



Use Case Infectious Diseases

Borchert, Dr. Schapranow
Data Management for Digital Health
Winter 2023

Agenda

Pillars of the Lecture

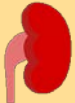
Medical Use Cases



Biology Recap



Oncology



Nephrology



Infectious
Diseases

Technology Foundation



Data
Sources



Data
Formats



Processing and
Analysis



Software
Architectures

Machine Learning

Data



Refine

Evaluate



Prediction +
Probability

**Use Case Infectious
Diseases**

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Digital Health, Winter
2023
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Agenda

Pillars of the Lecture

Medical Use Cases



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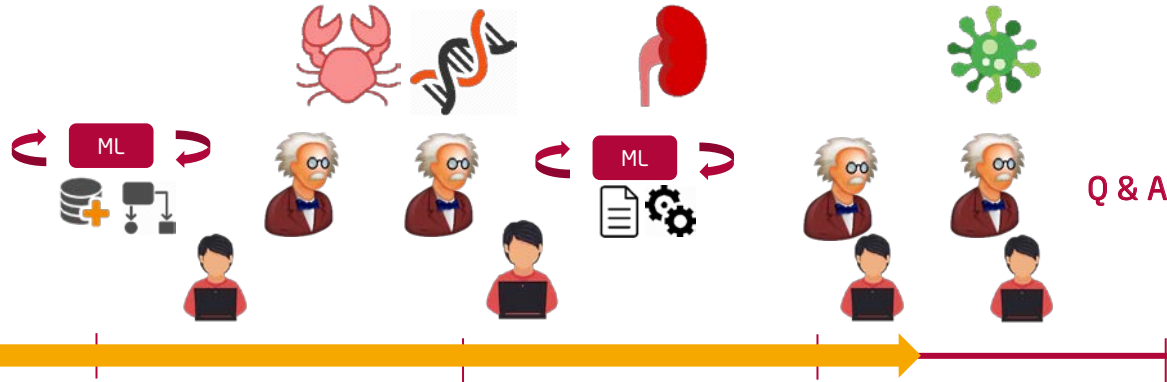
Prediction +
Probability

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Diseases**

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Lecture Schedule



Final Exam
Feb 13, 2024
11:00am,
Lecture Hall HS1

Nov

Dec

Jan

Feb

- Lecture Kickoff
- Actors in Healthcare
- Digital Health Data

- Machine Learning (ML) Foundations
- Use Case Oncology
- Biology Recap

- Natural Language Processing
- Use Case Nephrology & Intensive Care
- Supervised ML & Deep Learning

- Use Case Infectious Diseases
- Unsupervised ML

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Agenda

- Infectious Diseases
- Transmission Ways
- Treatment Options
- Containment Strategies
- Vaccinations

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News Coverage 2020

Reports about Coronavirus (on daily basis)



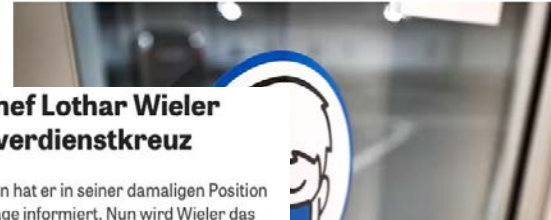
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Corona- und Grippevirus

In Spanien gilt wieder Maskenpflicht

Teilen Pocket 20



Ehemaliger RKI-Chef Lothar Wieler erhält das Bundesverdienstkreuz

In unzähligen Pressekonferenzen hat er in seiner damaligen Position als RKI-Chef über die Corona-Lage informiert. Nun wird Wieler das Bundesverdienstkreuz verliehen.

Aktualisiert am 10. Januar 2024, 16:33 Uhr / Quelle: ZEIT ONLINE, AFP, lak / 29 Kommentare /



Von März 2015 bis April 2023 war Lothar Wieler Präsident des Robert Koch-Instituts. © Bernd von Jutrczenka/dpa

WHO-Chef mahnt zur Vorsicht vor dem Coronavirus

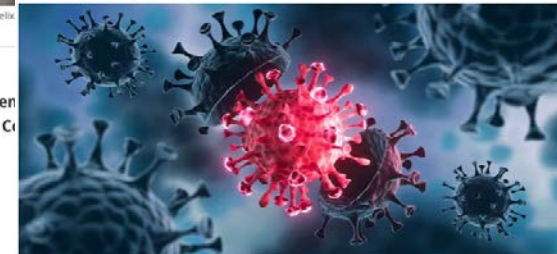
Das Virus "verändert sich weiter, und es tötet weiter", warnt der Chef der Weltgesundheitsorganisation. Er ruft dazu auf, sich impfen zu lassen und Masken zu tragen.

Aktualisiert am 10. Januar 2024, 19:13 Uhr / Quelle: ZEIT ONLINE, dpa, ak / 41 Kommentare /

Weltweit auf dem Vormarsch

Corona-Rekord wegen „Juno“ befürchtet - achten Sie auf diese drei Symptome

Teilen Pocket 269



Die Corona-Variante JN.1 ist weltweit auf dem Vormarsch

Getty Images/peterschreiber.media

Mittwoch, 10.01.2024, 09:41

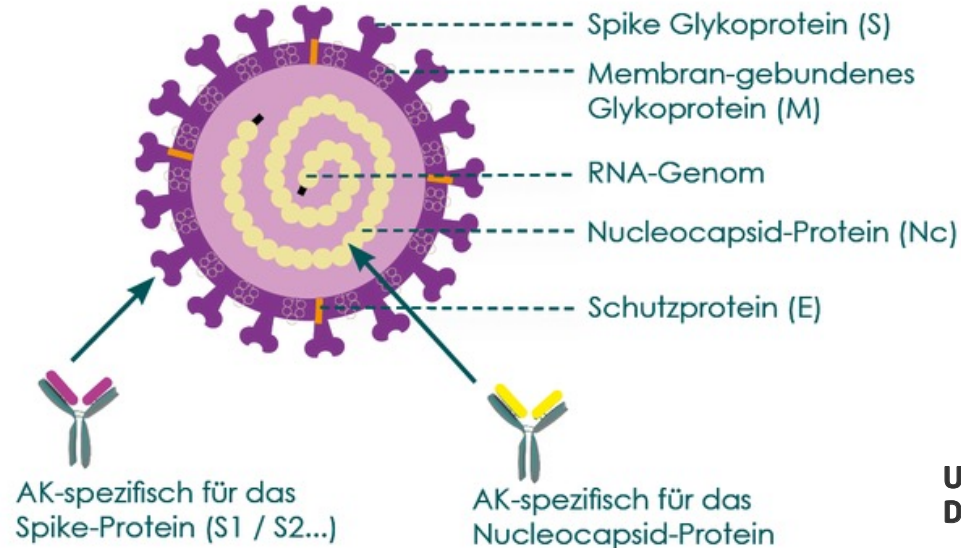
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Recap: Replication of Viruses

- RNA viruses are directly replicated by ribosomes of the host
- Coronavirus (SARS-CoV-2):
 - Type: RNA-based viruses surrounded by a hull
 - Genome: 30kpbs single-stranded RNA
 - Polarity: positive



<https://www.imd-berlin.de/spezielle-kompetenzen/covid-19.html>

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Infectious Diseases: Definitions

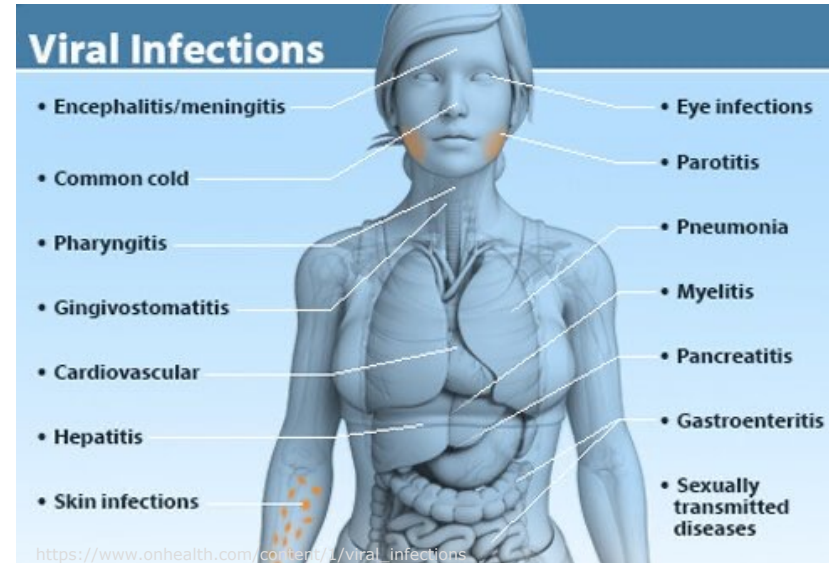
- **Infection** := Invasion + multiplication of disease-causing agents + host reaction
- **Disease-causing agents** := Pathogenic microorganisms, e.g. bacteria, viruses, parasites or fungi
- Infectious diseases can be spread directly or indirectly from one person to another
- **Zoonotic diseases** := Infectious diseases transmitted from animals to humans or vice versa.

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Infections by Body Location

- Infections can occur anywhere in your body.
- Common locations:
 - Eyes, ears, dermal
 - Respiratory system, e.g. mouth, throat, bronchia, lungs, mucous membranes
 - Urinary tract, e.g. kidneys and bladder
 - Blood system, e.g. cannula sites or wounds
 - Gastric system
- Other less common places:
 - Liver and abdomen
 - Oesophagus
 - Brain and spinal cord

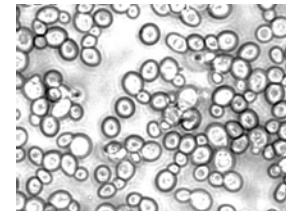
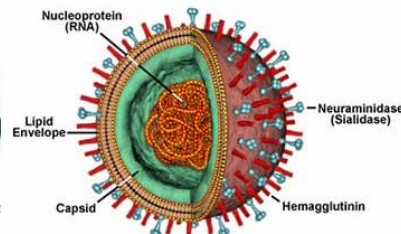
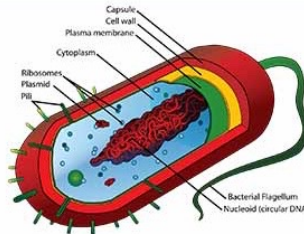


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Infections by Disease-causing Agent

Characteristics	Bacteria	Viruses	Fungi
Size	Larger (1 μm)	Smaller (20-400 nm)	Huge (2-10 μm)
Cell Wall	Peptidoglycan or Lipopolysaccharide	No cell wall, protein coat instead	Cell wall made up of chitin
Ribosomes	Present	Absent	Present
Number of cells	One cell (Unicellular)	No cells	Multicellular with complex cellular structures
Living organism	Living organism	"in-between"	Living organism
DNA and RNA	DNA and RNA floating in cytoplasm	DNA or RNA coated by protein	Eukaryotes, i.e. DNA and RNA
Infection	Localized	Systemic	Localized
Reproduction	Fission, a form of asexual reproduction	Invades host cells	Both: asexual and sexual methods
Examples	Staphylococcus aureus, Vibrio cholerae, etc.	HIV, Hep. A virus, Rhino virus, etc.	Saccharomyces cerevisiae, Histoplasma, Aspergillus niger, Agaricus boirus, etc.

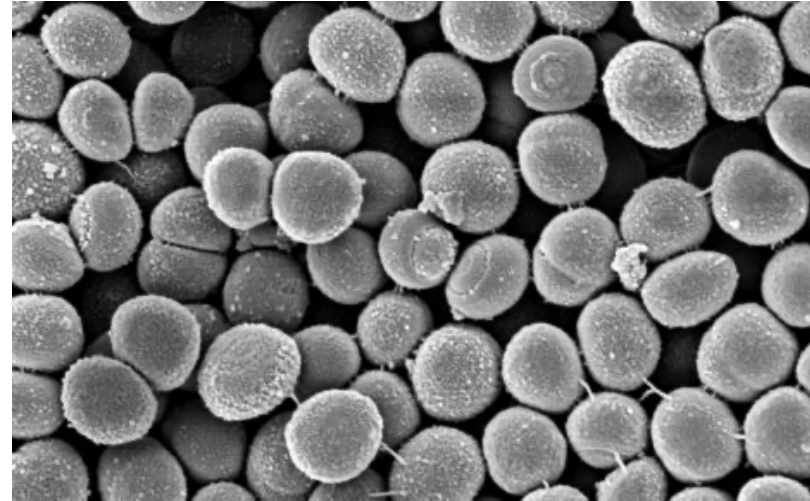


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Example: Methicillin-resistant Staphylococcus aureus (MRSA)

- Bacterium: Methicillin-resistant Staphylococcus aureus
- Incubation time:
 - 2-6 hours endogenous and
 - 4-10 days exogenous
- Transmission ways: Hands, surfaces in contact with hands (door handle, towel) ~6 months, often in elderly care homes and hospitals detected
- Symptoms (selected):
 - Dermal and wound infections,
 - Toxic shock syndrome, fever, multiple organ failure
- Vaccines: n/a

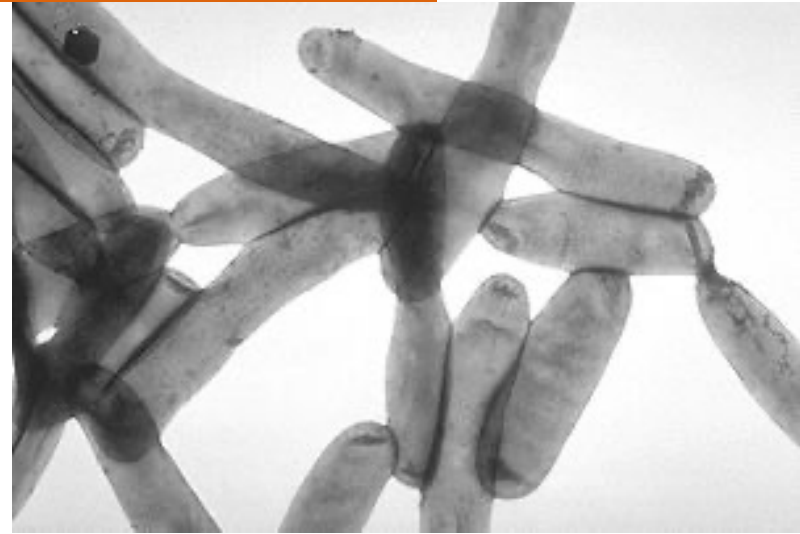


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Example: Legionnaires' disease

- Bacterium: Legionella
- Incubation time: 2-10 days
- Transmission ways: Water / aerosols, standing warm water systems (25-45°C)
- Symptoms (selected):
 - Coughing,
 - Fever,
 - Headache,
 - Severe forms of pneumonia possible
- Vaccines: n/a

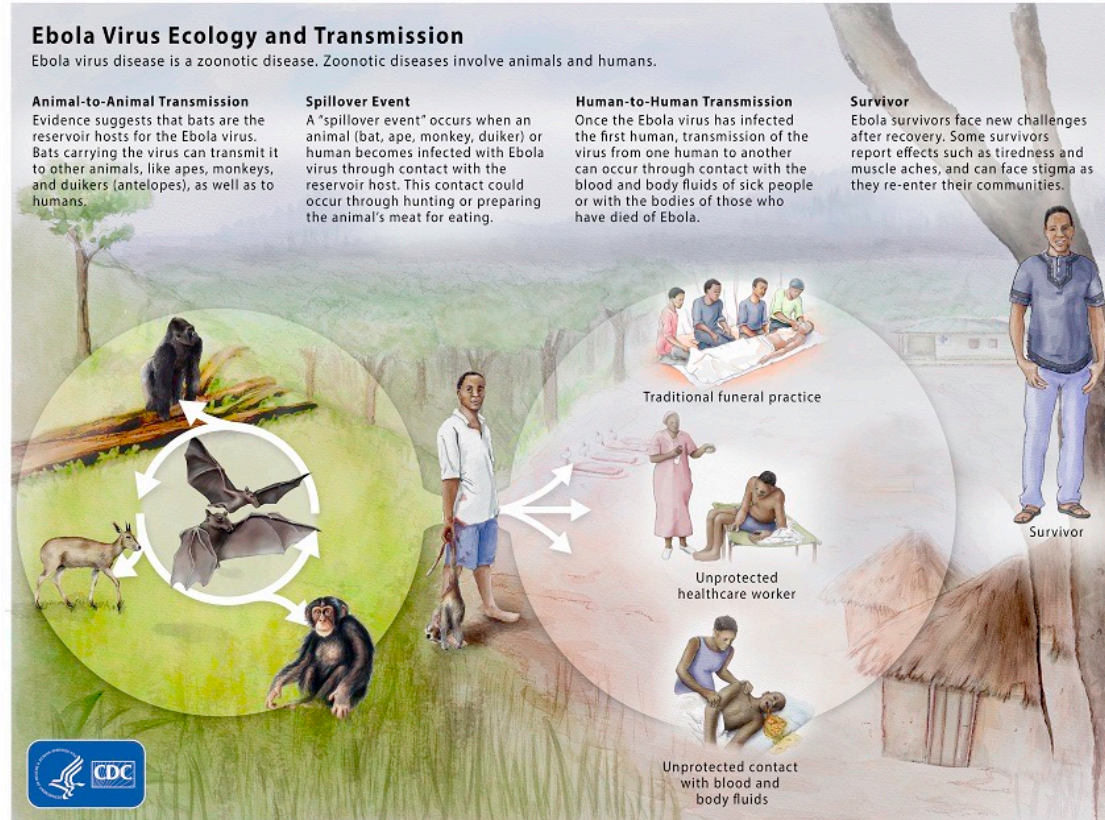


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Example: Ebola Virus Disease (EVD)

- Virus: Ebolavirus
- Incubation time: 21 days (avg. 8-10 days)
- Transmission ways: Blood, body fluids, infected tissues
- Symptoms (selected):
 - Fever, aches, pains
 - Weakness, fatigue
 - Diarrhea, vomiting
 - Unexplained hemorrhaging, bleeding or bruising
- Vaccines: rVSV-ZEBOV, approved by FDA in Dec. 2019



Example: Coronavirus Disease 2019 (COVID-19)

- Virus: SARS-CoV-2
- Incubation time: 2-14 days (avg. 5.8d)
- Transmission ways: Aerosols
- Symptoms (selected):
 - Fever or chills
 - Cough, shortness of breath
 - Fatigue
 - Pain, e.g. muscle, body aches, headache
 - Loss of taste or smell
 - Diarrhea, nausea or vomiting
- Vaccines: 7 authorized +3 (rolling review) in EU

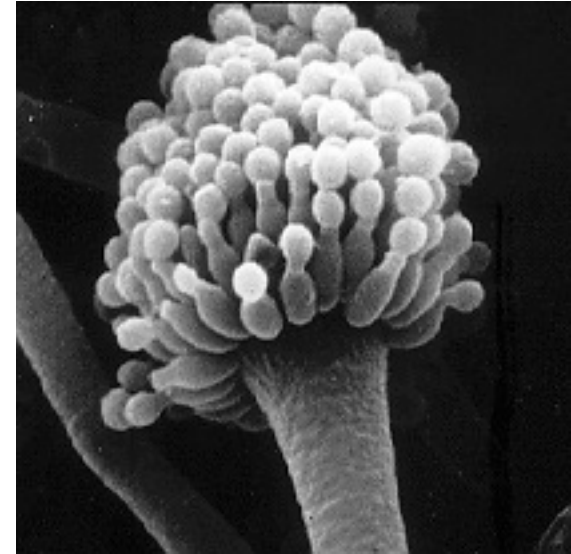


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Example: Aspergillosis

- Fungi: *Aspergillus fumigatus* or *Aspergillus flavus*
- Incubation time: Days up to weeks
- Transmission ways: Inhaling of fungi spores
- Symptoms (selected):
 - Pneumonia (immune suppressed persons), fever, coughing
 - Nose
 - Ear
 - Skin
 - Might affect also other organs
- Vaccines: n/a




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Example: Candidiasis

- Fungus: *Candida auris* (yeast)
- WHO rated *Candida auris* as critical in 2022
 - High outbreak potential, produced several hospital outbreaks
 - Intrinsically resistant to most available antifungal medicines
 - Thermoresistant, partially resistant to disinfectants
- Incubation time: n/a
- Transmission ways: Direct contact to funghi spores
- Symptoms (selected):
 - Ear infection
 - But also mouth, nasal, respiratory, inner organs
- Vaccines: n/a

Critical group	
	<i>Cryptococcus neoformans</i>
	<i>Candida auris</i>
	<i>Aspergillus fumigatus</i>
	<i>Candida albicans</i>

WHO fungal priority pathogens list to guide research, development and public health action, WHO, 2022



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Questions?

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Infections by Transmission Way

<< QUIZ >>

- Which of the following alternatives are possible transmission ways?
 - A. Air
 - B. Hand contact
 - C. Sexual contact
 - D. Blood contact



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Infections by Transmission Way

<< QUIZ >>

- Which of the following alternatives are possible transmission ways?
 - A. Air
 - B. Hand contact
 - C. Sexual contact
 - D. Blood contact



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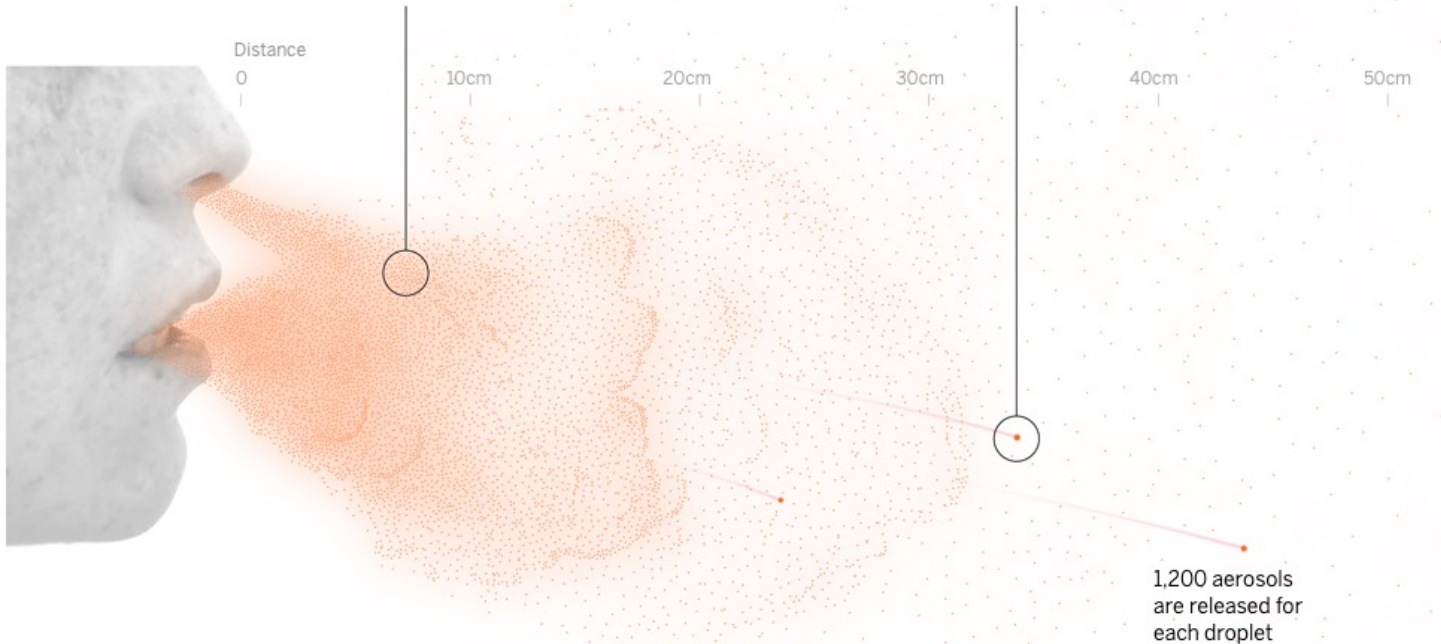
Transmission by Air

Aerosols

These are respiratory droplets that are less than 100 micrometers in diameter that **can remain suspended in the air for hours**

Droplets

These are particles that are larger than 300 micrometers and, due to air currents, **fall to the ground in seconds**



<https://english.eipais.com/society/2020-10-28/a-room-a-bar-and-a-class-how-the-coronavirus-is-spread-through-the-air.html>

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Prevent Transmission by Air Mask vs. Face Shields

Face shields no longer a substitute for masks

Face shields are now deemed to offer less protection against the spread of Covid-19 compared with face masks.

FACE MASK

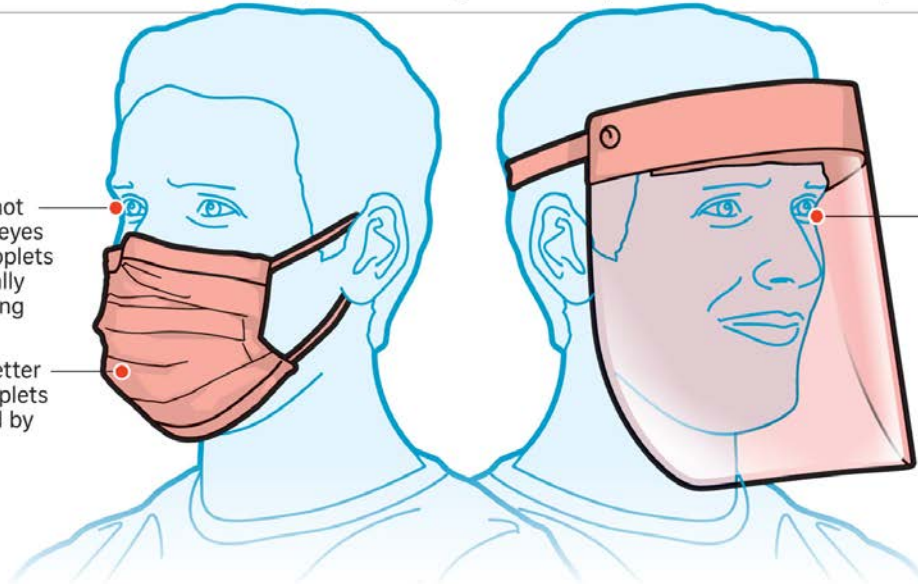
Default mode of protection against asymptomatic transmission



- Does not protect eyes from droplets potentially containing virus



- Can better trap droplets expelled by wearer



FACE SHIELD

Teachers, those with health issues and children aged 12 and below allowed to wear face shields in place of masks



- Protects eyes; helps prevent people from touching their faces; complements masks



- Does not effectively trap droplets, which Covid-19 predominantly spreads through



Maskenpflicht: Face Shields reichen nicht mehr aus

Stand: 21.10.2020 20:00 Uhr

In ganz Schleswig-Holstein gelten von Sonntag 24. 10. an erweiterte Regeln zum Tragen eines Mund-Nasen-Schutzes, etwa für Wochenmärkte. Und: Face Shields reichen nicht mehr aus.

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STRAITS TIMES GRAPHICS

Prevent Transmission by Air

<< QUIZ >>

- What is the most benefit from wearing an everyday mask?
 - A. Protect yourself if others are infected
 - B. Protect others if you are infected
 - C. Reduce the variability of the virus RNA
 - D. Protect your lung from cold winter air



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Protection through Masks: Filtering Face Piece (FFP)



Class (EN149)	Inward Leakage
FFP1	≤ 22%
FFP2	≤ 8%
FFP3	≤ 2%

Type	Mouth-nose protection	FFP2/FFP3 masks no valve	FFP2/FFP3 mask w/ valve	DIY masks from cotton	Scarf
Protects Yourself	✓	✓	✓	(✓)	(✓)
Protects Others	✓	✓	✗	✓	(✓)
Applicable for medical setting	✓	✓	✓	✗	✗

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How to Treat Infections?

<< QUIZ >>

- What are recommend treatment options for viruses?
 - A. Antibiotics
 - B. Antimycotics
 - C. Consumption of alcohol
 - D. None of the above



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BACTERIA

Strep throat
Tuberculosis
Whooping cough
UTI

Antibiotics?
YES

Adapted from: CDC

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Therapy Options (cont'd)



BACTERIA

Strep throat
Tuberculosis
Whooping cough
UTI

Antibiotics?
YES

Adapted from: CDC



VIRUS

Common cold
Flu
Sore throat

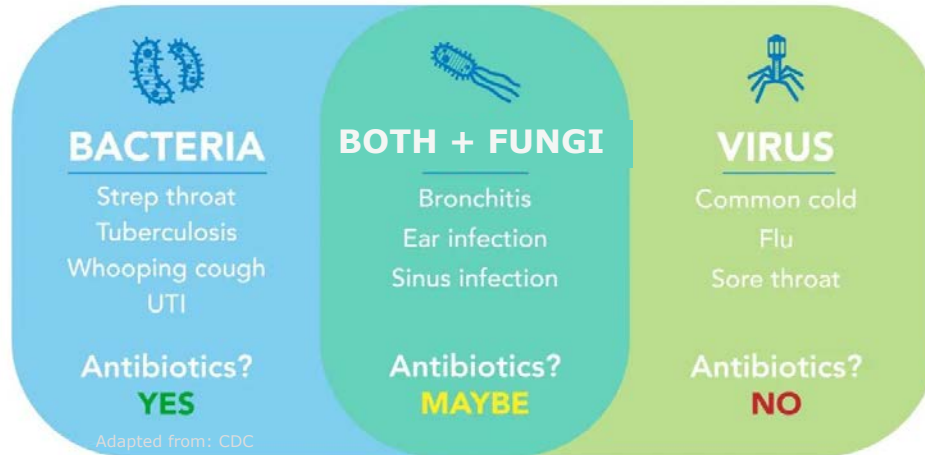
Antibiotics?
NO

- Antibiotics → works only against bacteria
- What works best against viruses?

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Therapy Options (cont'd)



- Antibiotics → works only against bacteria
- What works best against viruses? → a vital/trained immune system
- Antimycotics → works only against fungi

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Intensive Care Unit



Shanghai
January 4, 2023



- Severe infections might have systemic life-threatening impact, e.g.
 - Heart → Myocarditis
 - Brain → Encephalitis or Meningitis
 - Blood → Sepsis

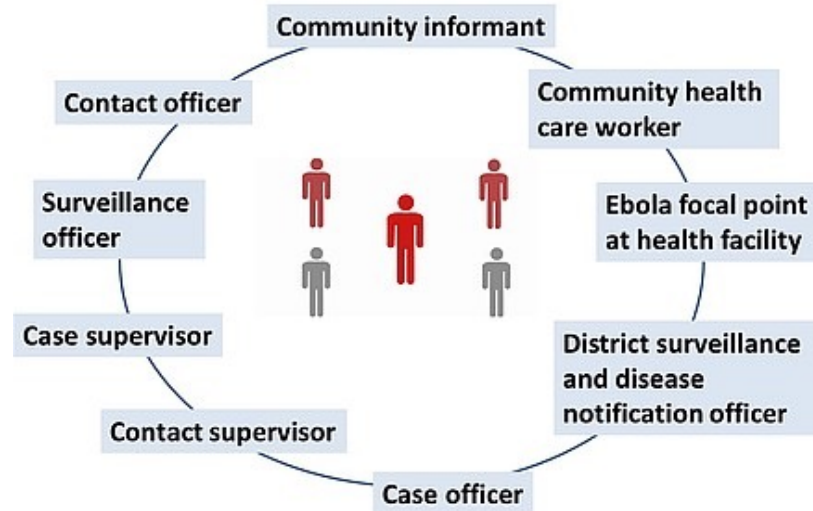
- Intensive Care Unit (ICU)
 - Remove all external stress
 - Allow body to recover
 - Constantly monitor vital parameters using sensors

Containment Strategies



Containment Strategies: Contact Tracing (unless a treatment is available)

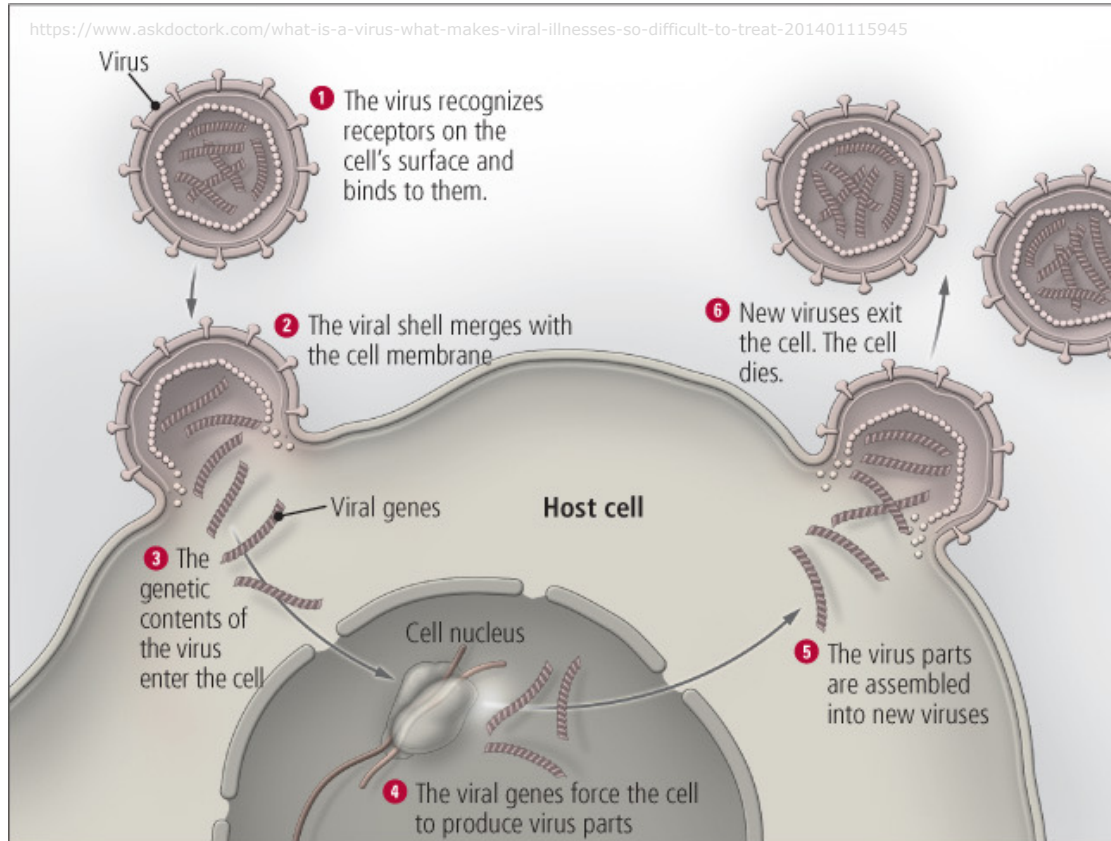
- Case := Confirmed infection, e.g. through positive testing
- Identify all contact persons of a case during the incubation time → suspects
- Isolate confirmed cases and all suspects
- Contact suspects for the incubation period daily and conduct symptom interviews



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Recap: How Do Viruses Replicate?



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Testing: Which Approach to Use?

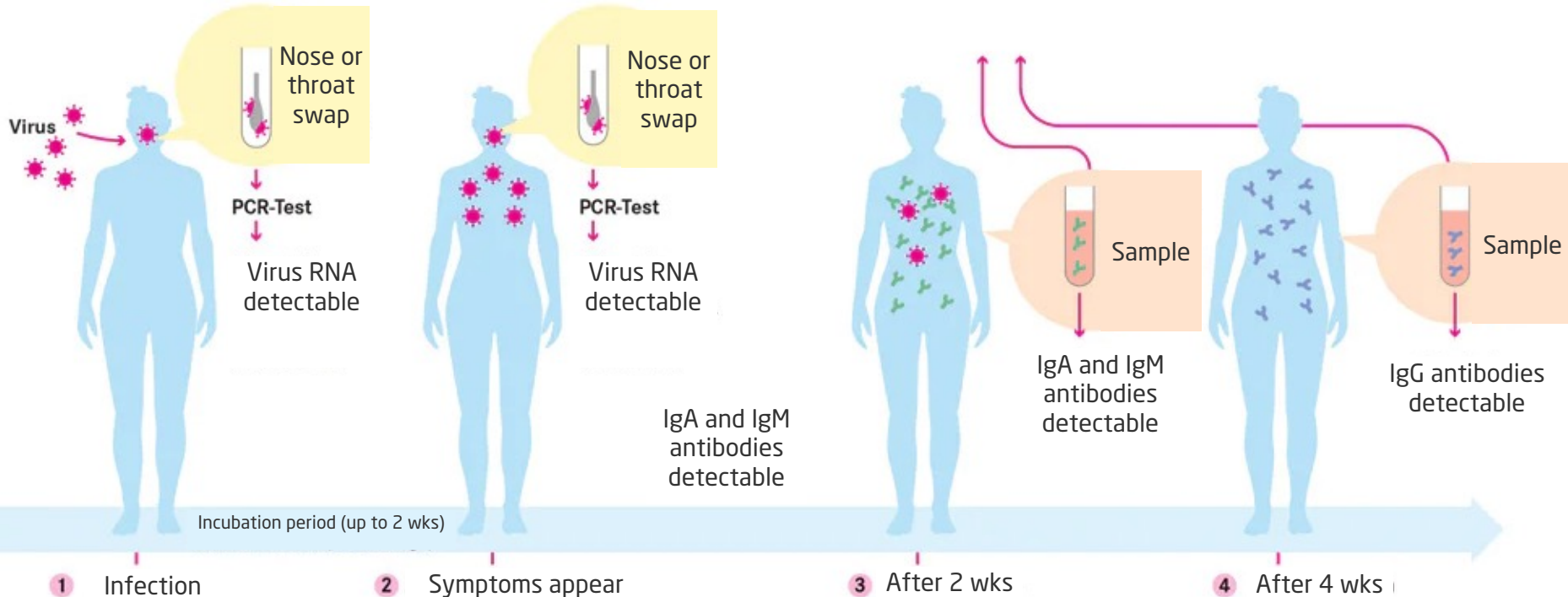
- Strategy (unless a treatment is available):
 - Identify contacts of infected people
 - Monitor contacts of infected people for the incubation time

Days	Status	Infectious	Symptoms	PCR	Antibody
Day 0	Infection	Yes	No	Neg.	Neg.
Day 0 to Incubation	Symptoms develop	Yes	Yes	Pos.	Neg.
Incubation + x days	Infection subsides	Yes	Yes	Pos.	Pos.
After weeks	Recovered	No	No	Neg.	Pos. (Neg.)

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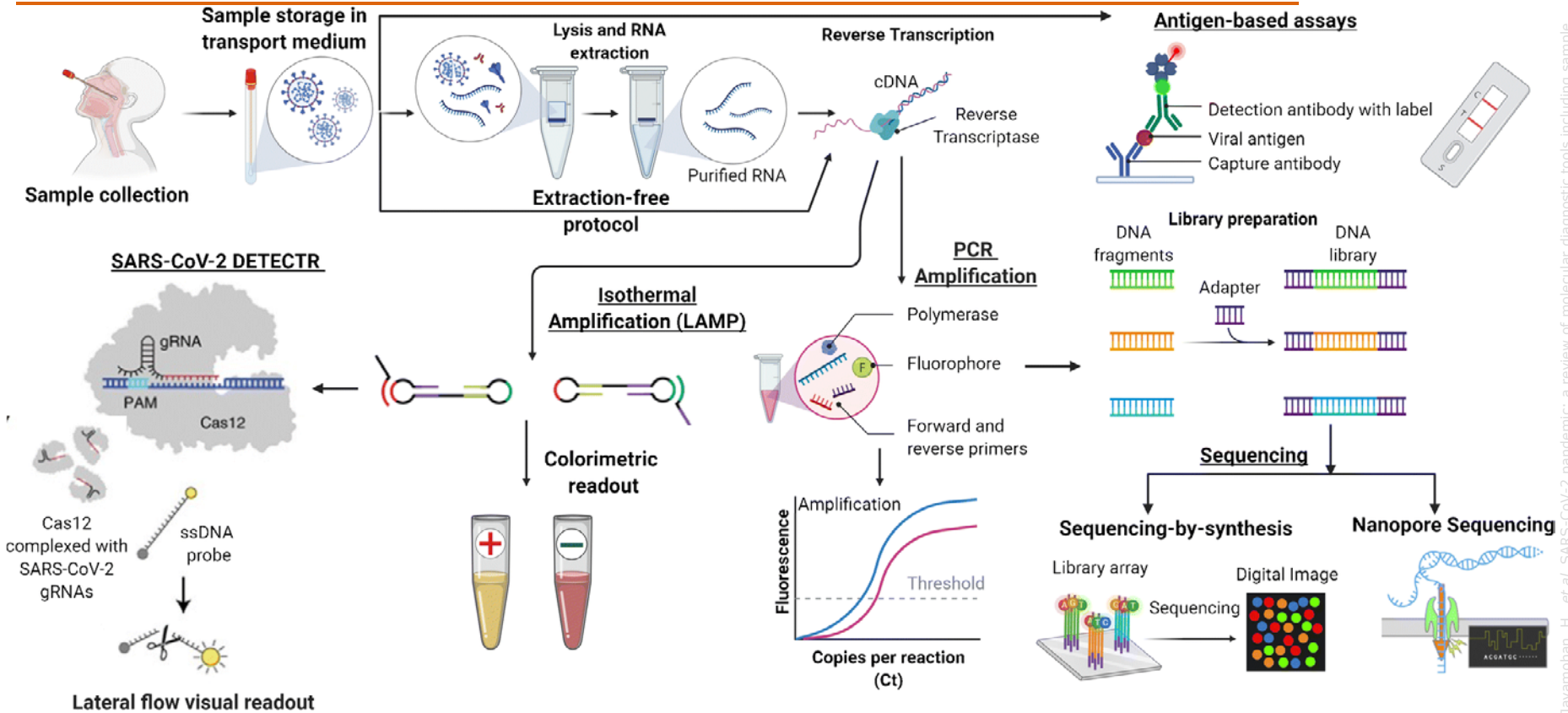
Testing: Which Approach to Use? (cont'd)



Test for Active Infections: rtPCR

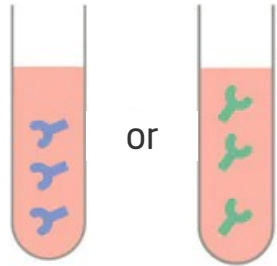
1. Obtain sample with virus RNA
2. Add enzymes to perform Reverse Transcription (rt)
3. Transcription results in complementary DNA strand (cDNA)
4. Perform Polymerase Chain Reaction (PCR) to perform amplification of DNA
5. Perform DNA sequencing

Test for Active Infections: rtPCR Alternatives

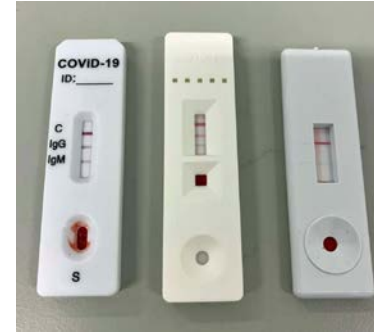
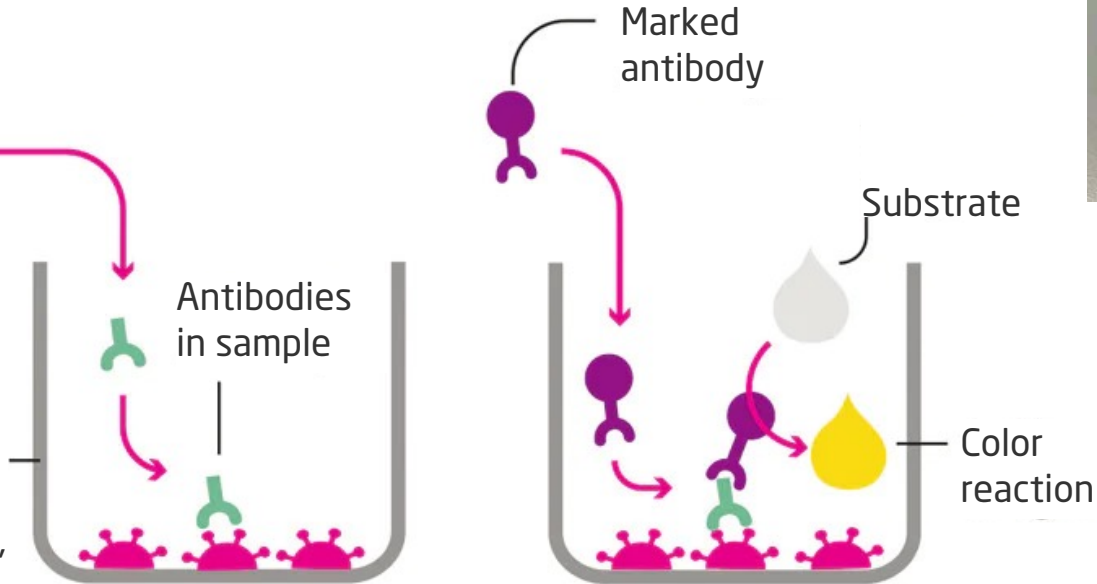


Test for Past Infections: Antibody Tests

Blood samples
from patients



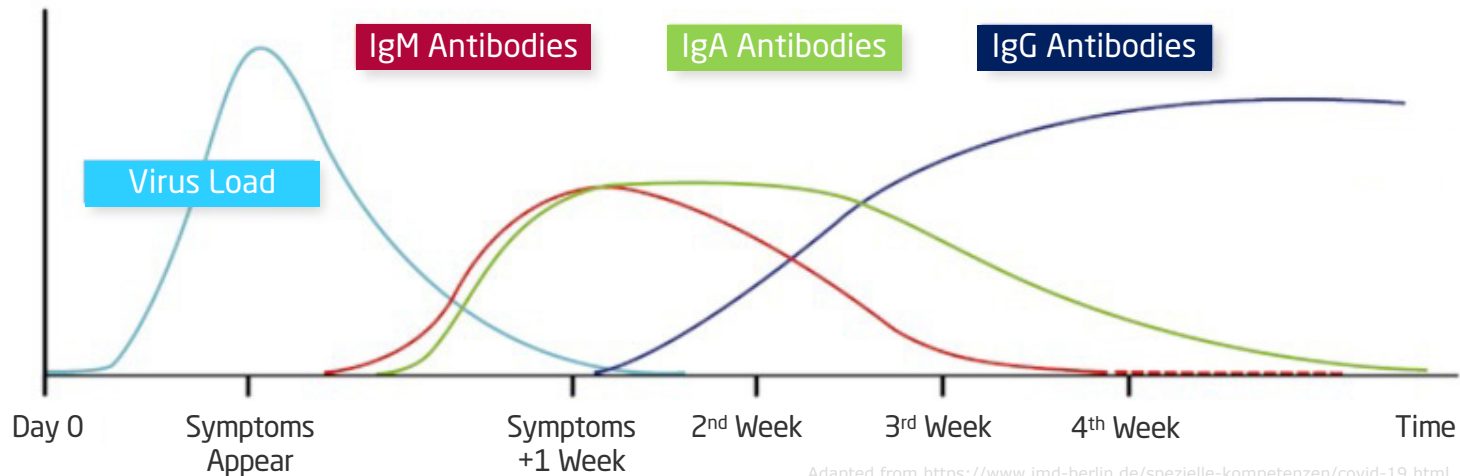
On plate, virus
protein/antigen you are
testing for, e.g. S1, S2, N,
E, M, ORF of COVID-19



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Test for Past Infections: Antibody Tests (cont'd)



Adapted from <https://www.imd-berlin.de/spezielle-kompetenzen/covid-19.html>

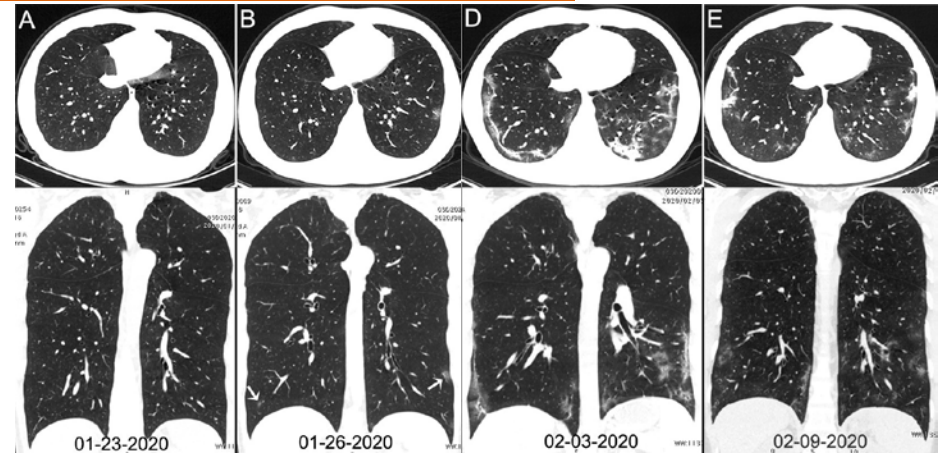
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Test for Active Infections: Use of Medical Imaging

- Pros:
 - Serial CT scans create results within minutes
 - 4-5 scans / hr or 40-50 / 8hr possible
- Cons:
 - Radiation dosage
 - Require access to CT scanners



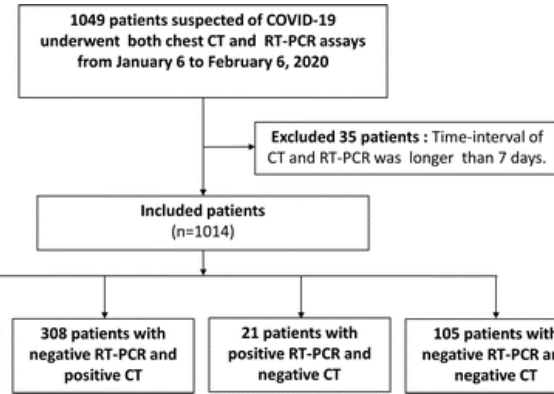
Correlation of Chest CT and RT-PCR Testing for Coronavirus Disease 2019 (COVID-19) in China: A Report of 1014 Cases

 Tao Ai*,  Zhenlu Yang*, Hongyan Hou, Chenao Zhan,  Chong Chen,  Wenzhi Lv,  Qian Tao, Z Sun,  Liming Xia ✉

* T.A. and Z.Y. contributed equally to this work.

✓ Author Affiliations

Published Online: Feb 26 2020 | <https://doi.org/10.1148/radiol.20200642>

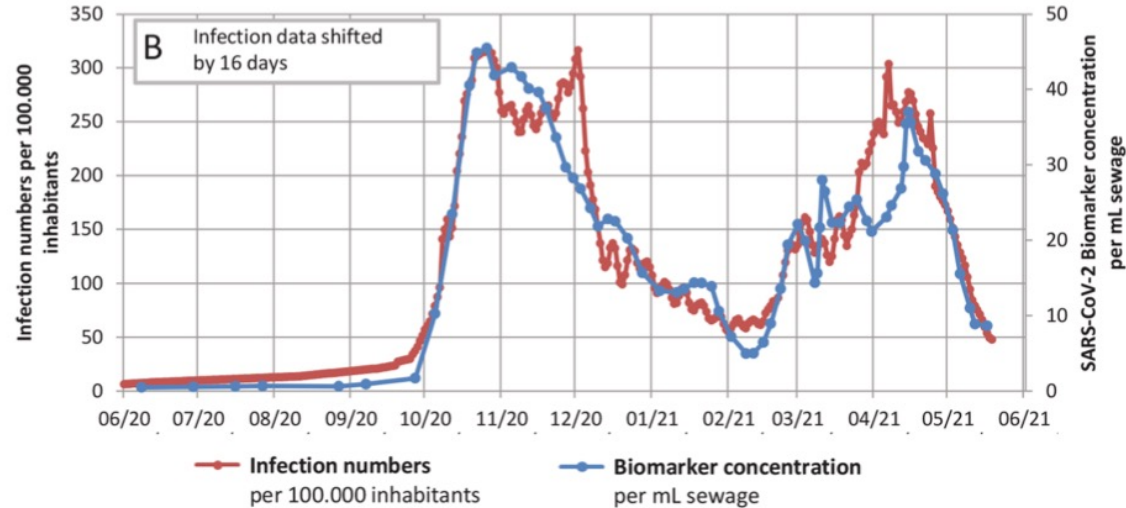


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Test for Active Infections: Waste Water Surveillance for Biomarkers

- Detection of SARS-CoV-2 gene fragments
- Enables approx. 2 weeks of forecast
- Data processing
 - Normalization, e.g. dry vs. heavy rain
 - Regression to remove peaks

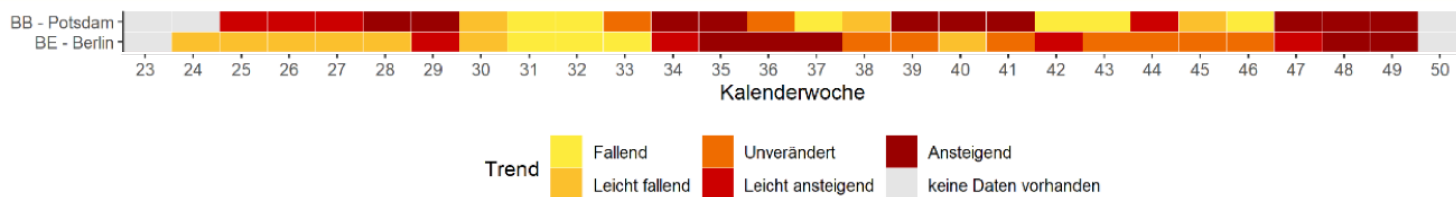


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Test for Active Infections: Waste Water Surveillance in Germany

Wöchentlicher COVID-19-Lagebericht vom 22.12.2022



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Muster 10C for SARS-CoV2-Testing

German form to order COVID-19 test

Auftrag für SARS-CoV-2 Testung
»»»»» Muster nicht kopieren! «««««

10C

Quantal
Geschlecht

Auftragsnummer des Labors
Hier bitte sorgfältig Barcode-Etikett erstellen!

Ersttestung weitere Testung

Testung nach Meldung „erhöhtes Risiko“ durch Corona-Warn-App (GOP 32811) **Diagnostische Abklärung (GOP 32816)**

Besonders Risikomerkmale einer Weiterverbreitung (nach Anamnese, bitte ankreuzen)

<input type="checkbox"/> Betreuung/untergebracht in:	<input type="checkbox"/> Medizinischen Einrichtungen (ambulante/poliklinische/ambulante Dienste, andere Masseneinrichtungen)	<input type="checkbox"/> Pflege- und anderen Wohnrichtungen (z.B. Unterverpackungsstellen, andere Masseneinrichtungen)
<input type="checkbox"/> Tätigkeit in Einrichtung:	<input type="checkbox"/> Gemeinschaftseinrichtungen (z.B. Kasse, Schule)	<input type="checkbox"/> Sonstigen Einrichtungen (z.B. nicht rechtlich feststehende ambulante Dienste der Capsulekapsel)

Das Einverständnis des Versicherten zum Übermitteln des Testergebnisses für Zwecke der Corona-Warn-App auf dem vom RKI betriebenen Server wurde erteilt. Dem Versicherten wurden Hinweise zum Datenschutz ausgehändigt.

Daten für das Gesundheitsamt/RKI - Übermittlung gemäß Infektionsschutzgesetz
Telefonnummer des Versicherten

Vertragsarztstempel / Unterschrift: Oberarzt

Namen, Vornamen des Versicherten



Gemeinsam schnell die **INFEKTIONSKETTE UNTERBRECHEN**
Die App als Beitrag, um die Pandemie weiter einzudämmen

Tragen Sie aktiv zur Eindämmung der Pandemie bei. Nutzen Sie die Corona-Warn-App.

Die App zu nutzen ist ganz einfach. Ihre Daten sind dabei sicher und werden nicht weitergegeben.

1. Laden Sie die App im Apple Store oder Google Play Store. Die App ist kostenlos.
2. Richten Sie die App ganz einfach ein. Sie werden dabei in der App angeleitet.
3. Scannen Sie den QR-Code und Sie erhalten eine Benachrichtigung, sobald Ihr Testergebnis vorliegt.
4. Im Falle eines positiven Testergebnisses können Sie andere App-Nutzer freiwillig warnen.

Hinweise zum Datenschutz: Sie möchten die Corona-Warn-App („App“) des Robert-Koch-Instituts („RKI“) zum Abrufen Ihres Testergebnisses verwenden. Um Ihr Testergebnis über die App abrufen zu können ist es notwendig, dass Ihr Testergebnis von dem Labor an die Server-Systeme der App übermittelt wird. Vorhanden dargestellt erfolgt dies, indem das Labor Ihr Testergebnis, verknüpft mit einem maschinenlesbaren QR-Code, auf einem hierfür bestimmten Server der App-Infrastruktur ablegt. Der QR-Code ist im Pseudonym, weitere Angaben zu Ihrer Person sind für die Anzeige des Testergebnisses in der App nicht erforderlich. Sie erhalten unterstehend eine Kopie des QR-Codes, der durch die Kamerafunktion Ihres Smartphones in die App eingelesen werden kann. Nur hierdurch ist eine Verknüpfung des Testergebnisses mit Ihrer App möglich. Mit Ihrer Einwilligung können Sie dann Ihr Testergebnis mit Hilfe der App abrufen. Ihr Testergebnis wird automatisch nach 21 Tagen auf dem Server gelöscht. Wenn Sie mit der Übermittlung Ihres pseudonymen Testergebnisses mittels des QR-Codes an die App-Infrastruktur zum Zweck des Testabrufs einverstanden sind, bestätigen Sie dies bitte gegenüber Ihrem Arzt. Sie können Ihre Einwilligung jederzeit mit Wirkung für die Zukunft widerrufen. Bitte beachten Sie jedoch, dass aufgrund der vorhandenen Pseudonymisierung eine Zuordnung zu Ihrer Person nicht erfolgen kann und daher eine Löschung Ihrer Daten erst mit Ablauf der 21-tägigen Speicherfrist automatisch erfolgt. Einzelheiten hierzu finden Sie zudem in den soZuserschutzhinweisen der Corona-Warn-App des RKI.

* Wenn Sie jünger als 16 Jahre alt sind, besprechen Sie die Nutzung der App bitte mit Ihren Eltern oder Ihrer sorgeberechtigten Person.



Ihre Notizen:



Scannen Sie diesen QR-Code

COVID-19 Lab Report Example: Negative E Gene Testing

- Nuclein test using Reverse Transcription Polymerase Chain Reaction (RT-PCR) + qPCR
- Lab time: <5 hrs
- Possible SARS-CoV-2 targets:
 - E Gene
 - N Gene
 - Orf Gene
 - M Gene

[REDACTED]		Tel.: [REDACTED]	Fax: [REDACTED]
Dr. med. [REDACTED]	[REDACTED]	Patient: [REDACTED]	[REDACTED]
[REDACTED]	[REDACTED]	Ext.-Nr: [REDACTED]	[REDACTED]
[REDACTED]	[REDACTED]	Geb.-Dat: [REDACTED]	[REDACTED]
[REDACTED]	RERK [REDACTED]	Ausg.-D.: 14.10.20/20: [REDACTED]	1/1
[REDACTED]	[REDACTED]	Labor-Nr: 14.10.2020	[REDACTED]
ENDBEFUND			
Eingesandtes Material: trockener Tupfer		Abnahme: 14.10.2020	
Eingang am 14.10.2020/15: [REDACTED]			
Nukleinsäurenachweis (PCR)		Messwert	
SARS-CoV-2 (E-Gen)		negativ	
Kein Nachweis von SARS-CoV2			
Abrechnungsinformation: (BSNR: [REDACTED])			
E-GO-Nr	Kosten(EUR)	Bezeichnung	Faktor(en)
32816	39.40	SARS-CoV-2 Screeningtest	
Diensthabender Arzt (14.10.20): [REDACTED]			

COVID-19 Lab Report Example: Positive N1, N2 Gene Testing

- Nuclein test using Reverse Transcription Polymerase Chain Reaction (RT-PCR)



Auftragsnummer: [REDACTED]
Probeneingangsdatum: 03.12.2020, 16: [REDACTED]
Probentyp: Rachenabstrich
Probenentnahmedatum: 03.12.2020, 10: [REDACTED]
Datum des Befundes: 03.12.2020, 21: [REDACTED]
Art des Befundes: Endbefund



Untersuchung auf SARS-CoV-2 Virus RNA



POSITIVER BEFUND // Es besteht ein relevantes Infektionsrisiko für Kontaktpersonen

INTERPRETATION

Es konnte Sars-CoV-2-spezifische RNA im gewonnenen Material nachgewiesen werden.

Damit ist eine aktuell vorliegende Infektion mit Sars-CoV-2 bestätigt.

Es besteht ein relevantes Infektionsrisiko für Kontaktpersonen und Schutzmaßnahmen müssen unmittelbar vorgenommen und mit dem zuständigen Gesundheitsamt abgestimmt werden.

Das Ergebnis wird von [REDACTED] an das zuständige Gesundheitsamt weitergeleitet.

Die normalisierten Ct-Werte für die untersuchten SARS-CoV-2 Gene liegen zwischen 35,3 und 35,3 Zyklen (semiquantitative RT-PCR; Schwelle < 36 Zyklen).



**CORONA
WARN-APP**



DIE CORONA-WARN-APP
**UNTERSTÜTZT
UNS IM KAMPF
GEGEN CORONA.**

Jetzt die Corona-Warn-App
herunterladen und Corona
gemeinsam bekämpfen.



COVID-19 Lab Report Example: Positive N1, N2 Gene Testing

- Nuclein test using Reverse Transcription Polymerase Chain Reaction (RT-PCR)
- SARS-CoV-2 targets:
 - N1 Gene
 - N2 Gene
- Human targets for QA:
 - RNaseP Gene

EMPFEHLUNGEN

Die Probandin /der Proband muss sich unverzüglich mit dem zuständigen Gesundheitsamt in Verbindung setzen.

METHODEN

Ribonukleinsäuren wurden vom Probenträger eluiert und aufgereinigt. Die Ribonukleinsäuren wurden revers transkribiert und auf dem LightCycler480 (Roche) gemäß Richtlinie der CDC für zwei Targets des SARS-CoV-2 (N1 und N2 Gene) sowie das humane RNaseP Gen (Kontrolle der Nukleinsäure-Extraktion und der Beprobung von menschlichem Material) durch Fluoreszenzdetektion quantifiziert (Real-Time PCR; CE-IVD registrierte Reagentien von Pentabase, DK). Die Nachweisgrenze („Limit-of-Detection“ – LOD) liegt bei 2 Viruspartikel pro µl, die Auswertung der quantitativen Daten erfolgte mit der LightCycler Software. Dieser Test wird derzeit von der Food and Drug Administration (FDA) geprüft und ist nur für die Verwendung im Rahmen der Emergency Use Authorization (EUA) der Food and Drug Administration vorgesehen.

Haftungsausschluss

Jede Verarbeitung einer klinischen Probe sowie die erforderliche (genetische) Untersuchung selbst basieren auf dem jeweils aktuellsten, wissenschaftlichen und analytischen Stand der Technik. In sehr wenigen Fällen können genetische Tests nicht das richtige Ergebnis zeigen. Zugrunde liegende Ursachen können z.B. eine niedrige Qualität des zugesandten Materials sein, z.B. durch fehlerhafte Abstriche oder nachträgliche Verunreinigung, oder ein Ausfall der Analyse durch unvorhersehbare oder unbekannte Gründe. Auch kann es sein, dass sich eine Infektion noch nicht ausreichend ausgebreitet hat und deswegen in der vorliegenden Probe noch nicht feststellbar war. Sofern das zugrundeliegende Problem von [REDACTED] nicht erkannt werden konnte, ist diese für das unvollständige, potenziell irreführende oder sogar falsche Ergebnis einer Analyse nicht verantwortlich.

Information

[REDACTED]

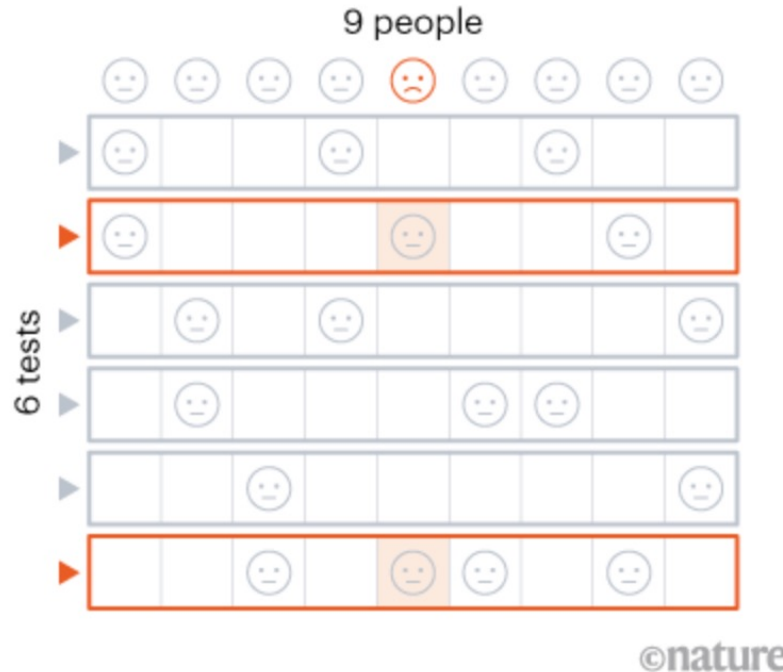
[REDACTED]

[REDACTED]

Scalability of Testing Strategies: Pooling

Method 4

This method uses only one round of testing. Samples are distributed into a matrix of overlapping groups.



nature



NEWS · 10 JULY 2020

The mathematical strategy that could transform coronavirus testing

Four charts show how pooling samples from many people can save time or resources.

Smriti Mallapaty

Use Case Infectious Diseases

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Digital Health, Winter
2023
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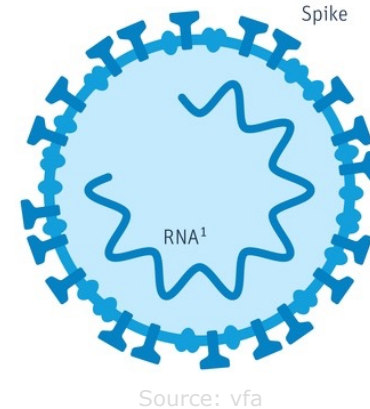
Vaccination



Photo by M. Schapranow, Hakan Nural



- RNA viruses are directly replicated by ribosomes of the host
- Coronavirus (SARS-CoV-2):
 - Type: RNA-based viruses surrounded by a hull
 - Genome: 30kbps single-stranded RNA
 - Polarity: positive
- Conservative: Inactivated virus containing relevant virus proteins
- Advanced, only blueprint for components injected:
 - Use of manipulated vector virus carrying selected genes of target virus
 - mRNA to trigger protein bio synthesis within host cells
 - Bio-technically synthesized recombinant virus protein



Monovalent COVID-19 Vaccines (Excerpt)

(last updated Jan 2023)

Codename	Type	Company	CC	Remarks
BNT162b2	mRNA	BioNTech / Pfizer	DE	EU license Dec 2020, 95% efficacy
mRNA-1273	mRNA	Nat'l Inst. of Allergy & Infectious Diseases / Moderna	US	EU license Jan 2021, 94% efficacy
CVnCoV	mRNA	Curevac	DE	Stopped Phase IIb/III Jun 2021: 47% efficacy, did not meet prespecified statistical success criteria
AZD1222	Vector	Oxford / AstraZeneca	UK	EU license Jan 2021, issues with dose/efficacy per target age group (60-90%), contamination, sinus venous thrombosis
Ad26.COV2-S	Vector	JnJ	US	EU license Mar 2021, 85% efficacy
Sputnik V	Vector	Gamaleya Res. Institute of Epidemiology & Microbiology	RU	EU rolling review since Mar 2021
CoronaVac	Inactivated	Sinopharm	CN	CN License Dec 2020, efficacy 86%, EU rolling review since May 2021
VLA2001	Inactivated	Valneva	FR	EU license Jun 2022, production stopped end of 2022 due to low demand
NVX-CoV2373	Recombinant protein	Novavax	US	EU license Dec 2021, 90% efficacy
CoVLP	Recombinant protein	Medicago / GSK	CA	CA license Feb 2022
VAT02/VAT13 booster	Recombinant protein	Sanofi / GSK	FR	EU license Nov 2022
PHH-1V booster	Recombinant protein	Hipra	ES	EU rolling review since Mar 2022

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Monovalent COVID-19 Vaccines (Excerpt)

(last updated Jan 2024)

Product Name	Type	Company	CC	Remarks
Comirnaty Omicron XBB.1.5	mRNA	BioNTech / Pfizer	DE	EU license Aug 2023
Spikevax XBB.1.5	mRNA	Nat'l Inst. of Allergy & Infectious Diseases / Moderna	US	EU license Sep 2023
Nuvaxovid XBB.1.5	Recombinant protein	Novavax	US	EU license Oct 2023

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Bivalent COVID-19 Vaccines (Excerpt)

(last updated Jan 2024)

Product Name	Type	Company	CC	Remarks
Comirnaty Original/Omicron BA.1	mRNA	BioNTech / Pfizer	DE	EU license Sep 2022
Comirnaty Original/Omicron BA.4/5	mRNA	BioNTech / Pfizer	DE	EU license Sep 2022
Spikevax bivalent Original/Omicron BA.1	mRNA	Nat'l Inst. of Allergy & Infectious Diseases / Moderna	US	EU license Sep 2022
Spikevax bivalent Original/Omicron BA.4/5	mRNA	Nat'l Inst. of Allergy & Infectious Diseases / Moderna	US	EU license Oct 2022

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Types of Vaccination: Overview

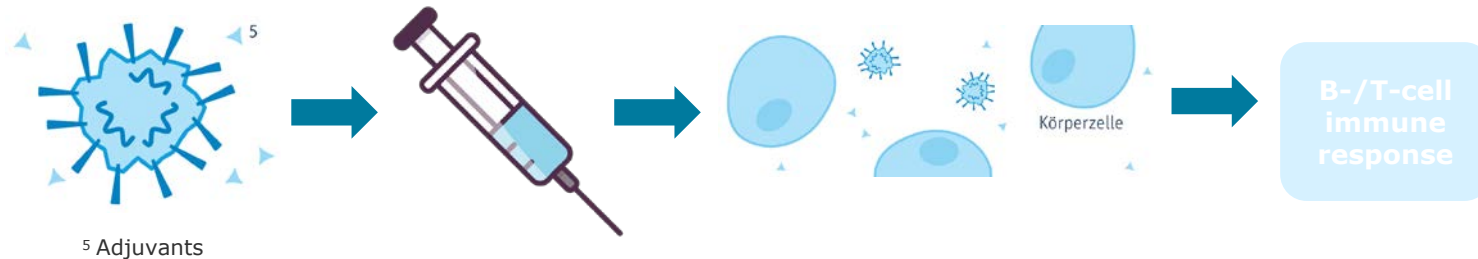
- Inactivated or attenuated Virus
- Vector-based
- Virus proteins
- mRNA-based
- DNA-based
- Peptide-based

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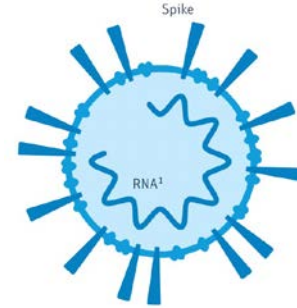
Types of Vaccination: Inactivated Vaccine

- Requires access to virus in sufficient quantity, e.g. grown in other hosts
- Inactivated virus cells are injected to trigger immune response



⁵ Adjuvants

- Original virus is in-activated (see hull)

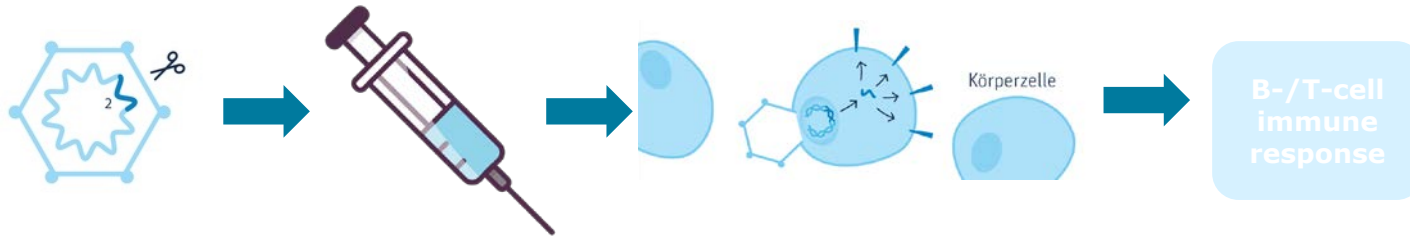


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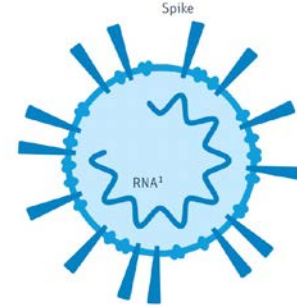
Types of Vaccination: Vector Vaccine

- Requires well-known vector virus as carrier, e.g. Adenovirus



- Vector virus is manipulated and target virus gene is added

- Vector virus invades body cell and releases its RNA
- Ribosomes read RNA and assemble spike protein
- Proteins are released by cell

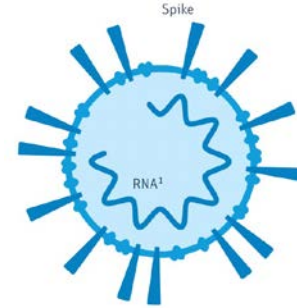
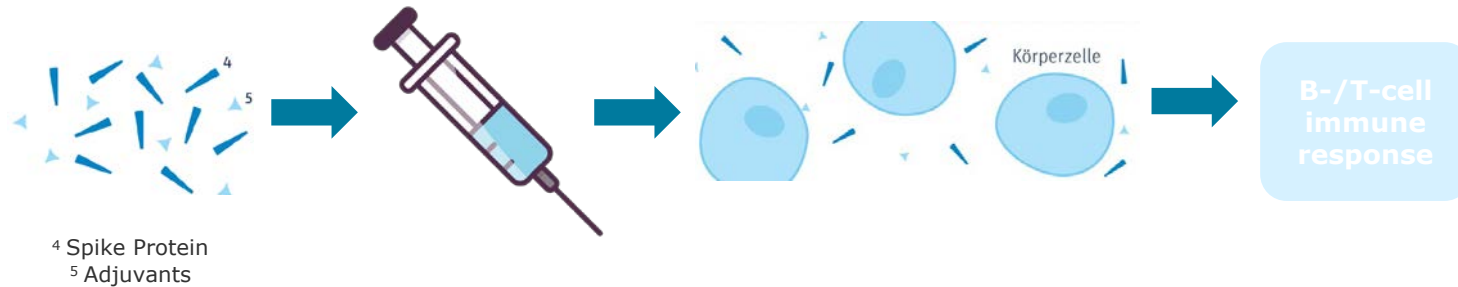


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Types of Vaccination: Protein Vaccine

- Virus protein is genetically engineered in the lab (not derived from original virus)

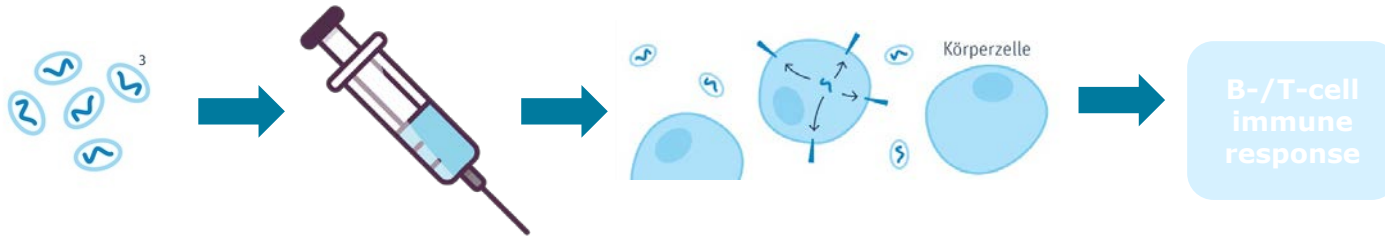


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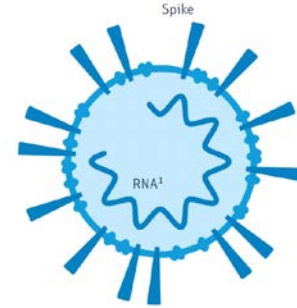
Types of Vaccination: mRNA Vaccine

- Requires synthesis and handling of very fragile RNA



- mRNA for spike protein covered by lipid hull

- Lipid hull allows to mRNA to enter body cells
- Ribosomes read RNA and assemble spike protein
- Proteins are released by cell



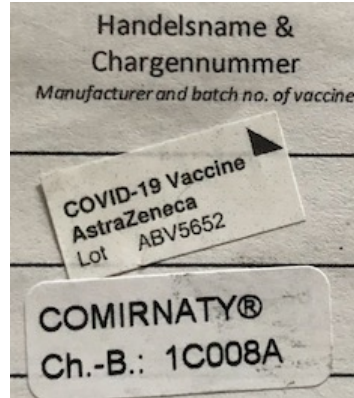
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Comirnaty / Tozinameran by BioNTech / Pfizer

What is in it?

- Active Ingredients: 30 µg nucleoside-modified mRNA encoding the S protein of SARS-CoV-2
- Lipids for packaging:
 - 430 µg (4-hydroxybutyl)azanediylbis(hexane-6,1-diyl)bis (ALC-3015),
 - 50 µg (2-hexyldecanoate),2-[(polyethylene glycol)-2000]-N,N-ditetradecylacetamide (ALC-0159),
 - 90 µg 1,2-distearoyl-sn-glycero-3-phosphocholine (DPSC), and
 - 200 µg Cholesterol.
- Salts:
 - 10 µg potassium chloride,
 - 10 µg monobasic potassium phosphate,
 - 360 µg sodium chloride
 - 70 µg basic sodium phosphate dihydrate
- Sugar: 6 mg sucrose

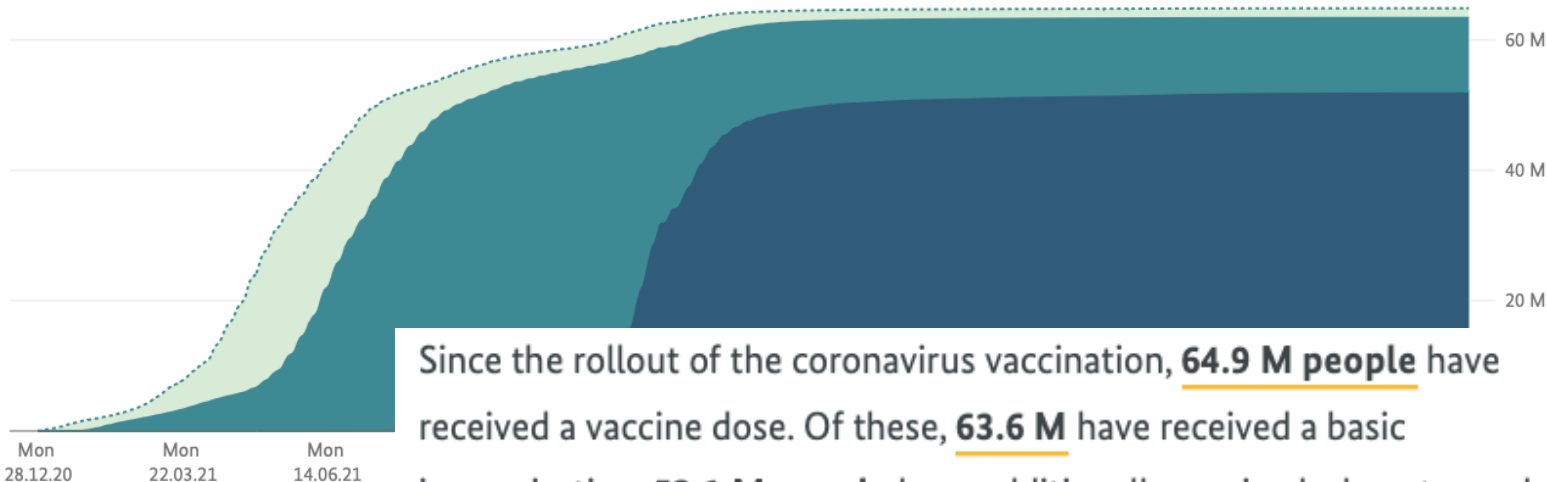


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Vaccinations in Germany

- People who have received a vaccine dose
- People with a basic immunisation
- Vaccinated people with one booster
- Vaccinated people with two boosters
- Vaccinated people with more than two boosters



Since the rollout of the coronavirus vaccination, **64.9 M people** have received a vaccine dose. Of these, **63.6 M** have received a basic immunisation. **52.1 M people** have additionally received a booster and **12.7 M people** have received at least two boosters.

Use Case Infectious Diseases

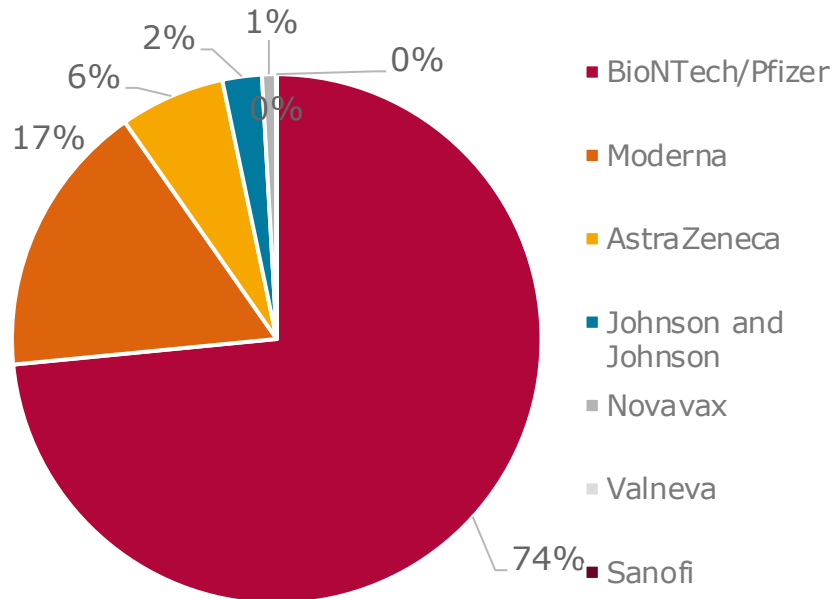
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As of: 8. April 2023 (Vaccinations)

Source: impfdashboard.de, Robert Koch Ins

Vaccinations by Vendor in Germany

A total of 224.1M COVID-19 vaccinations were applied in Germany (as of Apr 8, 2023)



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FAQ for COVID-19

Fact

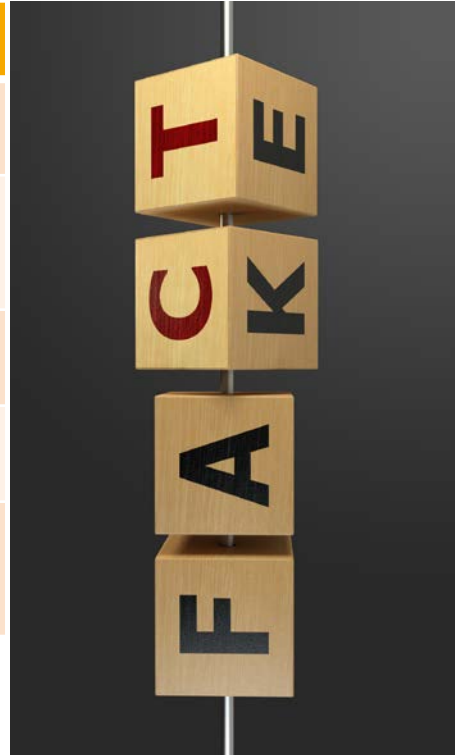
SARS-CoV-2 is a new Coronavirus variant

Severe infections exist and require people to stay on ICU sometimes up to weeks

Some people after infection die due to resulting complications

Vaccines of different type are available to reduce risk of death

A small number of people profits from spreading fake news around Coronavirus



Fake

Vaccines prevent infections / spread of the virus

Vaccines contain a chip because they are so expensive

Testing reveals more infections

Vaccines affect fertility

Toilet paper prevents virus spread

Nasal sprays contaminate / infect the brain

Regular use of antibiotics, alcohol, sodium chloride spray protect against infections

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What To Take Home?

- Infections may
 - Use many transmission ways
 - Affect different body locations
 - Be triggered by numerous agents
 - Result in life-threatening events
 - Require intensive care

- Bear in mind: Containment is the **only option** to fight a pandemic spread, if no therapy is available



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