바이러스학

Fall, 2023

화,목 13:30-14:45

Lecture Room: ,국제경영대학관 103호

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The overall objective of this course is to provide the students with a concept and working knowledge essential for an informed approach to the prevention and treatment of viral infections. I am aiming to supply just enough basic virology to underpin the more practical aspects – clinical manifestations, epidemiology, pathogenesis, immune responses, and so forth. The text for the course is Human Virology (2016), John Oxford, Paul Kellam, Leslie Collier, Oxford University Press, 5th Edition. Of course, I will make every efforts to teach the course with the aims of making the virus world to be understood by students.

The course will be scheduled approximately as follows:

1주 : Virology; how it all began and where it will go next (Chap 1)

2주 : General properties of viruses (Chap 2)

3주 : General properties of viruses (Chap 2), Viral replication and genetics (Chap 3)

4주 : Viral replication and genetics (Chap 3)

5주 : How viruses cause disease (Chap 4)

6주 : How viruses cause disease (Chap 4), Viruses and the community: the science and practice of epidemiology (Chap 6)

7주 : Viruses and the community: the science and practice of epidemiology (Chap 6).

Mid-Exam will be scheduled.

8주 : The clinical virology laboratory (Chap 29)

9주 : The clinical virology laboratory (Chap 29), Control of viral diseases by immunization (Chap 30)

10주: Control of viral diseases by immunization (Chap 30)

11주: Antiviral chemotherapy (Chap 31)

12주: Antiviral chemotherapy (Chap 31), Retroviruses: HIV-1 and -2 and HTLV (Chap 27)

13주: Retroviruses: HIV-1 and -2 and HTLV (Chap 27)

14주: Retroviruses: HIV-1 and -2 and HTLV (Chap 27), Coronaviruses (including SARS CoV and MERS CoV (Chap 13), Covid-19(?)

15주: Coronaviruses (including SARS CoV and MERS CoV (Chap 13), Covid-19(?).

Final Exam will be scheduled.

Chapter 1 Virology: how it all began and where it will go next

Virus/virology: A window to see the cell/life.

How does life began?

Created by God in religion.

Origin of outer space in cosmology.

Evolution; bacterial evolution from once free-living, self-replicating molecules (similar to viruses). Alternatively, viruses from cellular components (proteins/nucleic acids)

How virology, rather than the viruses themselves, evolved.

- Viruses cannot be seen by a light microscope (invented by Leeuwenhoek, 1673).
- Bacteria and yeasts were studied by Pasteur and Koch in 19th century, and discovered to be the causes of fermentation, putrefaction, and infectious diseases.

- Virus (Latin, **poisonous** fluid) pass through a Chamberland filter (exceptional bacteria; mycoplasma) ➔ Transmission by bacteria-free filtrates.
  - ✓ Acknowledged by studying tobacco mosaic disease, where the infectious agent smaller than bacteria was imagined by Iwanowski and Beijerinck and later in 1935 crystallized by Wendell Stanley, now known as tobacco mosaic virus (TMV). Afterwards, foot-and-mouth disease of cattle was also demonstrated to be caused by bacteria-free filtrates.
  - ✓ Viruses have an absolute requirement for living cells. ➔ Grow only in living cells (however, there are intracellular bacteria such as rickettsia, chlamydia). → dogs and rabbits for rabies vaccine; rabbits, calves, and sheep for smallpox vaccine.
  - ✓ **Culture of viruses in vitro:** virus was first grown in suspensions of **minced monkey kidney tissue** in 1938 with a subsequent success of poliovirus culture (Salk vaccine) → chick embryos (yellow fever, smallpox, influenza) → cell and tissue culture with antibiotics in 1940s and 1950s.
  - ✓ Now, the studies of viruses by molecular biological techniques: identify, isolate, clone and express specific nucleotide sequences with the use of microarrays, next generation sequencing (NGS), reverse genetics for RNA viruses, and even a success in the synthesis of polio virus.
  - ✓ Viruses are unique in that their genetic material may be either DNA or RNA; in fact, the RNA viruses well outnumber those with DNA.
- Yearly breakthroughs

  1937: TMV consists of protein and RNA.

  1944: Avery showed that DNA is the genetic material of bacteria (pneumococcus).

  1953: DNA structure was shown by Watson and Crick.

  1940s and 1950s with the works on bacteriophages: Viruses use enzymes (either encoded in their own nucleic acid or provided by the host cell), and host cell's ribosomes.
- **Control of viral diseases**
  - ✓ Immunology of virus infections → Vaccines.
  - ✓ Random screening → development of antiviral drug (**Aciclovir** against herpesviruses).
  - ✓ Tailor-made drugs (development of **Tamiflu®: targeting neuraminidase spike protein**).
  - ✓ RNAi development in progress.

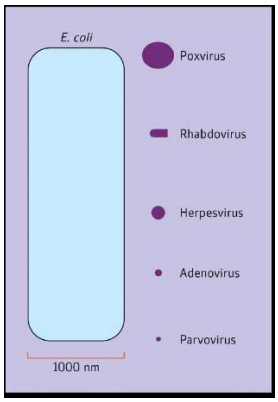
➢ Morphology: the shapes and sizes, by **EM** (1939)/filter/high-speed centrifuge.

- ✓ **The limit of resolution of the light microscope: 0.25 μm** → See most bacteria, but no viruses except Poxviruses and Phycodnaviruses.
- ✓ Tobacco mosaic virus (25x300 nm); the first seen under EM, a rigid rod-shaped helical capsid.
- ✓ Two basic patterns:

  Spherical (icosahedron, like adenovirus**).**

  Helical:→ rigid rod helix (plant viruses like tobacco mosaic virus),

  → flexible long helix (animal viruses).
- ✓ Many bacterial viruses like λ: both helical and icosahedral.
- ✓ Relative sizes of viruses as compared to the *E. coli*.



➢ **Additional notes for the introduction to viruses:**

- ✓ Virus as a genetic entity.
- ✓ Virion (virus particle) as a physical entity that occurs extracellularly.
- ✓ Small (mostly, 30-100 nm): exceptions [Poxviruses (200-400 nm), filoviruses like Ebola (1000 nm)].
- ✓ Require host: bacteria (mostly, 100 times larger), eukaryotic cells (1000 times larger).
- ✓ No (cell) division, but assembly.
- ✓ Intracellular parasites.
- ✓ Infection (certain viruses cause cancer)

➢ Genome:

- ✓ Viral DNA (3 kb to 375 kb)
  - ✧ single stranded or double stranded DNA
  - ✧ linear or circular DNA
  - ✧ linear double stranded DNA with nicked at various points in the chain
  - ✧ double stranded DNA with closed ends
- ✓ Viral RNA (3 kb to 30 kb)
  - ✧ **Linear**
  - ✧ Single or double stranded
  - ✧ One or several molecules of RNA
  - ✧ Positive (mRNA) or negative (complement of mRNA)
  - ✧ Ambisense; contain regions of both positive and negative stranded RNA. Examples: arenaviridae, some genera of bunyaviridae → replication by minus-sense strategy and thereby classified with minus-sense viruses.