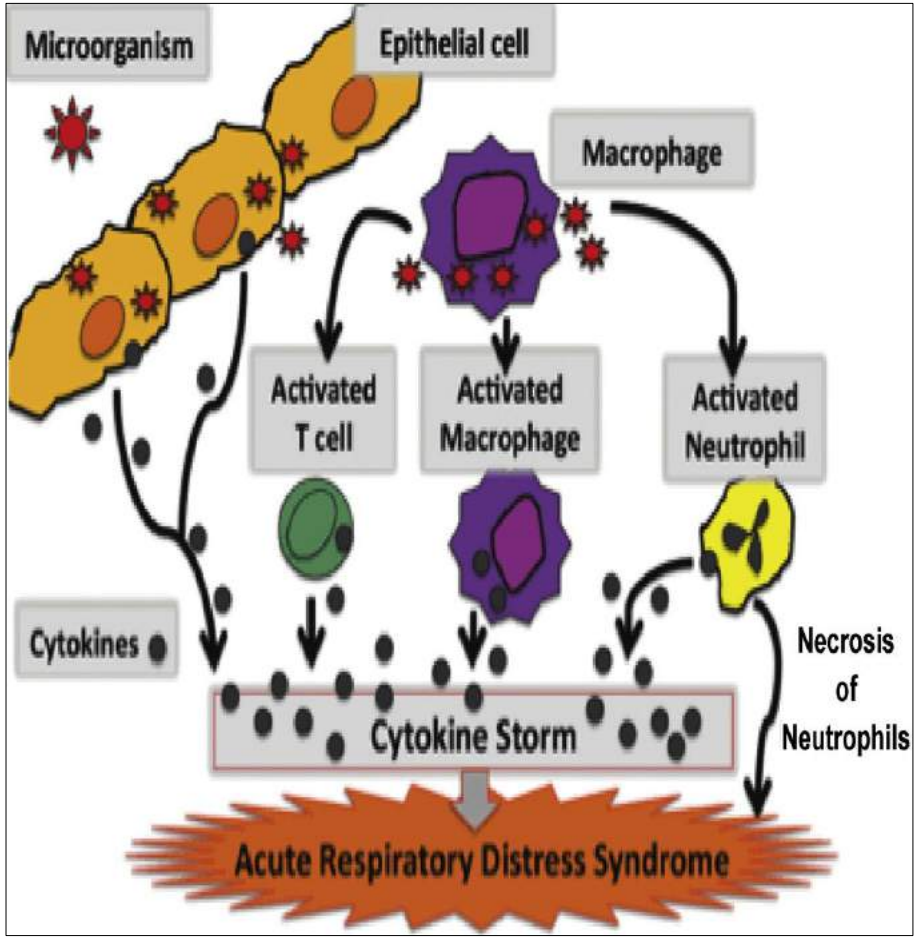
- Microbial antigens
- Result in excessive non specific activation of the T-Lymphocytes
- Activate 20-30% of T cells.





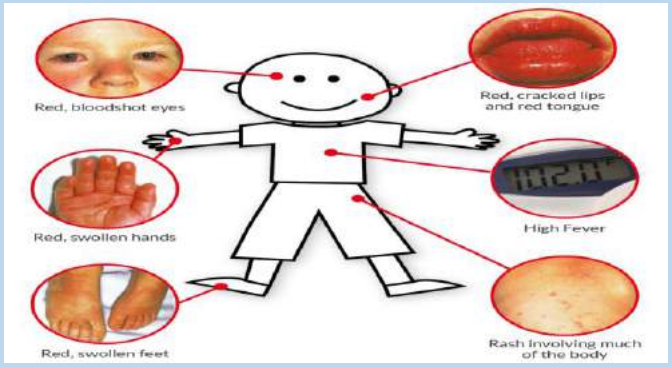
Effects of Super Antigens

- Inflammatory activity
- Cytotoxicity
- Mitogen activation
- Monocytic cell activation



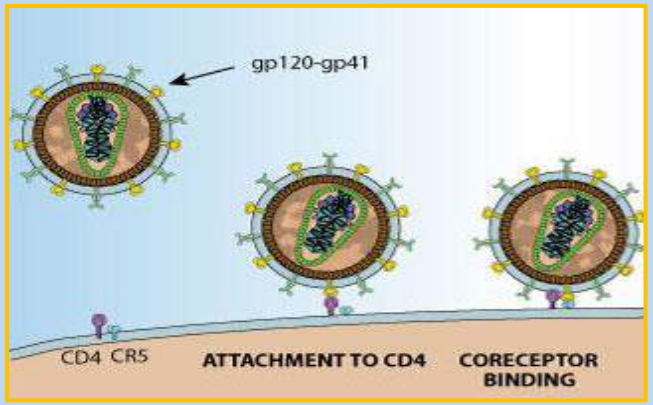
Diseases associated with superantigen production

- Eczema
- Guttate psoriasis
- Kawasaki disease
- Nasal polyps
- Rheumatic fever
- Rheumatoid arthritis
- Scarlet fever
- Toxic shock syndrome
- Infective endocarditis

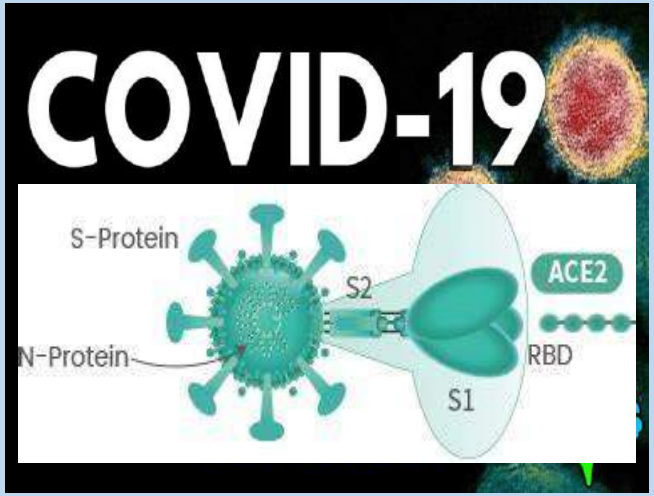


Examples

- **Bacteria**
  - Staphylococcal enterotoxin
  - Staphylococcal toxic shock syndrome toxin
  - Staphylococcal protein A
  - Streptococcal pyrogenic exotoxin



- **Virus**
  - HIV - GP 120
  - EB virus
  - Rabies virus
    - Nucleocapsid protein
  - SARS-CoV-2 - ????????????



SARS-CoV-2 – Super Antigen ?????

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An insertion unique to SARS-CoV-2 exhibits superantigenic character strengthened by recent mutations

Mary Hongying Cheng[a], She Zhang[a], Rebecca A. Porritt[b,c], Moshe Arditi[b,c,*] and Ivet Bahar[a,*]

[a]Department of Computational and Systems Biology, School of Medicine, University of Pittsburgh, Pittsburgh, PA 15261; Departments of [b]Pediatrics, Division of Pediatric Infectious Diseases and Immunology, [c]Biomedical Sciences, Infectious and Immunologic Diseases Research Center, Cedars-Sinai Medical Center, Los Angeles, CA 90048.

* These are the corresponding authors and contributed equally. Email: bahar@pitt.edu and Moshe.arditi@cshs.org.

Multisystem Inflammatory Syndrome in Children (MIS-C) associated with Coronavirus Disease 2019 (COVID-19) is a newly recognized condition in which children with recent SARS-CoV-2 infection present with a constellation of symptoms including hypotension, multiorgan involvement, and elevated inflammatory markers. These symptoms and the associated laboratory values strongly resemble toxic shock syndrome, an escalation of the cytotoxic adaptive immune response triggered upon the binding of pathogenic superantigens to MHCII molecules and T cell receptors (TCRs). Here, we used structure-based computational models to demonstrate that the SARS-CoV-2 spike (S) exhibits a high-affinity motif for binding TCR, interacting closely with both the α- and β-chains variable domains' complementarity-determining regions. The binding epitope on S harbors a sequence motif unique to SARS-CoV-2 (not present in any other SARS coronavirus), which is highly similar in both sequence and structure to bacterial superantigens. Further examination revealed that this interaction between the virus and human T cells is strengthened in the context of a recently reported rare mutation (D839Y/N/E) from a European strain of SARS-CoV-2. Furthermore, the interfacial region includes selected residues from a motif shared between the SARS viruses from the 2003 and 2019 pandemics, which has intracellular adhesion molecule (ICAM)-like character. These data suggest that the SARS-CoV-2

tested positive for COVID-19 (by PCR or serology) or had epidemiological links to COVID-19 (5-7). After initial reports in UK (5), many cases have now been reported in Europe (6, 7), and New York (USA CDC). However, no such cases have been reported in China, Japan, or South Korea, which have also been severely impacted by the COVID-19 pandemic (ECDC).

MIS-C manifests as persistent fever and hyperinflammation with multi organ system involvement including cardiac, gastrointestinal, renal, hematologic, dermatologic and neurologic symptoms (5-7) which are highly reminiscent of toxic shock syndrome (TSS) (8, 9) (**Table 1**), rather than Kawasaki disease due to marked demographic, clinical, and laboratory differences (6). The similarities to TSS and the association of MIS-C with COVID-19 led us to hypothesize that SARS-CoV-2 may possess superantigenic fragments that induce an inflammatory cascade and perhaps also contribute to the hyperinflammation and cytokine storm features observed in severe adult COVID-19 cases (3, 4). The question we raised is: does SARS-CoV-2 S possess superantigenic fragments that could elicit such reactions upon binding proteins involved in the host cell cytotoxic adaptive immune response? Such a reaction was not observed in the SARS-CoV pandemic of 2003 (shortly SARS1). What is unique to SARS-CoV-2, and how recent mutations in SARS-CoV-2 S may have promoted such an increased virulence?

https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7263503/pdf/nihpp-2020.05.21.109272.pdf

Assessment Time!!

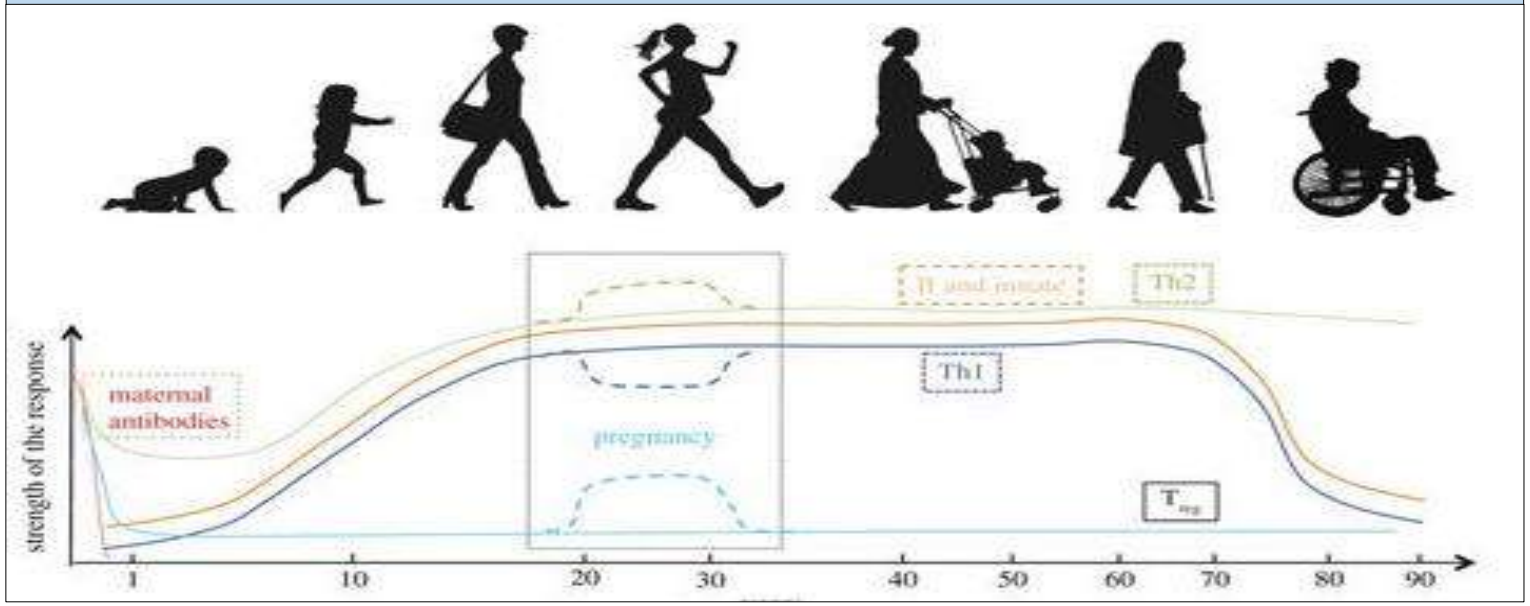
- Antibody binding sites on antigens are **Epitopes.**
- Adjuvants are also referred to as **Immunopotentiators** as they enhance immune response.
- Incomplete antigens are also known as **Haptens.**
- The antigens that need co stimulation from TH cells for the production specific immune response are **Thymus dependent antigens.**
- Class of Antigens that cause excess and non specific activation of T-lymphocytes are **Super antigens.**

Student Assignment

- Find out the adjuvants being used recently in vaccine preparations.
- List out the bacterial super antigens.
- Arrange the given biomolecules (Polysaccharides, Lipids, Proteins, Nucleic acids) in ascending order on the basis of their antigenicity.

Conclusions

- Exposure to different antigens make us build immunity from the very beginning of our life.
- The knowledge of antigens has lead to the understanding of immune response and development of Immunology.



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Dr.K. Sravanthi
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JAM-Biotechnology

- **The test will be of entirely objective type, with three different patterns of questions, namely**

(i) Multiple Choice Questions (MCQ)

(ii) Multiple Select Questions (MSQ) and

(iii) Numerical Answer Type (NAT) questions.

For more details: https://jam.iitr.ac.in/

Graduate Aptitude Test-Biotechnology (GAT-B)

- Graduate Aptitude Test-Biotechnology (GAT-B) is an All India Entrance Examination to test the eligibility of bonafide Indian nationals for admissions to DBT supported Post Graduate programmes in Biotechnology and allied areas, at participating institutions/universities in India.
- DBT supported Post Graduate programmes include: M.Sc. Biotechnology and allied areas; M.Tech. Biotechnology and allied areas; M.Sc. Agricultural Biotechnology and M.V. Sc. Animal Biotechnology.

Mode of Examination

- The Examinations will be conducted in Computer Based Test (CBT) mode.
- The pattern of question papers will comprise Multiple Choice Questions in the following areas as given below.

Graduate Aptitude Test-Biotechnology (GAT-B) 2021			
Sections	**No. of Questions**	**No. of Questions to be Attempted**	**Marks**
Part A / Section A (Multiple choice questions of the level of 10+2 in the subjects: Physics, Chemistry, Mathematics and Biology)	**60**	**60**	**1x60 = 60**
Part B / Section B (Multiple choice questions of Graduate / Bachelor's level in the subjects: Basic Biology, Life Sciences, Biotechnology and allied areas as per syllabus given)	**100**	**60**	**3x60 = 180**
Total	**160**	**120**	**240**

Graduate Aptitude Test-Biotechnology (GAT-B) 2021

The Question Paper for GAT-B 2021 Entrance Examination will have two parts/sections:

- **Part A / Section A:** Part A / Section A will have 60 compulsory multiple choice questions of the level of 10+2 in the subjects: Physics, Chemistry, Mathematics and Biology. **Each correct answer is of One (1) mark. There will be negative marking and for each wrong answer, half (1/2 or 0.5) mark will be deducted.**

- **Part B / Section B:** Part B / Section B will have multiple choice questions of Bachelor's (Graduate) level requiring thinking and analysis. There will be questions from Basic Biology, Life Sciences, Biotechnology and allied areas as per the syllabus of GAT-B 2021. There will be 100 questions out of which candidates will have to attempt 60 questions. **Each correct answer is of Three (3) marks. There will be negative marking and for each wrong answer, One (1) mark will be deducted.**

For more information: https://dbt.nta.ac.in/

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- This is a 3-year program. Students start in July each year, and join labs to which they have been assigned in their offer letter.
- MSc students attend basic core courses together with the Ph.D. and Int. Ph.D. students. The 12 credit requirement is satisfied by these courses, after which MSc students engage in full time research.
- For more information: https://www.tifr.res.in

CUCET-2022

- The current CUCET (CUCET 2022) will be conducted in online mode by the National Testing Agency (NTA).

- To start with, the test will be conducted once for the academic session 2022-2023, but from the subsequent years, the test will be conducted twice a year giving students an opportunity to improve their scores if needed.
- There will be 54 CUCET participating Universities and colleges from the academic session 2022-2023, previously it was only 12 till the last academic year.

- There are 54 Central Universities in India at the moment including University of Delhi (DU), Jawaharlal Nehru University (JNU), Banaras Hindu University (BHU), etc.

- Banaras Hindu University
- Delhi University
- Aligarh Muslim University
- Jamia Millia Islamia
- Jawaharlal Nehru University
- Babasaheb Bhimrao Ambedkar University
- Guru Ghasidas Vishwavidyalaya
- Tezpur University
- University of Allahabad
- Visva-Bharati University
- Dr. Hari Singh Gour University
- English and Foreign Languages University
- North Eastern Hill University
- Hemwati Nandan Bahuguna Garhwal University
- University of Hyderabad
- Manipur University
- Pondicherry University
- Rajiv Gandhi University
- Tripura University
- Assam University
- Nagaland University
- Mahatma Gandhi Antarrashtriya Hindi Vishwavidyalaya
- Maulana Azad National Urdu University
- Mizoram University
- Indira Gandhi National Tribal University
- Sikkim University
- Central University of South Bihar

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- Mizoram University
- Indira Gandhi National Tribal University
- Sikkim University
- Central University of South Bihar
- Dr. Rajendra Prasad Central Agriculture University
- National Sanskrit University[note 3]
- Shri Lal Bahadur Shastri National Sanskrit University
- Central Sanskrit University
- Indira Gandhi National Open University
- Central Agricultural University
- Indian Maritime University
- Central University of Gujarat
- Central University of Haryana
- Central University of Himachal Pradesh
- Central University of Kashmir
- Central University of Jharkhand
- Central University of Karnataka
- Central University of Kerala
- Central University of Odisha
- Central University of Punjab
- Central University of Rajasthan
- Central University of Tamil Nadu
- Nalanda University
- South Asian University
- Central University of Jammu
- Rajiv Gandhi National Aviation University
- Rani Lakshmi Bai Central Agricultural University
- Mahatma Gandhi Central University

- National Sports University
- Central Tribal University of Andhra Pradesh
- Central University of Andhra Pradesh
- National Sanskrit University[note 3]
- Shri Lal Bahadur Shastri National Sanskrit University
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- Central University of Kashmir
- Central University of Jharkhand
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- National Sports University
- Central Tribal University of Andhra Pradesh
- Central University of Andhra Pradesh

- Each candidate must carefully check the CUCET Universities before applying.
- Candidates need to select a minimum of three CUCET Universities in the form.
- There will be no conversion of universities allowed after the submission of the application form. So, select your preferred CUCET University carefully.
- In case a candidate wishes to apply to more than three CUCET Universities, he/she will have to pay extra Rs. 800 (Rs. 350 by SC/ST).
- To get admission to your preferred university, students need to report to the selected CUCET University.

CPGET- Common Postgraduate Entrance Tests

- A state level Common Post Graduate Entrance Tests (CPGET) are being conducted by Osmania University for admissions into various P.G (M.A., M.Sc., M.Com, etc;) courses, P.G. Diploma courses and 5 years Integrated Programmes (M.A., M.Sc., M.B.A) offered by Osmania, Kakatiya, Telangana, Mahatma Gandhi, Palamuru, Satavahana and Jawaharlal Nehru Technological Universities every year.

Examination Pattern of CPGET

1. The entrance tests in all the subjects will be of 90 minutes duration the question paper consists of 100 objective (multiple choice only) type questions for 100 marks.

2. The entrance test will consist of any 3 or 4 varieties of objective type items such as analogies, classification, matching, comprehension of a research study / experiment / theoretical point of view, etc., with multiple answers besides the usual multiple choice items. The items will be framed only from the syllabus of entrance test.

3. Pattern of Entrance Test for Admission into M.Sc. Biochemistry, Environmental Science, Forensic Science, Genetics and Microbiology is as follows. Candidates have to appear for a common entrance test, namely BCESFSG&M comprising of Part-A (Chemistry for 40 Marks) and Part-B (One of the optional studied at B.Sc. level among the optional subjects: Physics, Botany, Zoology, Genetics, Microbiology and Biochemistry) for 60 Marks.

4. Pattern of Entrance Test for Admissions into M.Sc.Bio-Technology comprising of Part-A (Chemistry for 40 marks) and part-B (Bio Technology for 60 Marks)

THANK YOU

Topic: Effect of light on the movement of organisms

Dr. K. Sravanthi

Dept. of Microbiology

Telangana Social welfare Residential Armed forces preparatory degree college, Bhongir

Effects of Light on the movements of Organisms

Objectives

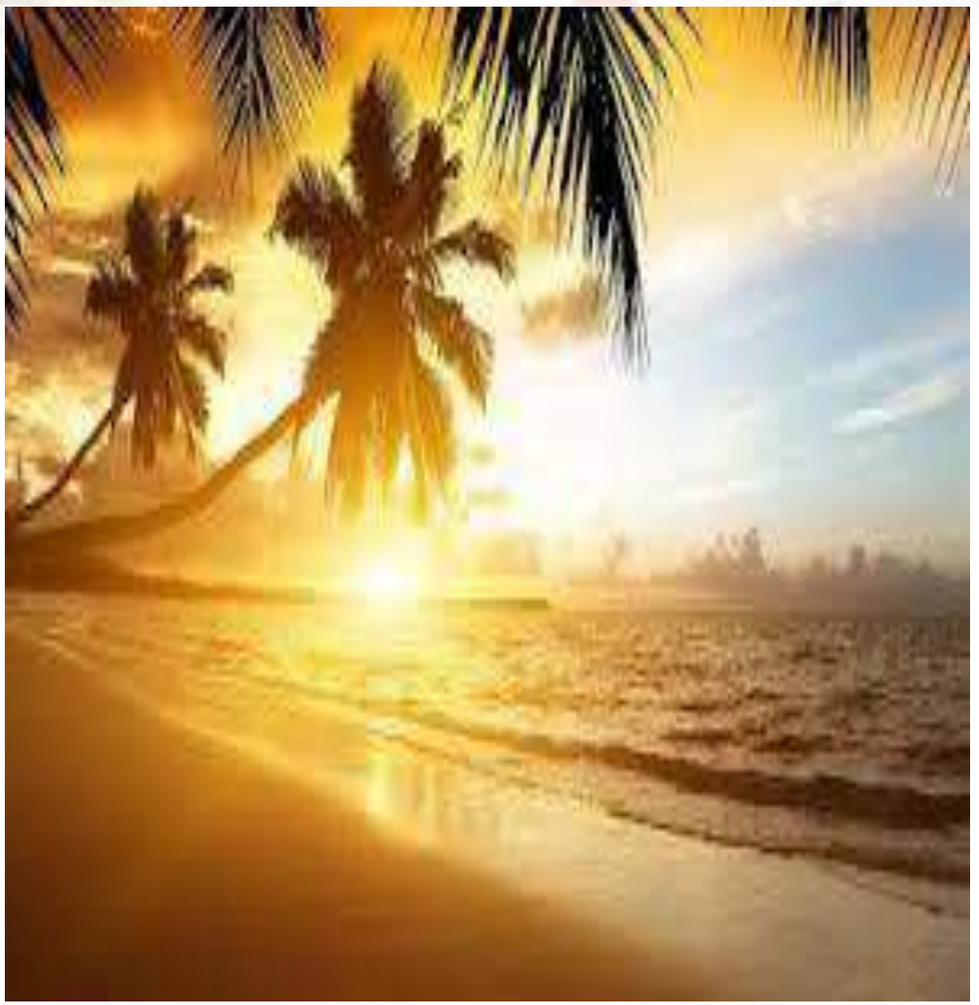
- Solar light - Biological significance
- Photo taxis – Definition
- Types of photo taxis
- Factors effecting photo taxis
- Photo taxis – Relevance in Daily life
- Phototropism
- Artificial light – Impact
- Summary

What is Light?

- Light -an electromagnetic radiation
- Most important abiotic ecological factor

The sources of light:

- The Sun
- Moon
- Stars
- Lightning
- Volcanoes
- Bioluminescent organisms.



Light-Biological Significance

- **Sun –most important**

Sunlight is comprised of:

- **Cosmic rays**
- **Gamma rays**
- **X rays**
- **Ultraviolet rays**
- **Visible light**
- **Infrared rays**
- **Radio waves**

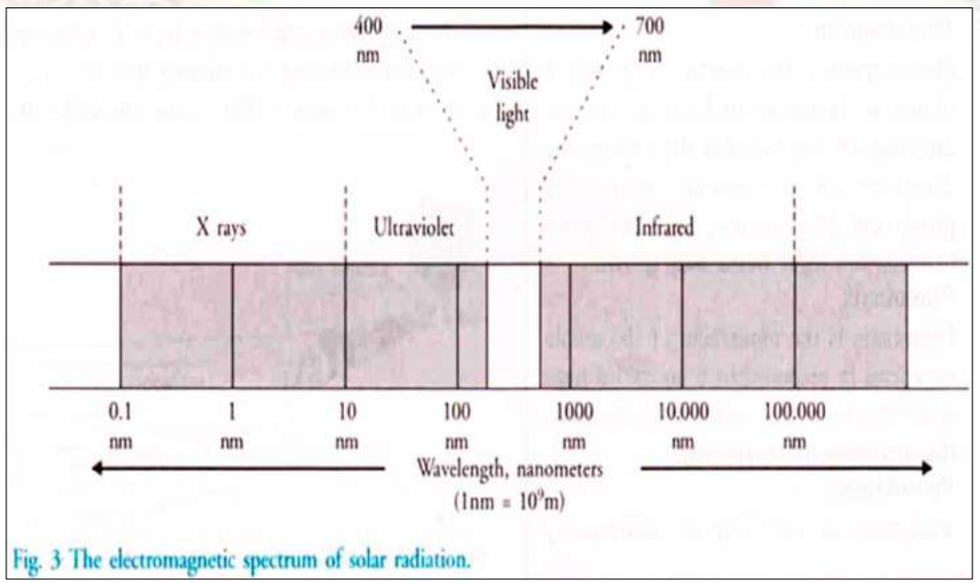
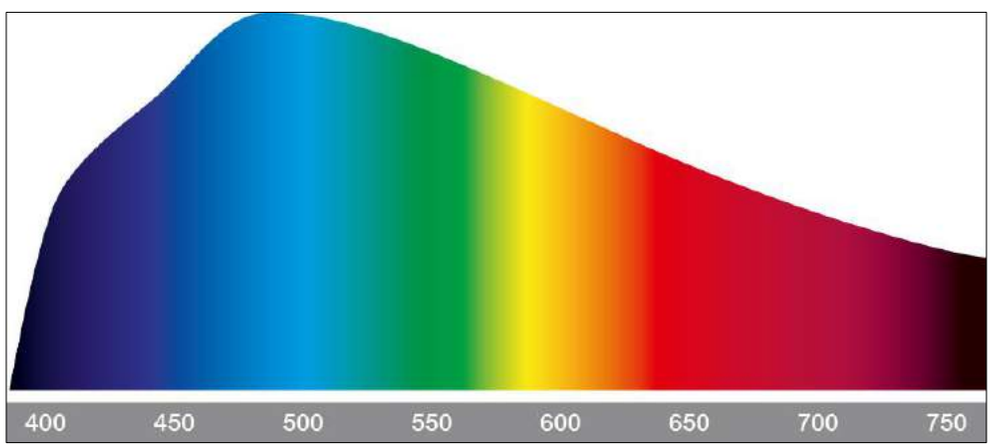


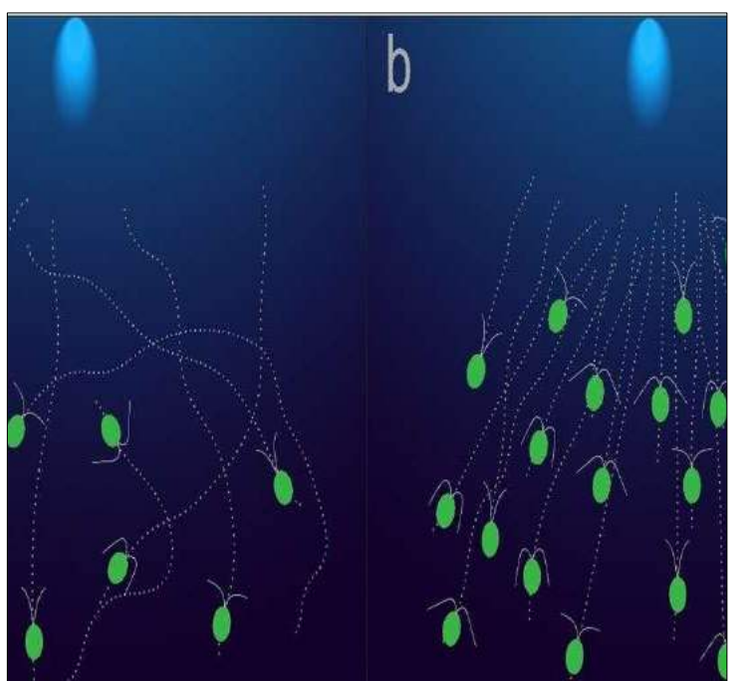
Fig. 3 The electromagnetic spectrum of solar radiation.

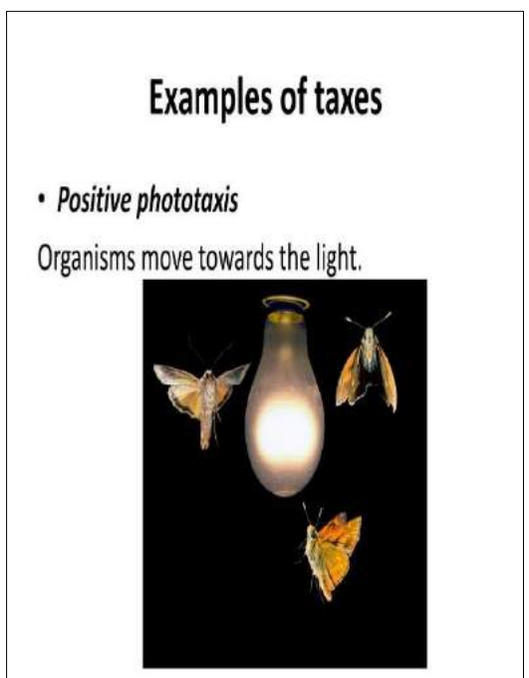


What is Photo taxis?

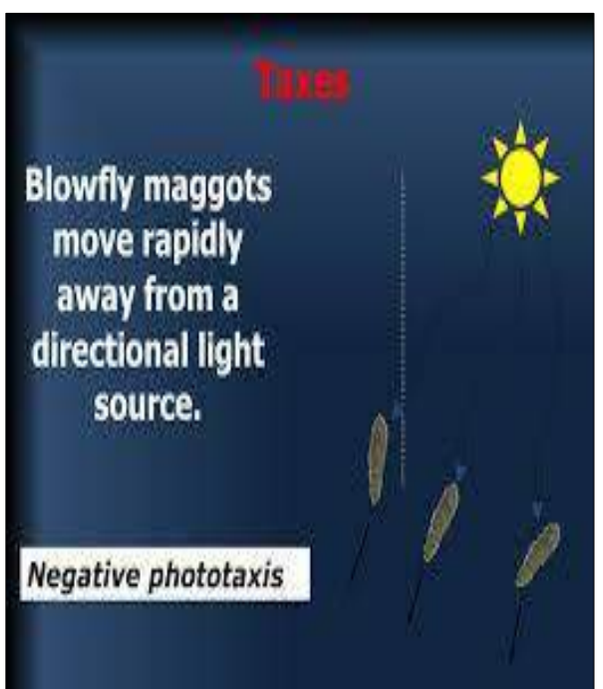
- **Locomotory movement of organisms towards or away from the stimulus of light.**

Positive Photo taxis





Negative Photo taxis



Two types of positive Photo taxis are observed in prokaryotes

1.Scotto Photo taxis- Observed under microscope.

2.True Photo taxis - Directed movement towards an increasing amount of light.

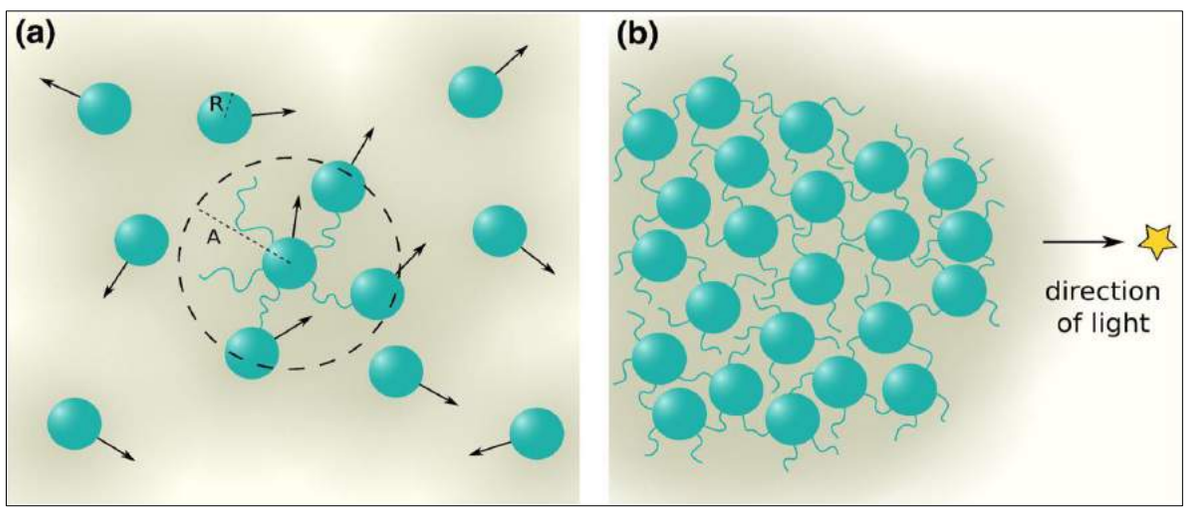
Photo tactic responses are observed in

I. Prokaryotes – Eg: Cyanobacteria & Serratia
II. Eukaryotes – Eg: Tetrahymena, Euglena
III. Plants – Eg: Green Algae
IV. Zooplankton Eg: Jelly fish

Photosynthesis in Cyanobacteria

- **Oscillatoria & spirulina species position to optimize photosynthetic activity**

- **Migrate vertically down into the microbial mat when light levels are too high.**



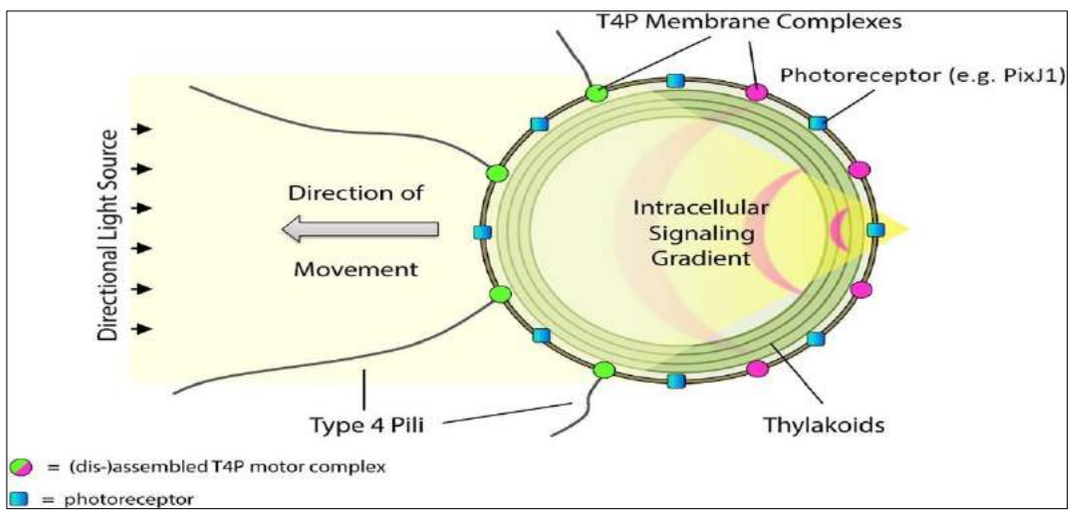


Photo taxis in Zooplankton

- **Marine annelid Platynereis and nectochaete larva**
- **Two pairs of complex pigment cup eyes contain photoreceptor cells.**
- **Adaption on the bottom of the sea**
- **Two rhabdomeric opsins and a Go-opsin.**

Photo taxis in Jelly fish

- **Positive and negative photo taxis is observed in genus Polyorchis.**
- **Use ocelli to detect the presence and absence of light.**
- **Many jellyfishes are in symbiosis with photosynthetic zooxanthellae**

Euglena

- Unicellular, flagellate & have characters of plants & animals
- Positive during photosynthesis

Water fleas/Daphnia

- Found in fresh water lakes & ponds
- High temperature: Negative photo taxis
- Low temperature:+Ve photo taxis

Photo taxis in Insects

- **Positive photo taxis -** **Many flying insects such as moths, grasshoppers, and flies.**

- **Negative photo taxis -** **Larval Drosophila melanogaster**

Factors Effecting Photo taxis

1.Intensity of Light:

Euglena gracilis **shows positive and negative phototaxis based on light intensity.**

2.Temperature:

Inversely proportional.

3. Artificial Light:

May lead to changes in normal activities of animals or even fatal.

Photo taxis-Relevance in daily life

- **Insect traps:**

Using UV- Rays or normal light, insects are attracted, trapped and killed

- **Covering with films :**

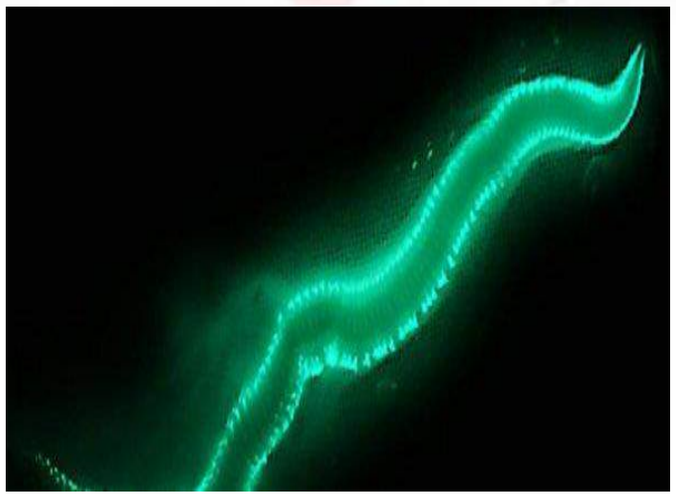
Filters out and prevent invasion of whiteflies

- **Reflective materials:**

Control approach of flying insects such as aphids

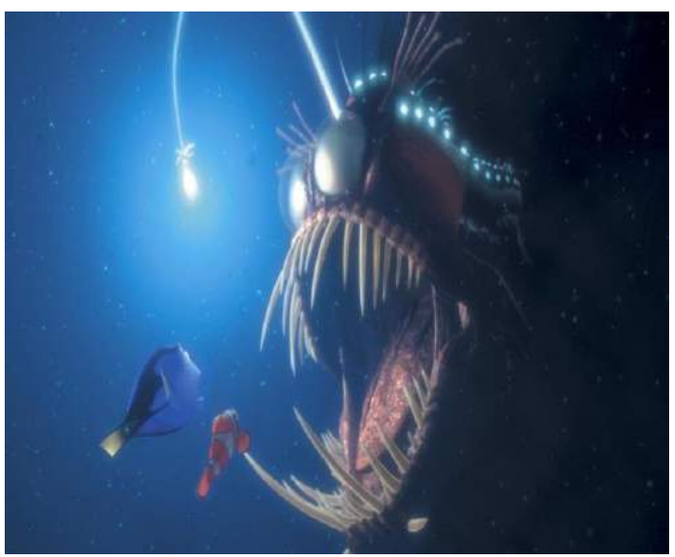
Bioluminescence

Definition-Emission of light by living organisms.



Attract a Mate

- **Male Caribbean ostracod attracts females.**
- ***Odontosyllis enopla*** **to attract males**



Attract Prey

- **Use their light to lure prey towards them**

  Eg: Whales and squids attracted by sharks

Phototropism

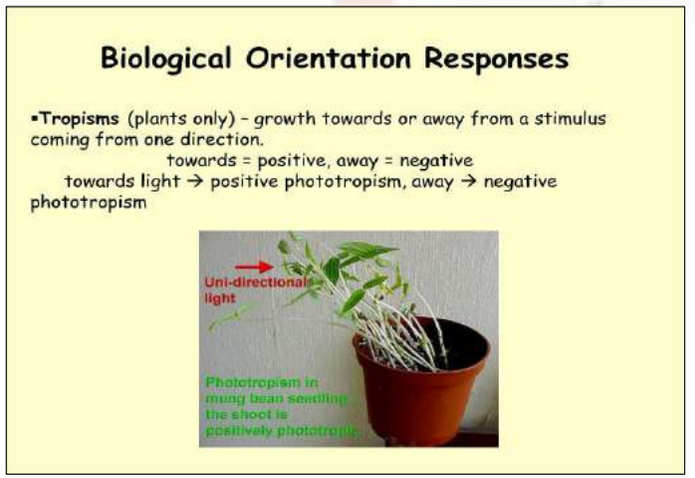
- Growth in response to a light stimulus

- Towards a light source - Positive phototropism

  Eg: Plant shoots

- Away from light – Negative phototropism (skototropism).

  Eg: Some vine shoots

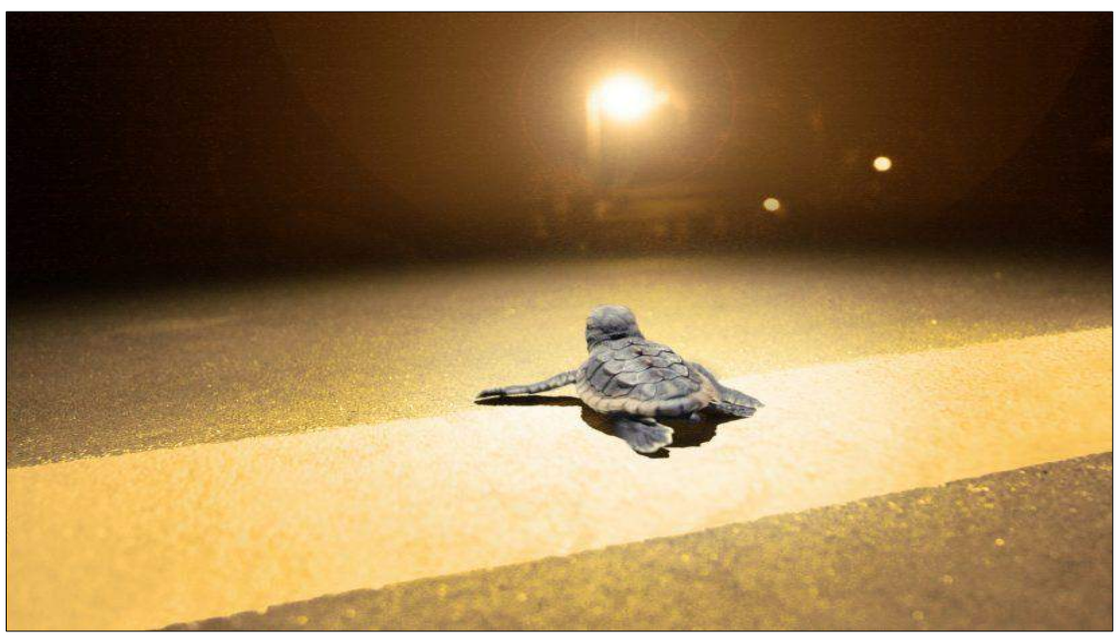


Impact of Artificial Light

- Artificial Lights Disrupt the World's Ecosystems
- Artificial Lights Can Lead Baby Sea turtles to their Demise
- Artificial Lights have Devastating Effects on Many Bird Species
- Ecosystems: Everything is Connected

Sea-Turtles

- Beach lights distract hatchlings
- In Florida alone,millions of hatchlings die every year



Insects

- Can create a fatal attraction.
- Impact all species that rely on insects for food or pollination.
- Effects food webs

Recent Breakthroughs

- **A new study from the Indian Institute of Science (IISc) describes how certain algae collectively sense and respond to light, a phenomenon called phototaxis.**

Sujeet Kumar Chaudhary et al. Reentrant Efficiency of Chlamydomonas reinhardtii. Cells, Biophysical journal journal(2019)

- **“Host Winged Pea Aphids Can Modify Photo taxis in Different Development Stages to Assist Their Distribution”**

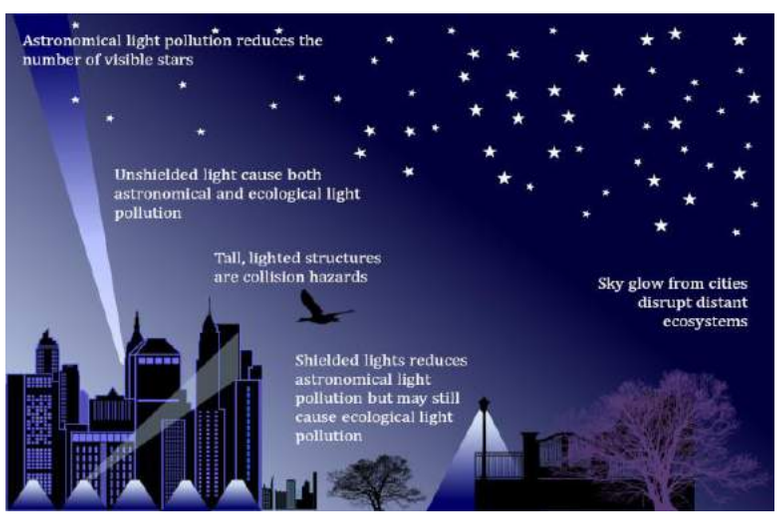
Front. Physiol., 02 August 2016

Summary

- Sun-Ultimate source of light
- Phototaxis:movement towards or away from light source
- Adequate amounts of light is required to function properly
- Organisms adjust themselves to light potential
- Artificial lights mislead the organisms and effect their migratory and hunting abilities
- Usage of newer light sources can promote IPM and balance ecosystem

Conclusion

- **Though light is very important abiotic factor, over-illumination may lead to light pollution.**
- **Light at Night- Mixed blessing for life**
- **Luckily, light pollution is reversible and our light practices can be rechecked.**
- **Motion detector lights can be installed.**
- **Green buildings can be constructed.**



- **“The only way to address light pollution effectively is that we as a society need to decide it’s something we care about”**
- **This will take time, but light pollution is a problem with a clear solution. Once we solve it, the results benefit us all.**

THANK YOU

Topic: Factors effecting Microbial Growth

Dr. K. Sravanthi

Lecturer in Microbiology,

TGSWRAFPDCW, Bhongir

Factors effecting Microbial Growth

- **Temperature**
- **pH**
- **Oxygen**
- **Salt and sugar concentrations**
- **Radiation**

Temperature

Temperature influences the Microorganisms

Temperature - Enzymatic activity

Cardinal temperature – **Minimum**

Optimum

Maximum

Microbial growth temperature dependence

Temperature

- The optimum temperature is always closer to the maximum.
- The cardinal temperatures for a particular species are not rigidly fixed but often depend to some extent on other environmental factors such as pH and the available nutrients.

Temperature

The temp - growth range seems to be water.

Based on temp requirement microorganism are

1. Psychrophiles
2. Mesophiles
3. Thermophiles
4. Hyperthermophiles

Temperature

- Minimum – 0^0C
- Optimum - 15^0C
- Maximum – 20^0C
- *Chlamydomonas nivalis* (algae), Pseudomonas, Vibrio, Alcaligenes, Bacillus, Arthrobacter, Moritella, Photobacterium, and Shewanella

Temperature-psychrophiles

Species can grow at 0 to 7°C even though they have optima between 20 and 30°C, and maxima at about 35°C. These are called **psychrotrophs** or **facultative psychrophiles**

Temperature-mesophiles

Minimum – 20^0C
Optimum - 35-38^0C
Maximum – 45^0C
Almost all human pathogens are mesophiles,

Temperature-thermophiles

- Minimum – 45^0C
- Optimum - $55\text{-}65^0$C
- Live in compost areas
- Hot water lines
- Hot springs

Temperature-hyperthermophiles

- Minimum – 55^0C
- Optimum - 80-113^0C
- *Pyrococcus abyssi* and *Pyrodictium occultum*
- Live in sea floor

pH

- Acidophiles – Optimum pH 0-5.5
- Eg: Majority of fungi and few bacteria
- *Cyanidium caldarium* (algae), *Sulfolobus acidocaldarius* (Archae) grow at pH 1 to 3 and at high temperatures
- *Ferroplasma acidarmanus* and Picrophilus oshimae (pH-0)

Neutrophiles – Optimum pH 6-8

Eg: Majority of Bacteria and algae

Basophiles/ alkalophiles –Optimum pH 8-12

Extreme alkalophiles have growth optima at pH 10 or higher

Eg: *Bacillus alcalophilus, Salmonella*

Oxygen concentration

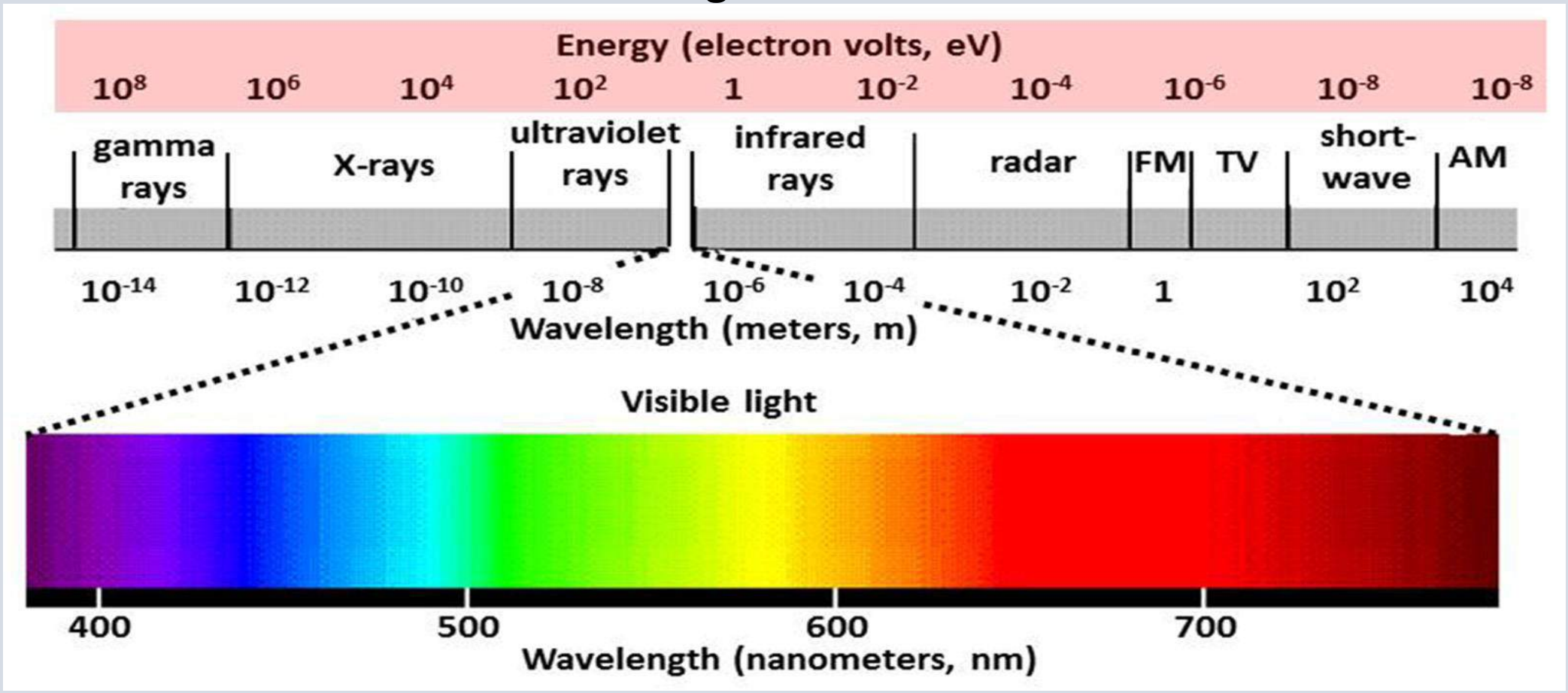
- Aerobes
- Facultative anaerobes
- Anaerobes
- Aerotolerant anaerobes

Pressure

- Atm pressure – 1
- In the sea pressure increases as going deeper
- Barophiles –
- Barotolerant –
- *Photobacterium*, *Shewanella*, *Colwellia*, *Pyrococcus spp.*, *Methanococcus jannaschii*

Radiation

Electromagnetic radiation



Osmotic pressure and water activity

Microorganism in

1. Hypotonic – Plasmoptyis – burst
2. Hyper tonic – plasmolysis – shrink
3. Iso osmotic – live cell
4. Many organism maintain solutes in the cell according to surrounding solute concentration

Osmotic pressure and water activity

Microorganism	Water activity required for growth
Bacteria	0.91
Yeasts	0.88
molds	0.80
Halophilic bacteria	0.75

THANK YOU

Topic: Microbial Growth

Dr. K. Sravanthi

Lecturer in Microbiology,

TGSWRAFPDCW, Bhongir

Objectives

- Growth
- Growth curve
- Mathematics of microbial growth
- Factors effecting microbial growth

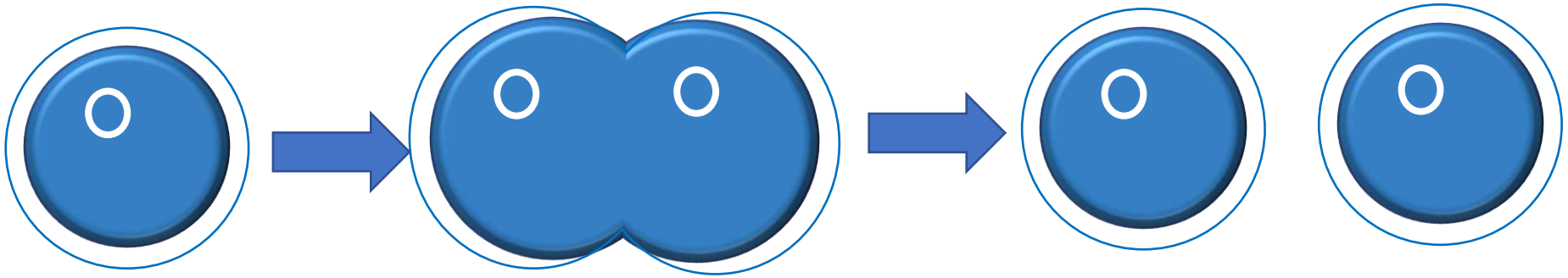
Microbial Growth

- Increase in the size-Increase in the cell components.
- Coenocytic cells
- Increase in the cell number
- Geomatric increase

Microbial Growth

1 → 2 → 4 → 8 → 16 → 32

Total number of cells after n generation= 2^n



Microbial Growth

- Generation time- time required to double the number
- Generation time “t”
- *E.coli*- 20 min
- *Bacillus*- 30 min
- *Staphylococcus aureus* - 30 min
- *Streptococcus lactis* – 26 min
- *S. cerevisiae* – 120 min

For E.g:

- N_0 = Initial microbial number
- N_t = total number of microorganisms at time t
- n = number of generations in time t

Then total number of microbial cells after time t with n number of generations is

$$N_t = No \times 2^n$$

Eg:

- Apply logarithms at the base 10,
- log Nt = log No + n log 2,
- log Nt- log No=n log 2
- $n = \frac{\log Nt - \log No}{\log 2}$

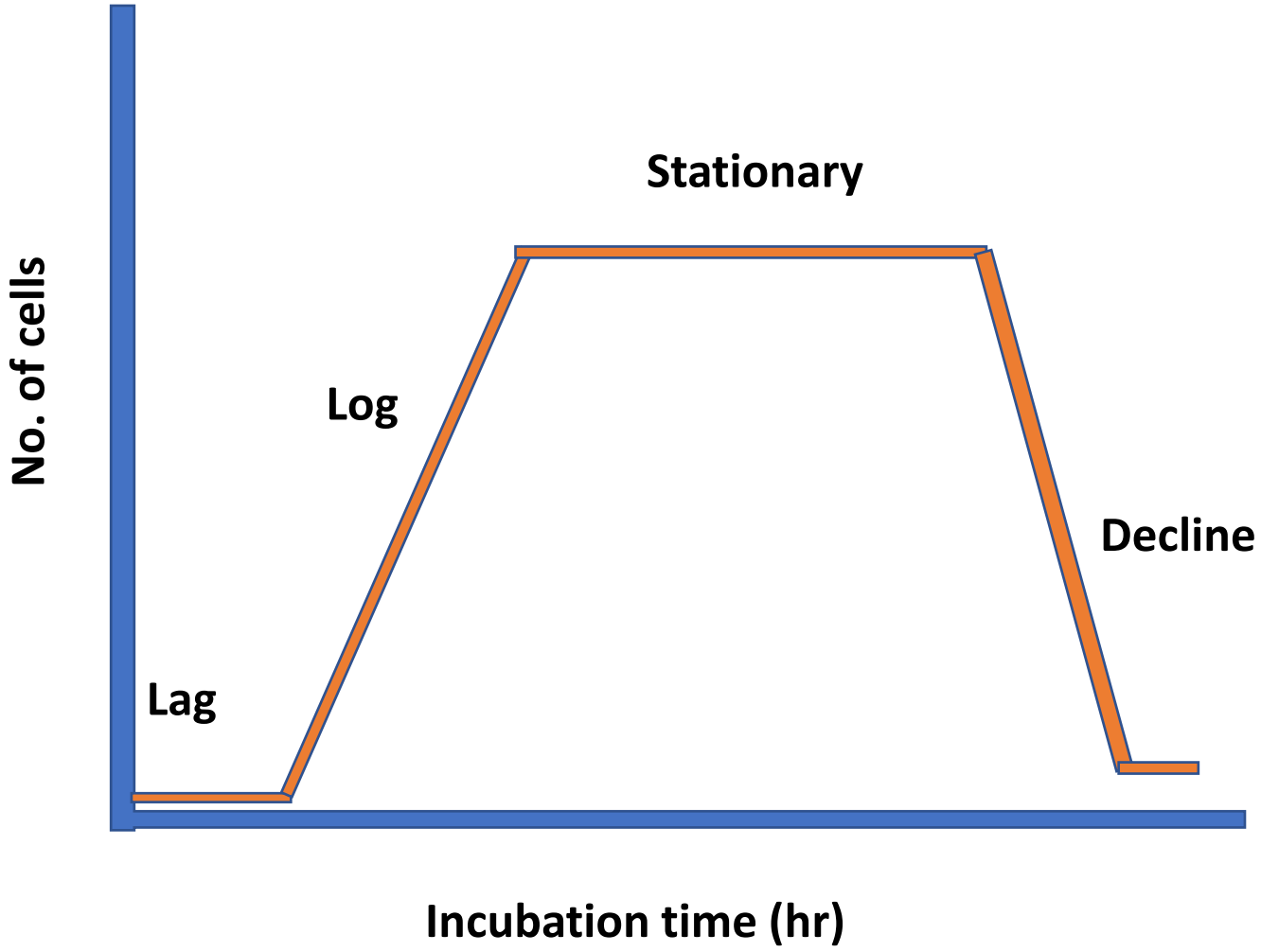
Eg:

- Growth rate is number of generation (n) per time (t)
- Growth rate = n/t
- Growth rate = $\frac{\log Nt - \log No}{\log 2t}$

Microbial Growth curve

Lag phase
Log phase/Exponential phase
Stationery phase
Death phase/Decline phase

Growth curve



Lag phase

- No increase in the cell number
- But active in stage- protein synthesis, ribosomes
- Cells adjust according to the environment
- Lag phase period may change with the different situations

Log phase

- Rapid increase in the cell number- logarithmically
- Maximum growth rate- constant
- Uniform population
- Shift up
- Shift down

Stationary phase

- Microbial growth ceases & growth curve becomes horizontal
- Bacteria population at 10^9 cell/mL
- Protozoan and algal cultures - 10^6 cells/mL
- Viable cells number is same

Stationary phase- Reasons

- Nutrient depletion
- O_2 depletion
- Toxic product accumulation
- Starvation

Death phase

- Nutrient deprivation
- Buildup of toxic wastes
- Microbes usually dies in a logarithmic fashion,
- The death rate may decrease after the population has been drastically reduced.

THANK YOU