Basic virology and diagnostics

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Terminology

- **SARS-CoV-2**
  - The novel coronavirus causing the current pandemic
- **2019-nCoV**
  - Previously used name of SARS-CoV-2
- **COVID-19**
  - The disease caused by SARS-CoV-2
- **COVID-19 virus**
  - Colloquial name for SARS-CoV-2
Phylogeny: Types of Viruses

Possible structural components:
- Virus proteins
- Envelope from host cell
- Nucleoprotein
- Capsid forming virus structure

Classification based on nucleic acid polarity:
- ds DNA
  - Herpesvirus
  - Pox virus
  - Adenovirus
  - Hepadnavirus
- ss DNA
  - Parovirus
- +ss RNA
  - Picornaviridae
    - Calicivirus
  - Togavirus & Arenaviruses
    - Coronavirus
- -ss RNA
  - Paramyxoviridae
  - Orthomyxoviridae
    - Arenavirus
    - Rhabdoviridae
- +ss RNA
  - Retroviridae (HIV)
  - Reverse transcriptase
  - New virus

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Coronaviruses

- **4 classes**
  - Alpha, Beta, Gamma, Delta
- **7 "human" kinds**
- Most human strains cause mild URT infections or pneumonia
- **Other known strains:**
  - SARS, MERS
- **Genome:**
  - Single-strand RNA
  - 30 kb
Viruses and cells

Size: 20-250 nm
CoV: approx. 100 nm

Size: 500-5000 nm:
E.col: 2000 nm

Size: 10-100 microm.
Airway epithelium; 10 microm.
Viral Lifecycle

1. Virus binds to cell receptors
2. Viral RNA is released into the cell
3. Replication of viral RNA occurs
4. Protein synthesis occurs
5. Viral particles mature
6. New viral particles assemble
7. Viral particles are released from the cell
8. Endoplasmic reticulum and Golgi apparatus are involved in the process
Host response

- **Cytotoxic T-cells**
  - Recognize infected cells and kill them

- **Interferons**
  - Inhibit replication of viral genetic material
  - Express substances that increase T-cell recognition

- **Antibodies**
  - Specific response, identifies virus and induce phagocytosis
Transmission

- **Entry via eyes, nose, mouth**
- **Droplets**
  - From coughing and sneezing
- **Aerosol**
  - Rarely, but possible in special circumstances
- **Surfaces**
  - Virus can survive for hours on contaminated surfaces
Prevention

• Vaccines?
  – To be determined...

• Hand hygiene
  – Soap and water

• Cover sneezes and coughs

• Distance
  – At least 1 metre

• Protective equipment
  – For healthcare staff
Antibiotics?

- By definition, antibiotics are not effective against viruses!
- Secondary bacterial infections occur in up to 50% of severely ill patients.
Reported COVID-19 Cases

Number of cases
- ≤ 99
- 100 - 999
- 1,000 - 9,999
- ≥ 10,000

Countries and territories reporting cases

Date of production: 05/04/2020

The boundaries and names shown on this map do not imply official endorsement or acceptance by the European Union.
COVID-19 Disease Progression

From: Fei Zhou et.al. https://doi.org/10.1016/S0140-6736(20)30566-3
Relevant diagnostics

- **WHO Technical guidance**

- X-ray
- Biomarkers
- Genomics
- NAAT
- Serology
Biomarkers

- **Procalcitonin**
  - Within normal range (at admission)
  - 5% >0.5 ng/mL

- **C-reactive protein, CRP**
  - 60% of patients had >10 mg/L (at admission)

*Source: Clinical Characteristics of Coronavirus Disease 2019 in China. DOI: 10.1056/NEJMoa2002032*
NAAT

- BSL-2 laboratory required
- Positive results from a few days post-infection up to 3 weeks after clinical cure
- rRT-PCr
  - Real-time reverse transcriptase PCR
  - Genes of interest: N, E, S and RdRP
- Commercial kits for platforms from diagnostic manufacturers exist
  - Including geneXpert Xpress

Please see:
Serology

- Under development, no validated methods available
- Detect antibodies against virus
  - E.g. ELISA
- Slower response than PCR
- Important in later stages of pandemic
A WORLD FREE FROM FEAR OF UNTREATABLE INFECTIONS