

# Host-Pathogen Relationship in 3D

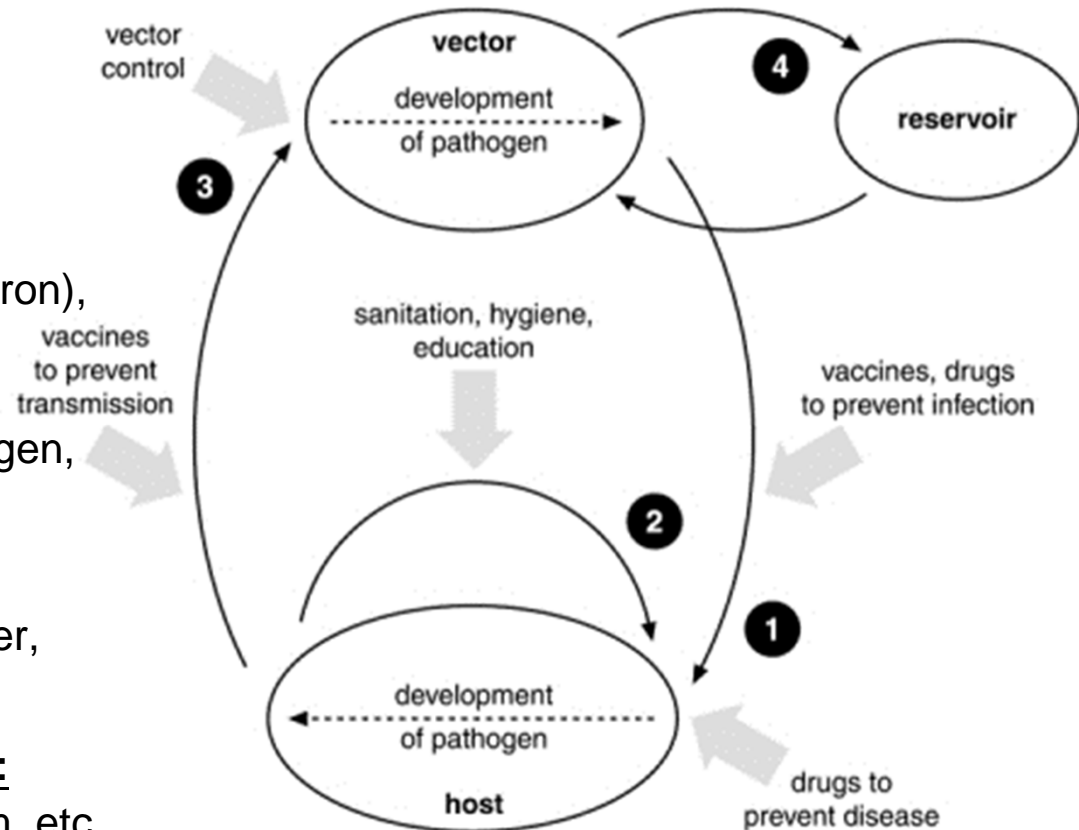
Name: Ma Hok Lun, Helen

(PhD, Yr 2)

Date: 2010-12-7

# Host-Pathogen Relationship (The Basis)

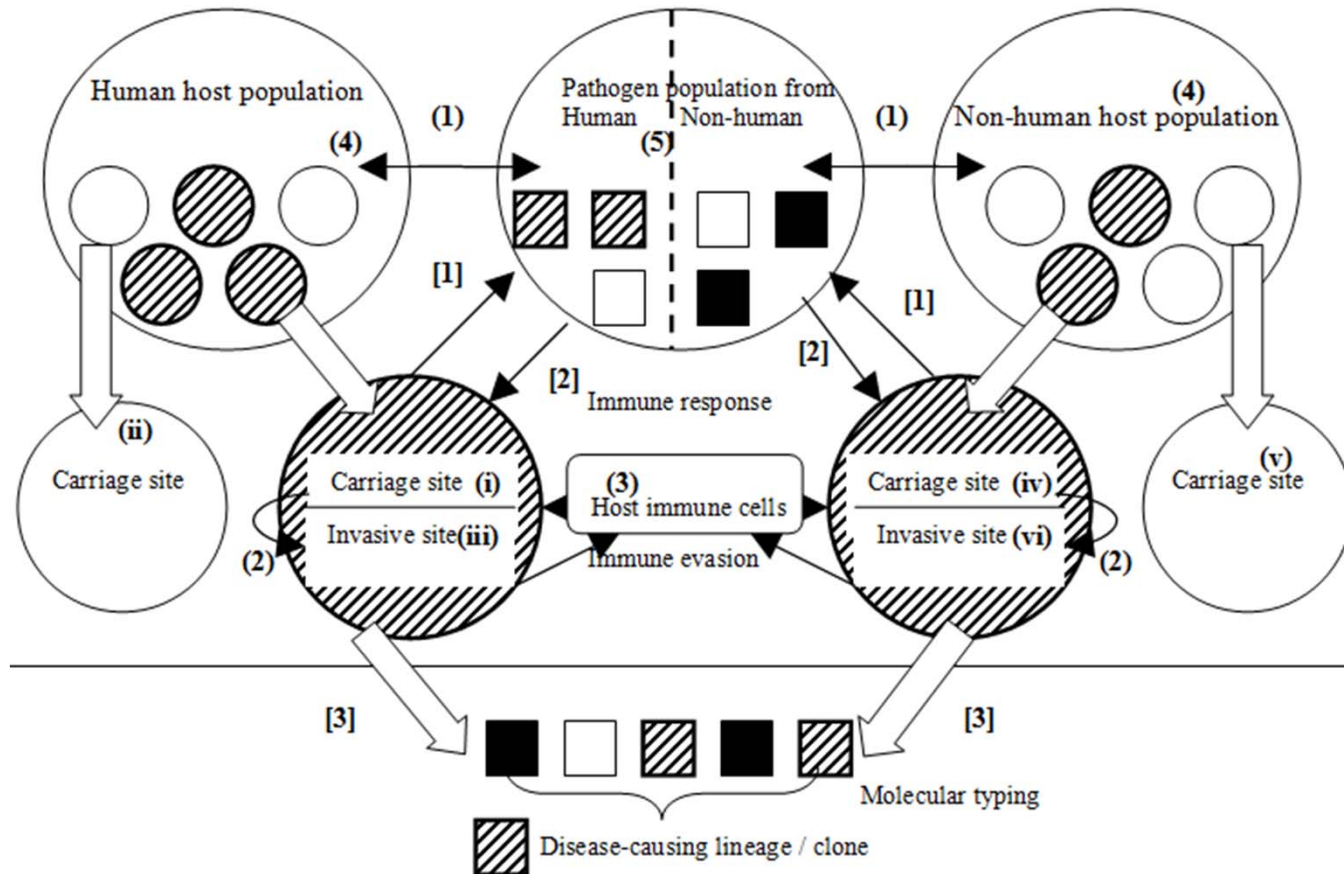
- **Definition of pathogen:**
- Microorganisms that are capable of causing disease
- **Types of pathogens:**
- **By organism identity:**
- Viruses, Bacteria, Fungi, Protozoa, (Piron), etc.
- **By ability to cause infection:**
- True pathogen vs. opportunistic pathogen, etc.
- **Types of hosts:**
- Definitive (Final), Intermediate, Transfer, Reservoir, etc.
- **Types of Host-pathogen interaction:**
- Commensalism, Mutualism, Parasitism, etc.



Bethesda, NIH, 2007

<http://www.icp.ucl.ac.be/~opperd/parasites/types3.htm>

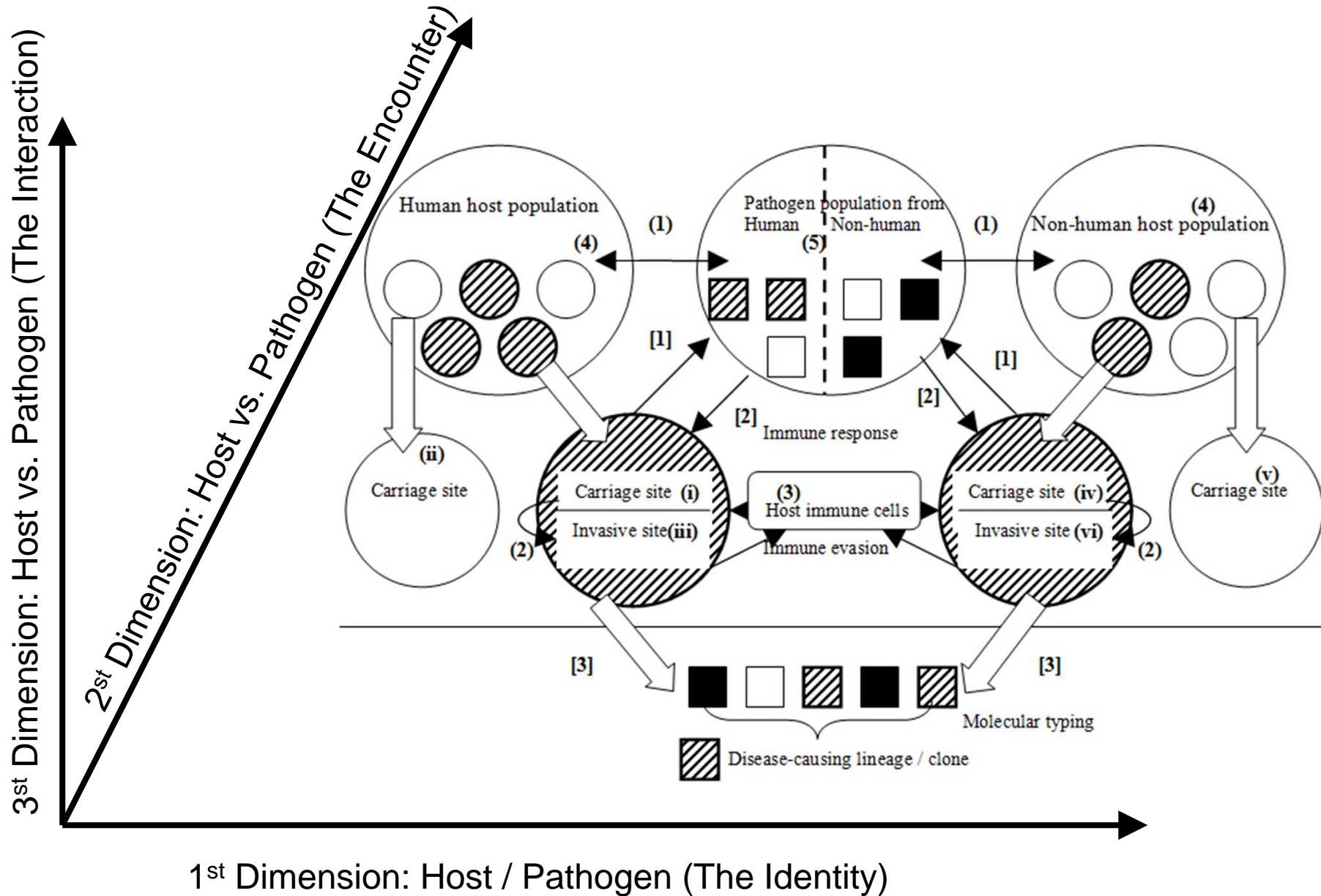
# Host-Pathogen Relationship (The Basis)



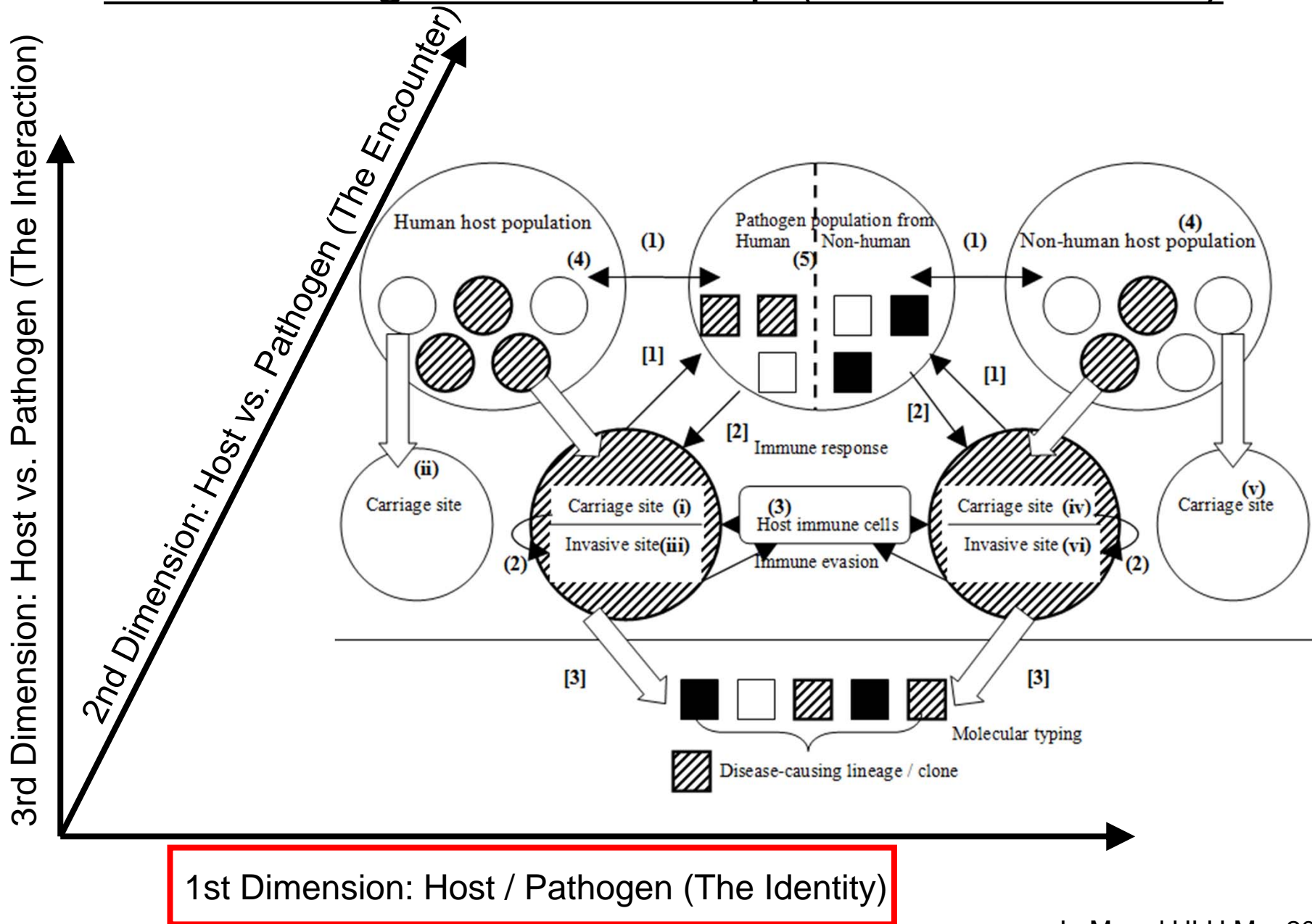
- **Schematic diagram of Host-Pathogen Interaction:**

- (1) Transmission between host and pathogen
- (2) Transmission within host (carriage vs. invasive sites)
- (3) Host immune response vs. Pathogen immune evasion
- (4) Individual factors of particular host that affect (1) to (3)
- (5) Strain-dependent factors among pathogens

# Host-Pathogen Relationship (The Dimensions)



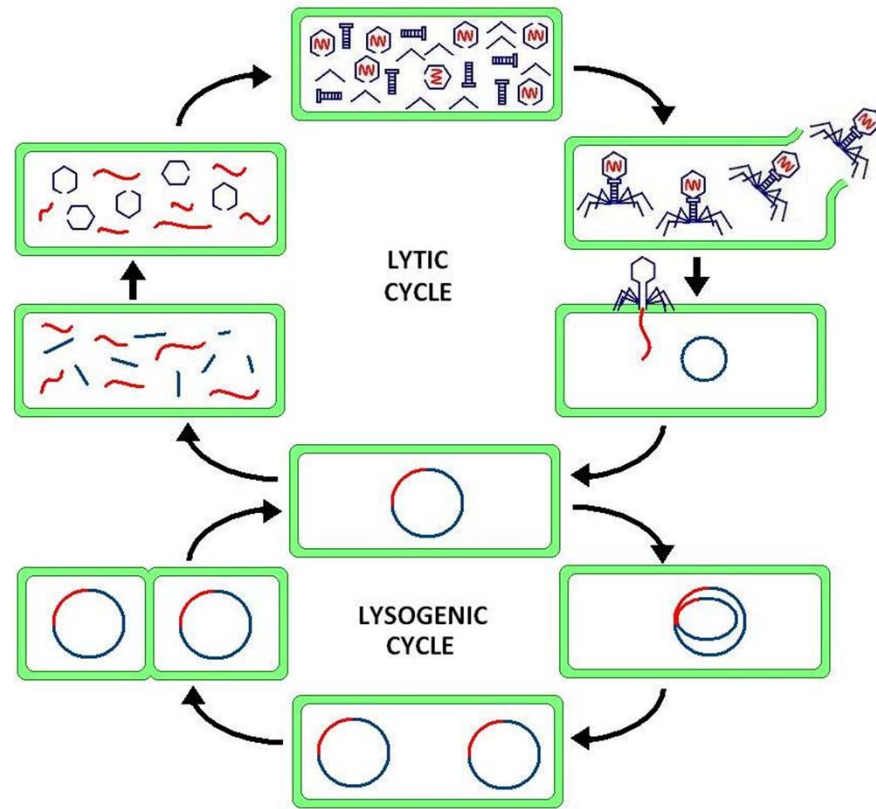
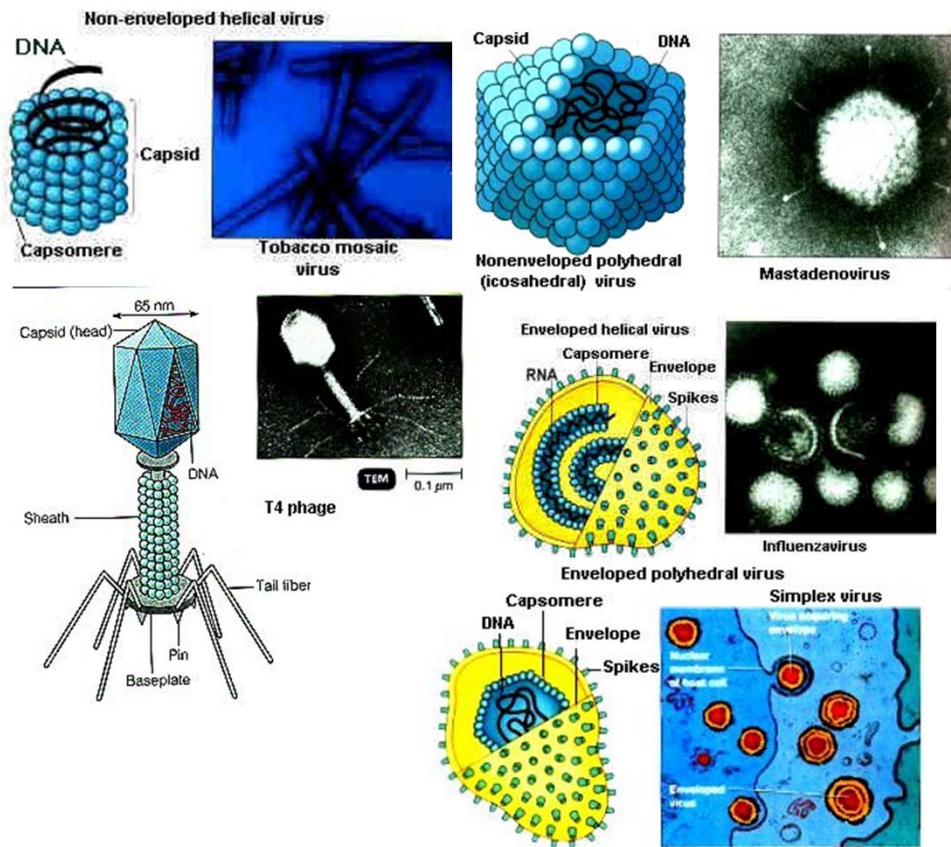
# Host-Pathogen Relationship (The Dimensions)





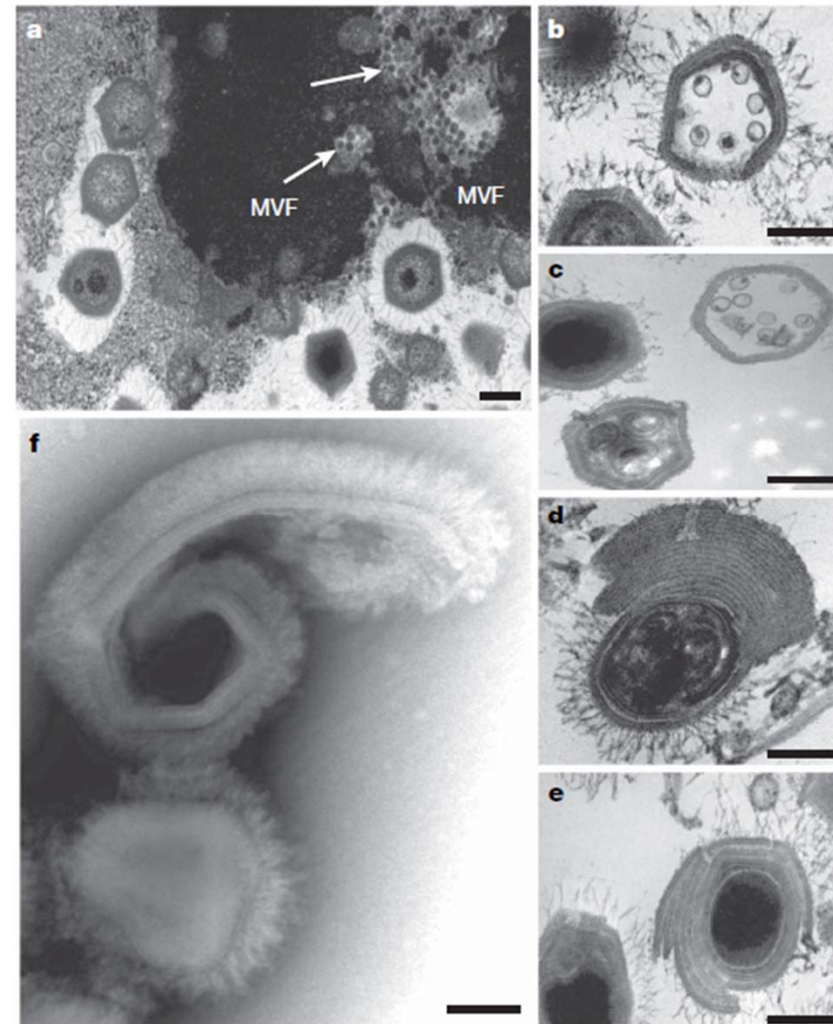
# 1st Dimension: Host / Pathogen (The Identity)

- Our usual understanding on viruses:
- An envelope of nucleic acid that takes over host's machinery to reproduce
- Our usual understanding on viral life cycle:
- Lytic vs. Lysogenic cycle



# 1st Dimension: Host / Pathogen (The Identity)

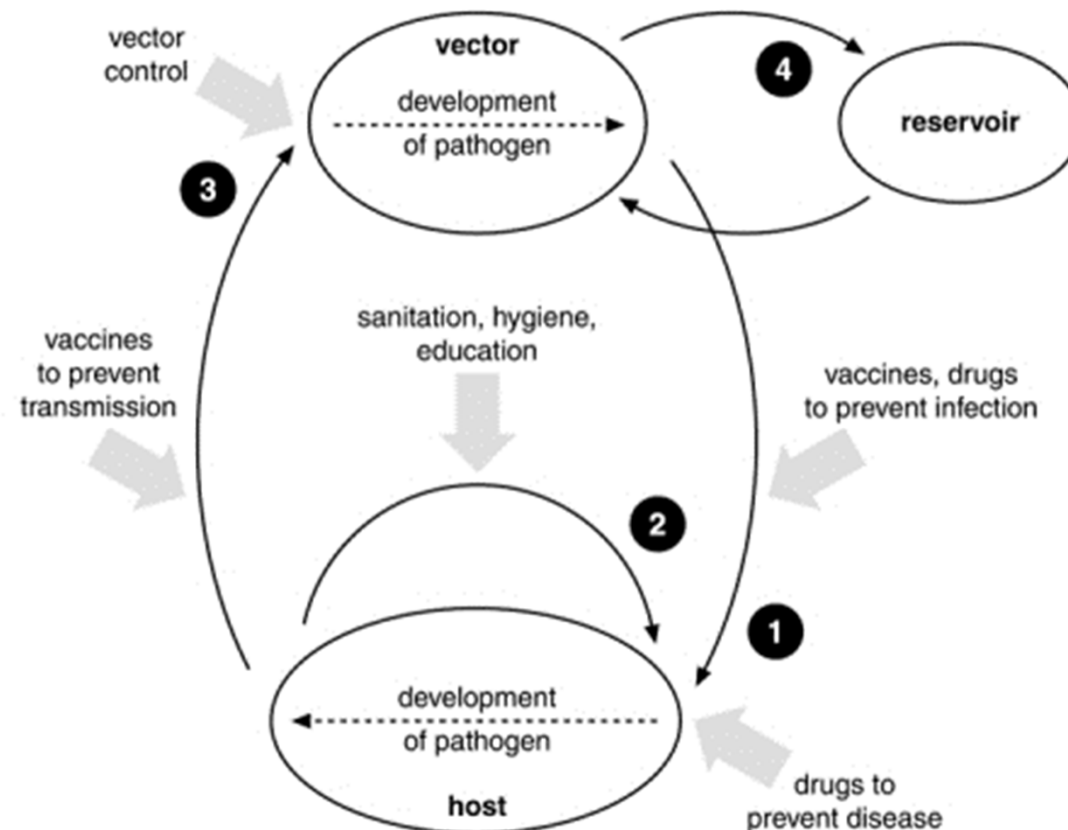
- **Pathogen:**
- *Acanthameoba polyphaga* mimivirus (mamavirus, APMV)
- The largest known virus
- **Host:**
- Ameoba (*Acanthameoba polyphaga*, *Acanthameoba castellanii*, etc.)
- **Pathogen's "pathogen":**
- Sputnik, icosahedral viron particle
- A currently unknown family of virus
- Take over the ameoba machinery taken over by mamavirus to reproduce
- Identified as "Virophage" (compared to bacteriophage)



Pathogenicity is the ongoing evolution between a parasite and a particular host.

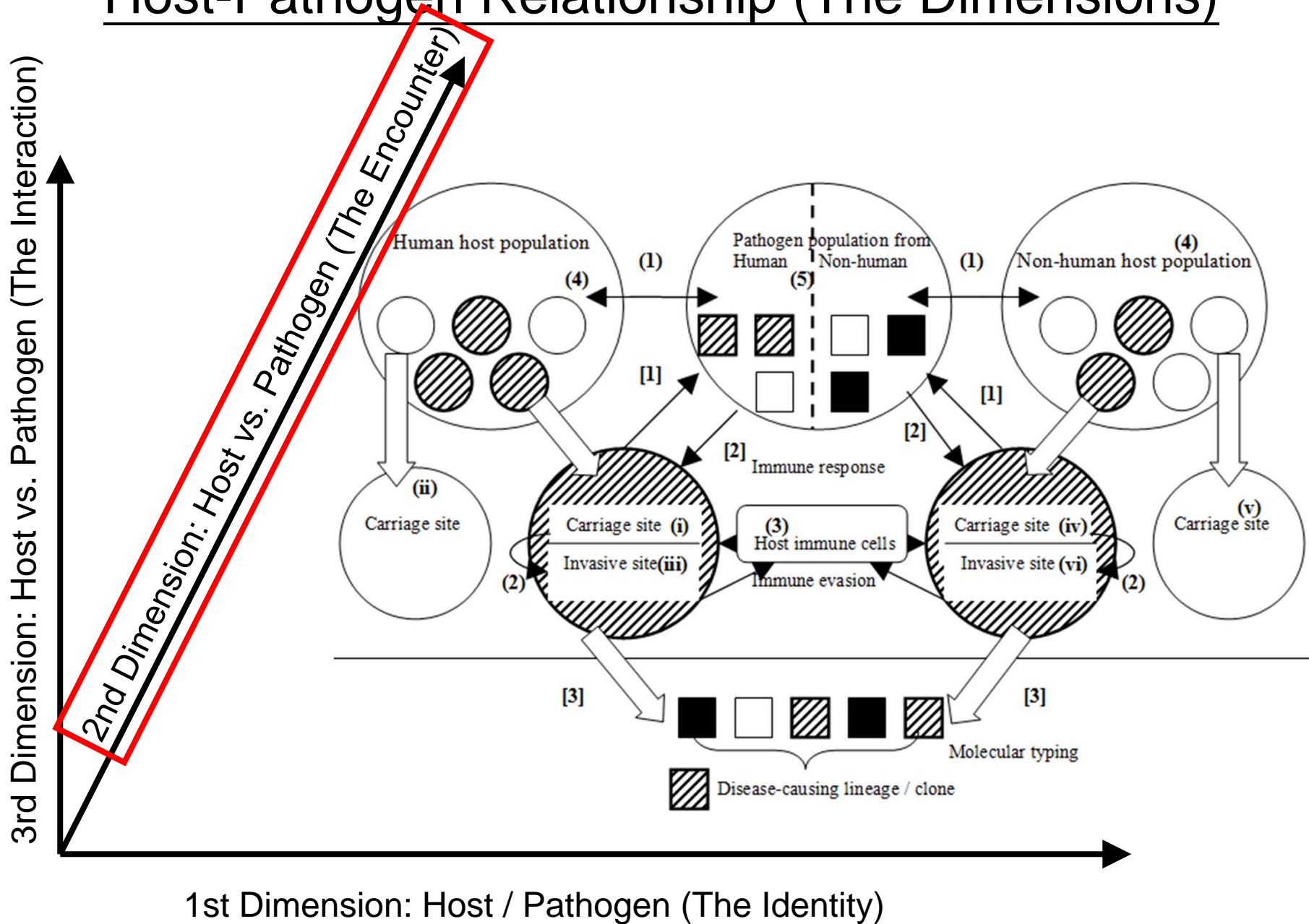
# 1st Dimension: Host / Pathogen (The Identity)

- Pathogenicity is the ongoing evolution between a parasite and a particular host.
- The identity of a “Host” and a “Pathogen” is not fixed.
- The rationale we use for defining “Host-Pathogen” relationship is oversimplified.



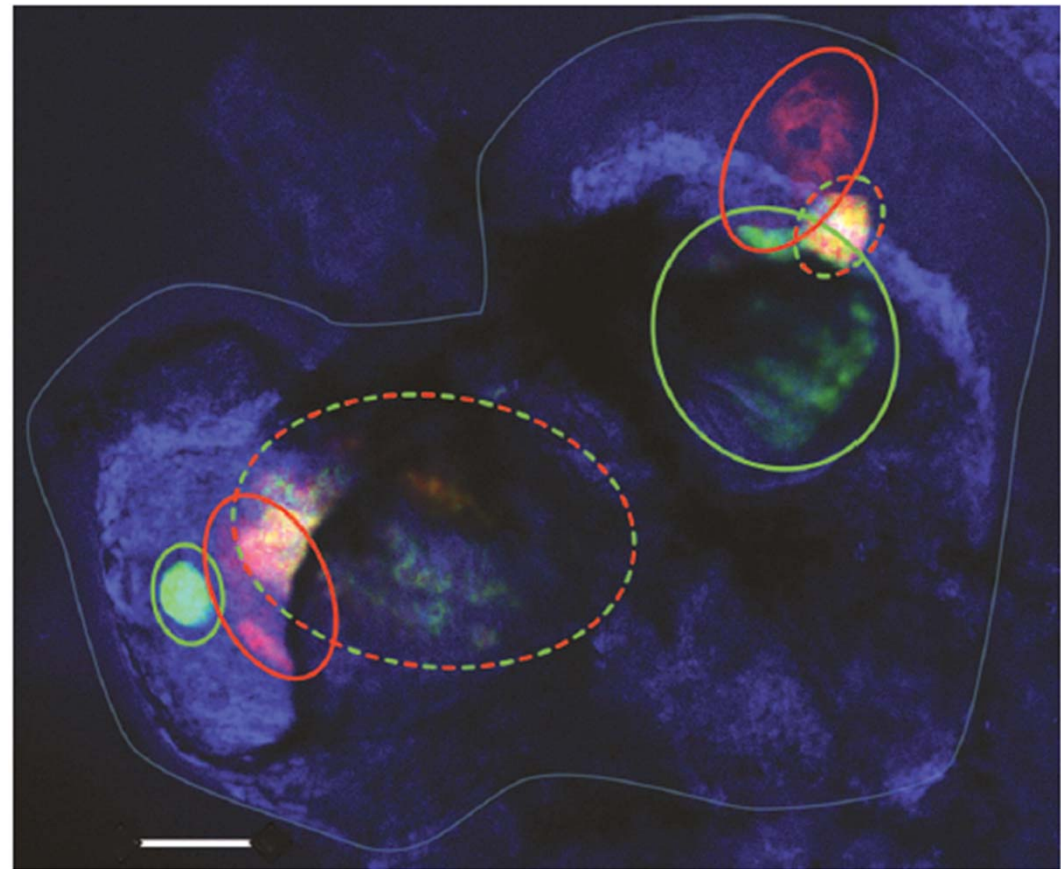
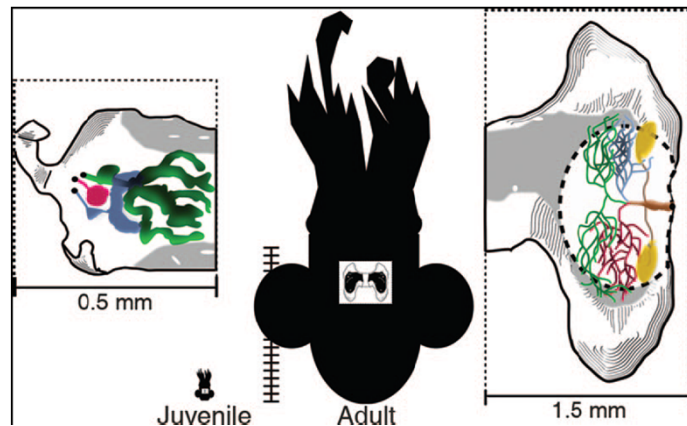


# Host-Pathogen Relationship (The Dimensions)



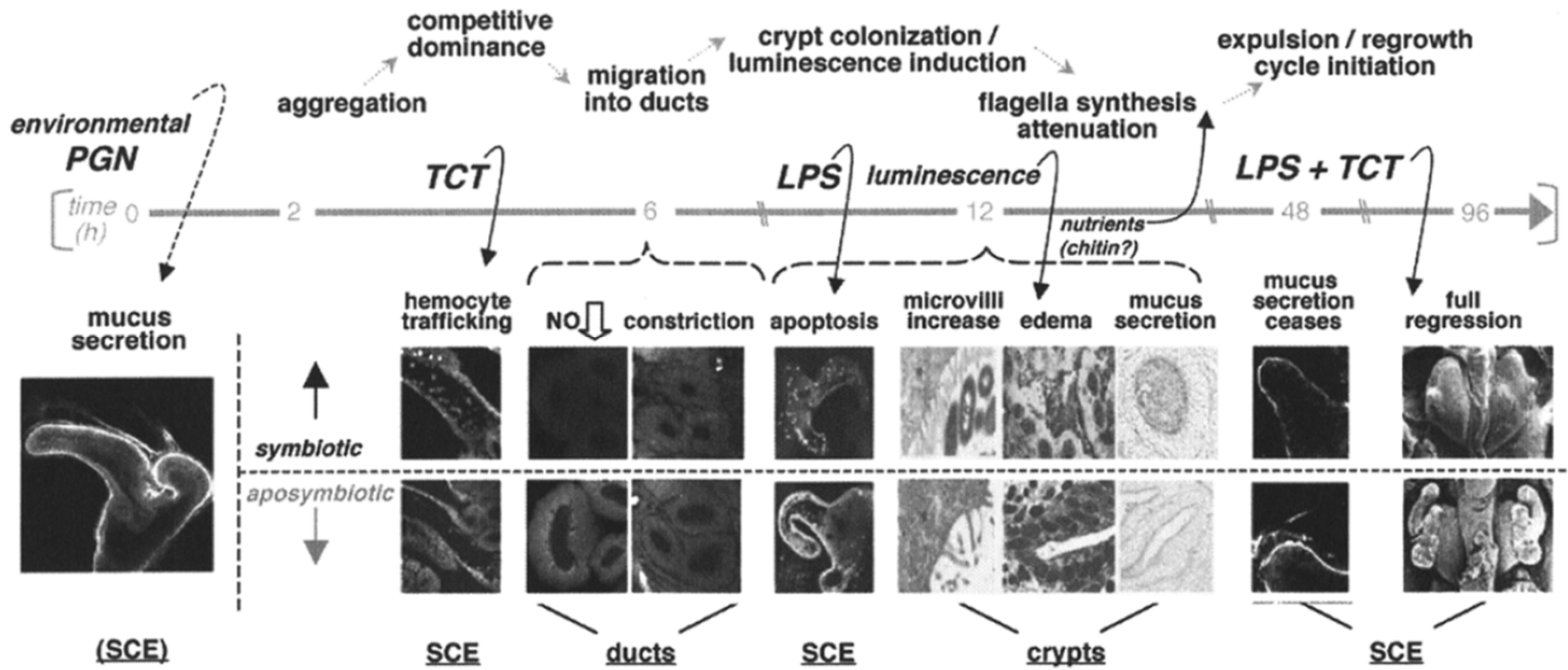
## 2nd Dimension: Host vs. Pathogen (The Encounter)

- “Pathogen”: *Vibrio fischeri*, produce biofilm in host, responsible for Bioluminescence
- Host: Various marine animals, such as Hawaiian bobtail squid (*Euprymna scolopes*)



# 2nd Dimension: Host vs. Pathogen (The Encounter)

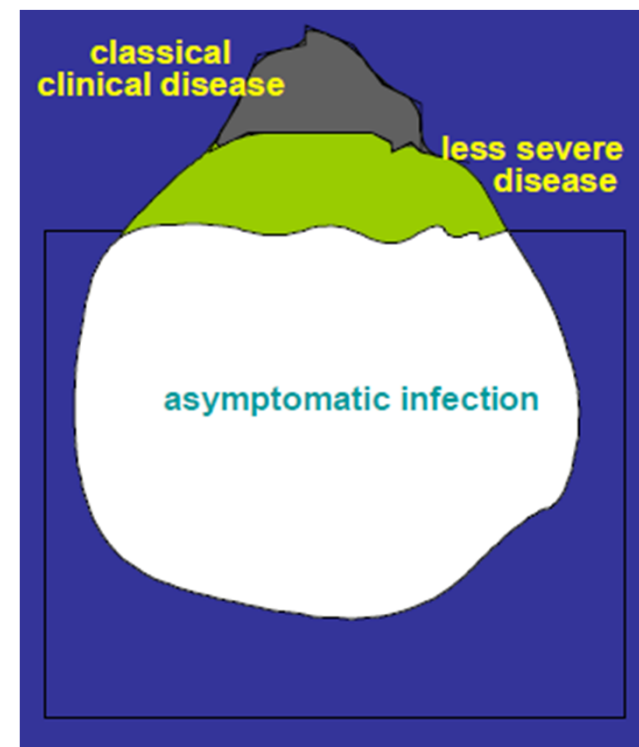
- Signaling molecules responsible for establishment of symbiosis:
  - PGN, peptidoglycan
  - TCT, tracheal toxin (derivative of PGN)
  - LPS, lipopolysaccharide
- } **Common virulence factors**



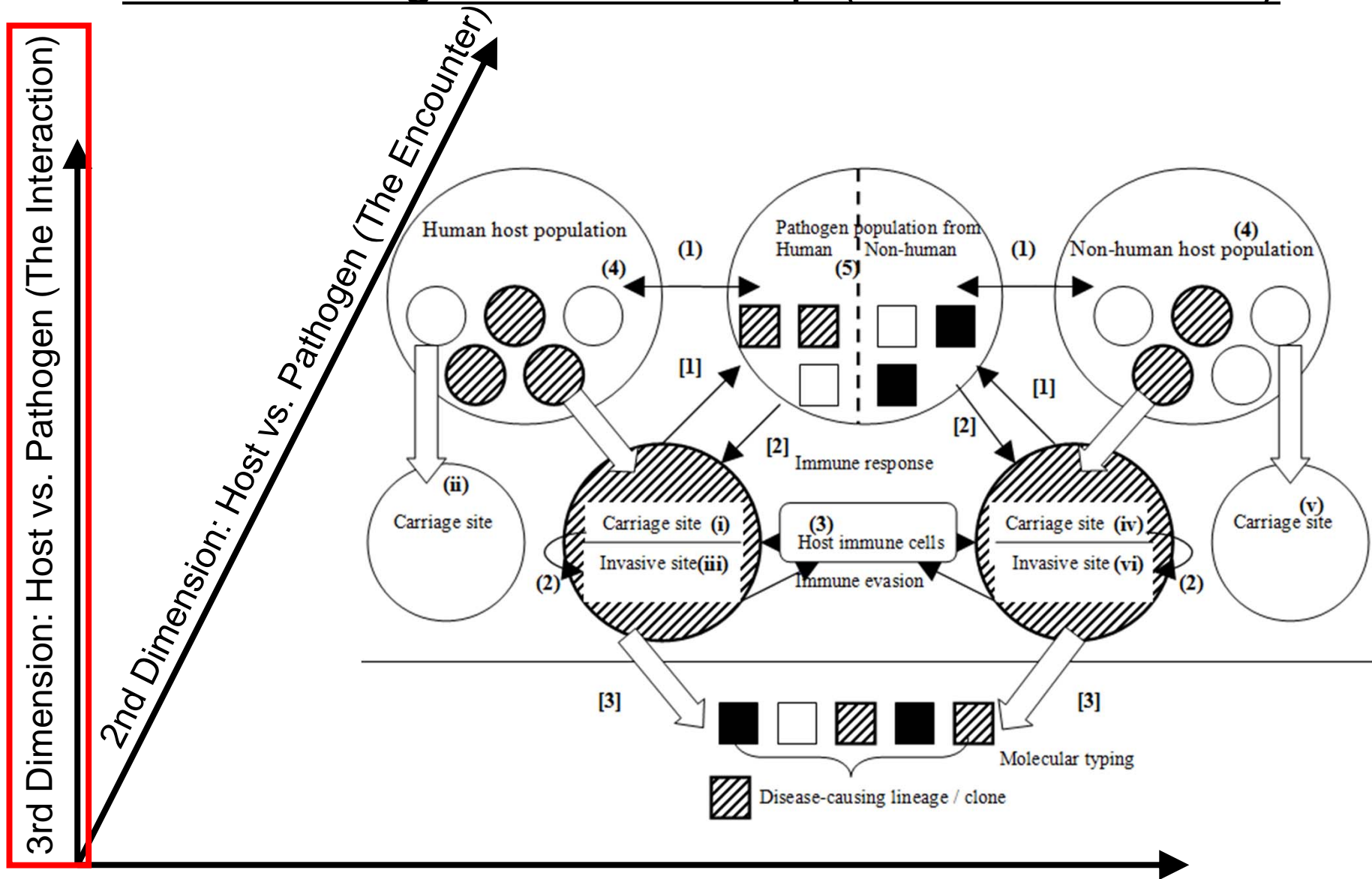
The real identity of virulence factors are signaling molecules!

## 2nd Dimension: Host vs. Pathogen (The Encounter)

- The real identity of **virulence factors** are **signaling molecules!**
- Types of Host-pathogen interaction:
- Commensalism, Mutualism, Parasitism, etc.
- Definition of Infection:
- When a pathogen invades and begins growing within a host.
- Definition of Disease:
- Consequence of the invasion and growth of a pathogen, tissue function is impaired.
- The Iceberg Concept of Infection:
- “Disease is the more the exception than the rule.”



# Host-Pathogen Relationship (The Dimensions)



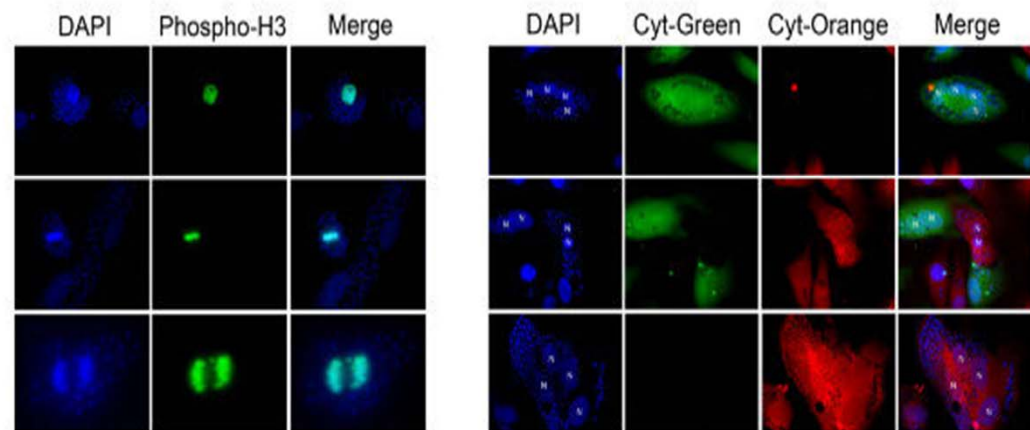
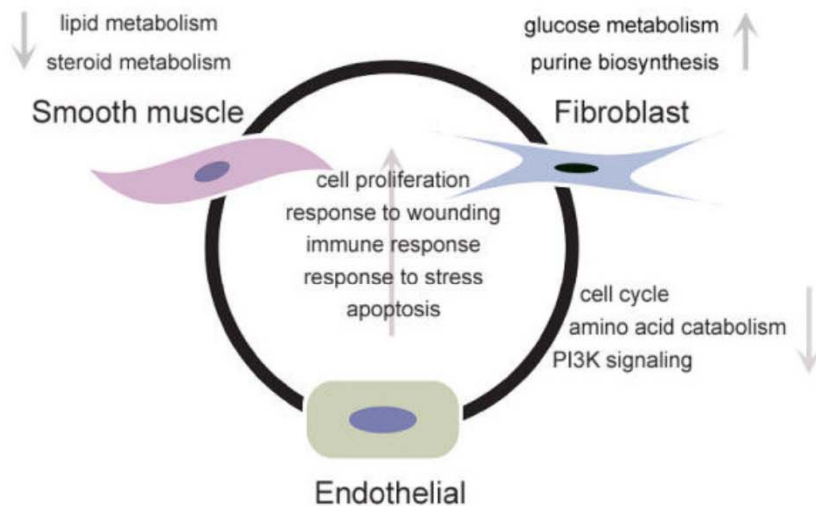
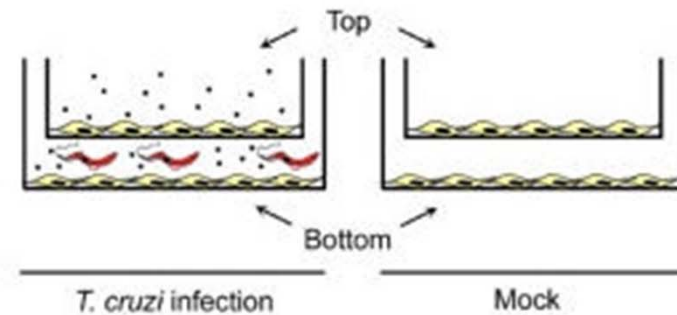
1st Dimension: Host / Pathogen (The Identity)

Willey J *et. al.*, 2008  
Ip M and HLH Ma, 2010



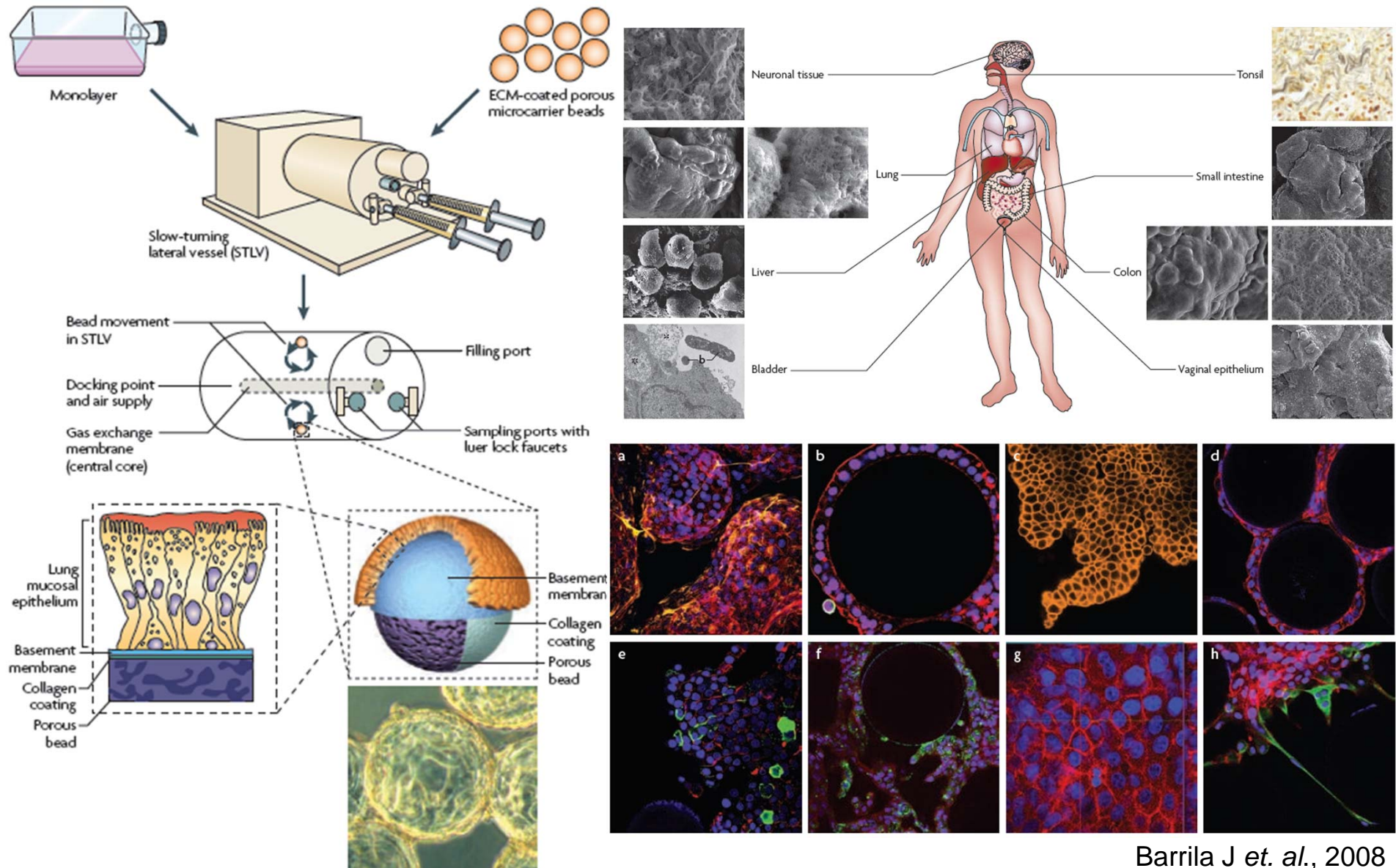
# 3rd Dimension: Host vs. Pathogen (The Interaction)

- **A more practical issue: How we study Host-Pathogen Interaction?**
- **Host:** changes in gene expression, cytokine release, changes in metabolism, etc.
- **Pathogen:** changes in gene expression, life-cycle, etc.
- E.g. in *Trypanosoma cruzi*,
- an intracellular protozoa that cause
- South-American sleeping sickness



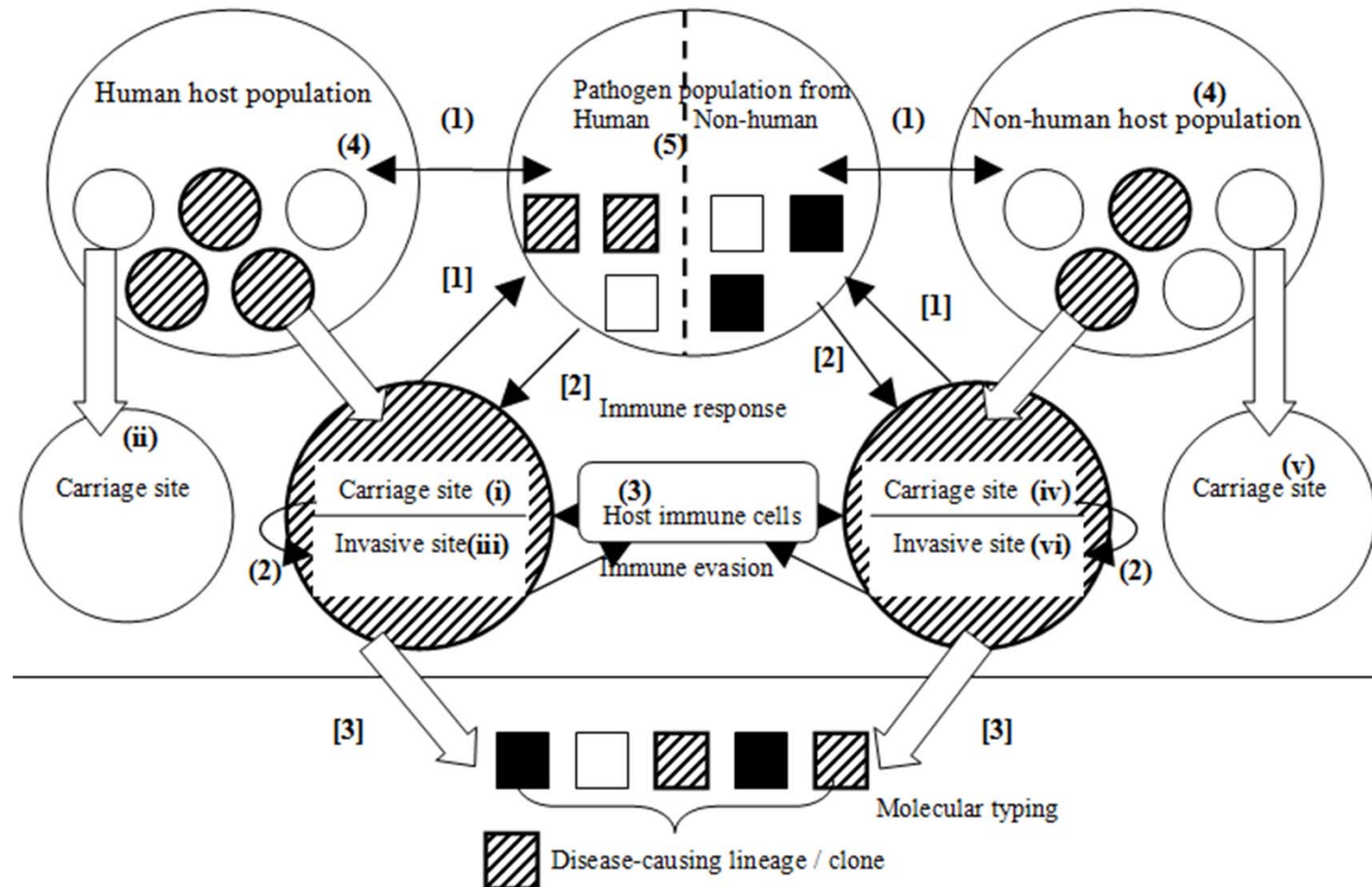
# 3rd Dimension: Host vs. Pathogen (The Interaction)

- It depends on what question we ask:



# 3rd Dimension: Host vs. Pathogen (The Interaction)

- Various choice of methods to study “Host-Pathogen Relationship”
- The question we ask may “simplify” or “complicate” the answer.



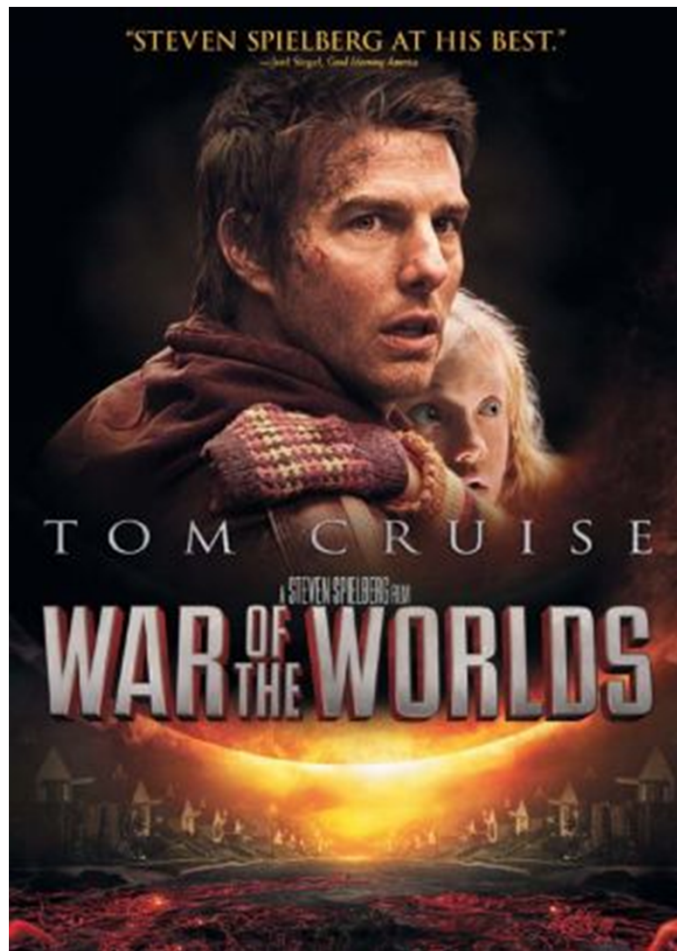
# Host-Pathogen Relationship (Among the Dimensions)

- 1st Dimension: Host / Pathogen (The Identity)
- Pathogenicity is the **ongoing evolution** between a parasite and a particular host.
  - The identity of a “Host” and a “Pathogen” is not fixed.
- The rationale we use for defining “Host-Pathogen” relationship is **oversimplified**.
  - 2nd Dimension: Host vs. Pathogen (The Encounter)
    - “Disease is the more the exception than the rule.”
    - The **real identity of virulence factors** are signaling molecules!
  - 3rd Dimension: Host vs. Pathogen (The Interaction)
  - Various choice of methods to study “Host-Pathogen Relationship”
  - The question we ask may “simplify” or “complicate” the answer.



# 4th Dimension: Host vs. Pathogen (The Co-evolution)

- Host-Pathogen Relationship in Science Fictions:
- In film “War of the Worlds” (H.G. Wells, adopted by Steven Spielberg) ,
- Alien creatures die out as they lack immunity against microbes on Earth.



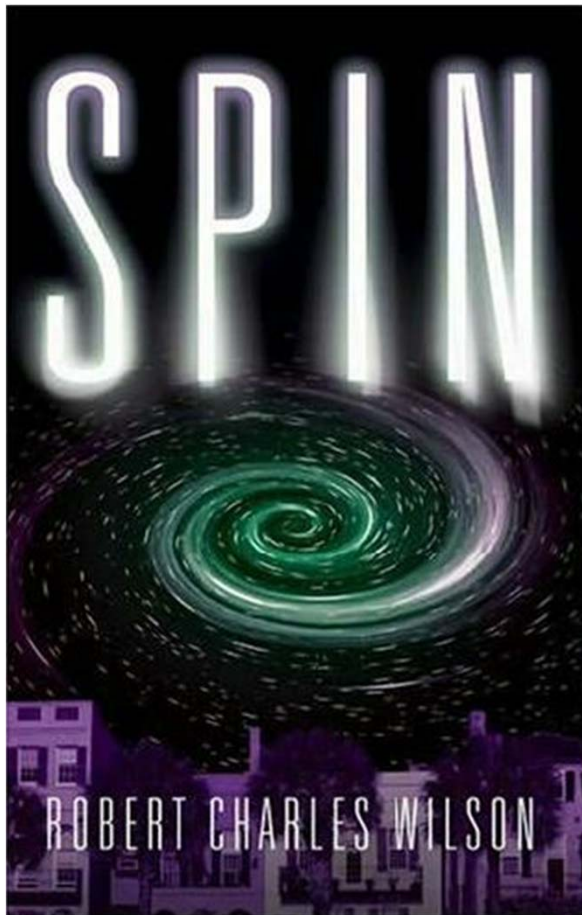
<http://scifilounge.blogspot.com/2010/10/war-of-worlds.html>

[http://en.wikipedia.org/wiki/The\\_War\\_of\\_the\\_Worlds](http://en.wikipedia.org/wiki/The_War_of_the_Worlds)

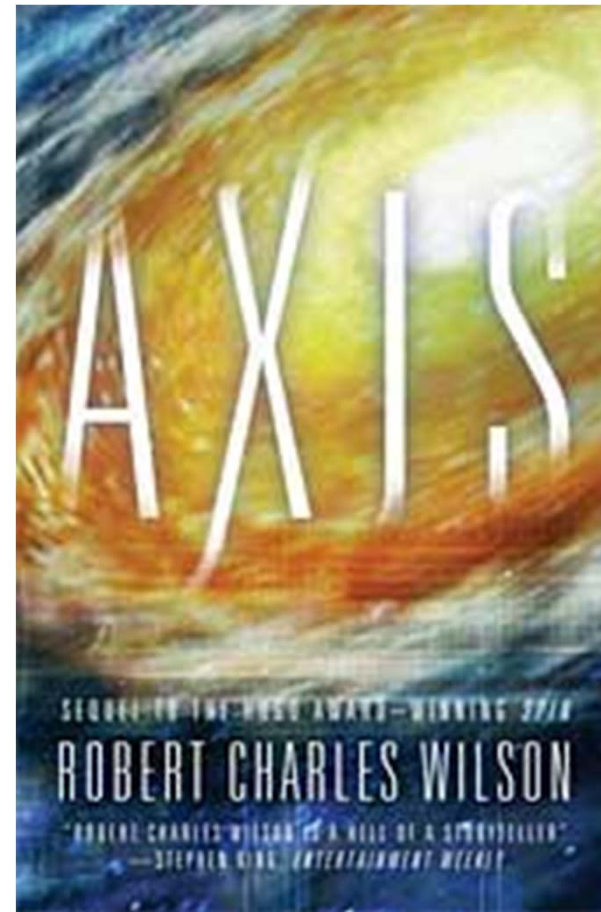


## 4th Dimension: Host vs. Pathogen (The Co-evolution)

- In “Spin” and “Axis” (R.C. Wilson, winner of Hugo Award),
- Human moves to live on a new planet, and was said to immune to all alien pathogens as they lack appropriate receptors to interact.



[http://en.wikipedia.org/wiki/Spin\\_\(novel\)](http://en.wikipedia.org/wiki/Spin_(novel))



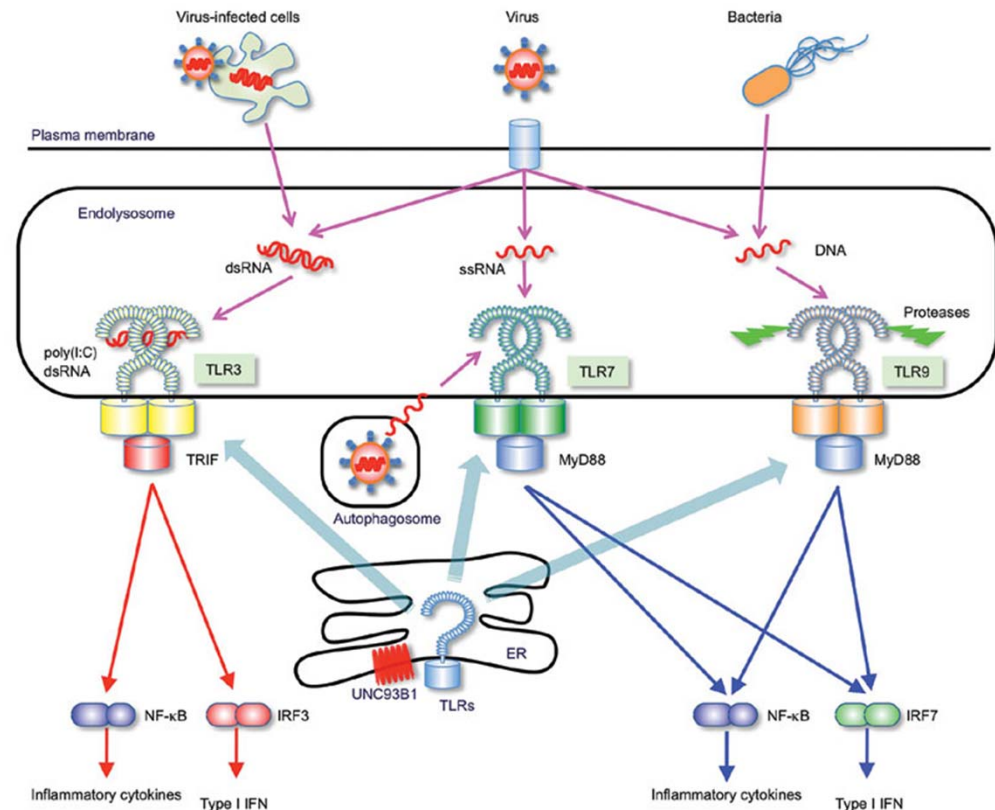
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# 4th Dimension: Host vs. Pathogen (The Co-evolution)

## Infection vs. Immunity

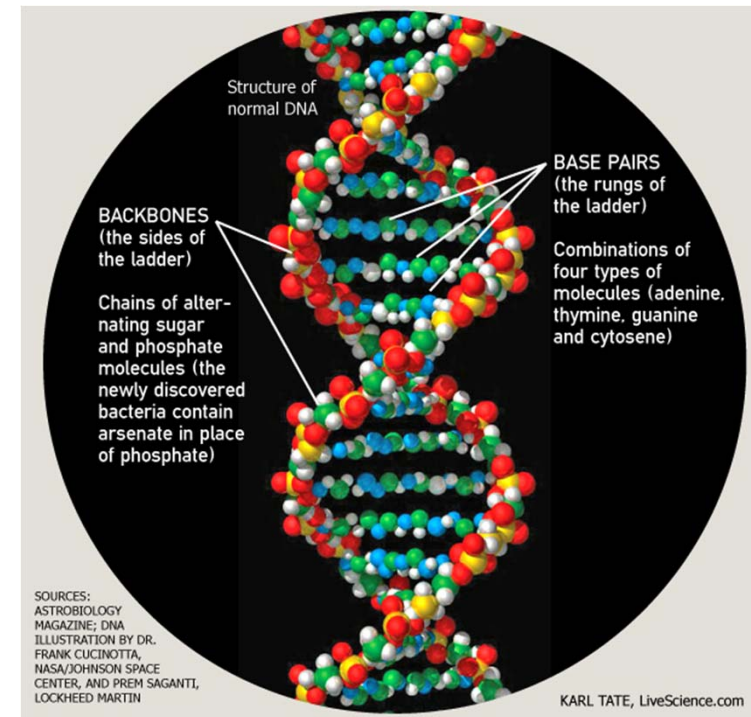
If we encounter alien microbes, are we prone to infection or not?

- Molecular level of Host-Pathogen Interaction
- Translated as Multiple Ligand-Receptor Binding
- Resulted from ages of Host-Pathogen Co-evolution
- Virulence (Pathogen) vs. Resistance (Host)



# 4th Dimension: Host vs. Pathogen (The Co-evolution)

- Infection vs. Immunity
- If we encounter alien microbes, are we prone to infection or not?
  
- 1st Dimension:  
Host / Pathogen (The Identity)
  
- 2nd Dimension:  
Host vs. Pathogen (The Encounter)
  
- 3rd Dimension:  
Host vs. Pathogen (The Interaction)



**END**