

Biosafety – from sample collection to the laboratory

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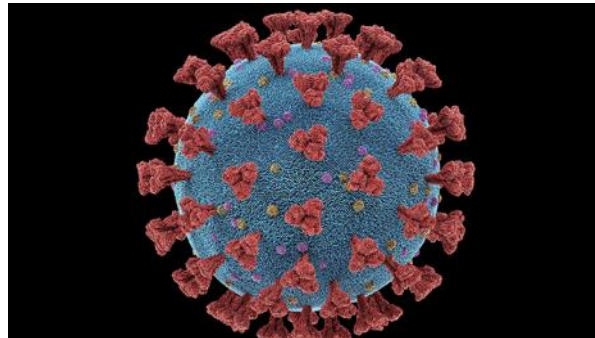
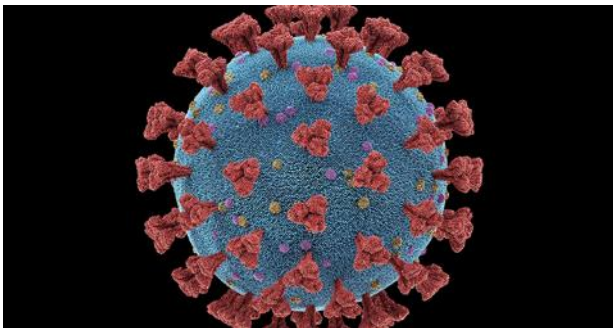
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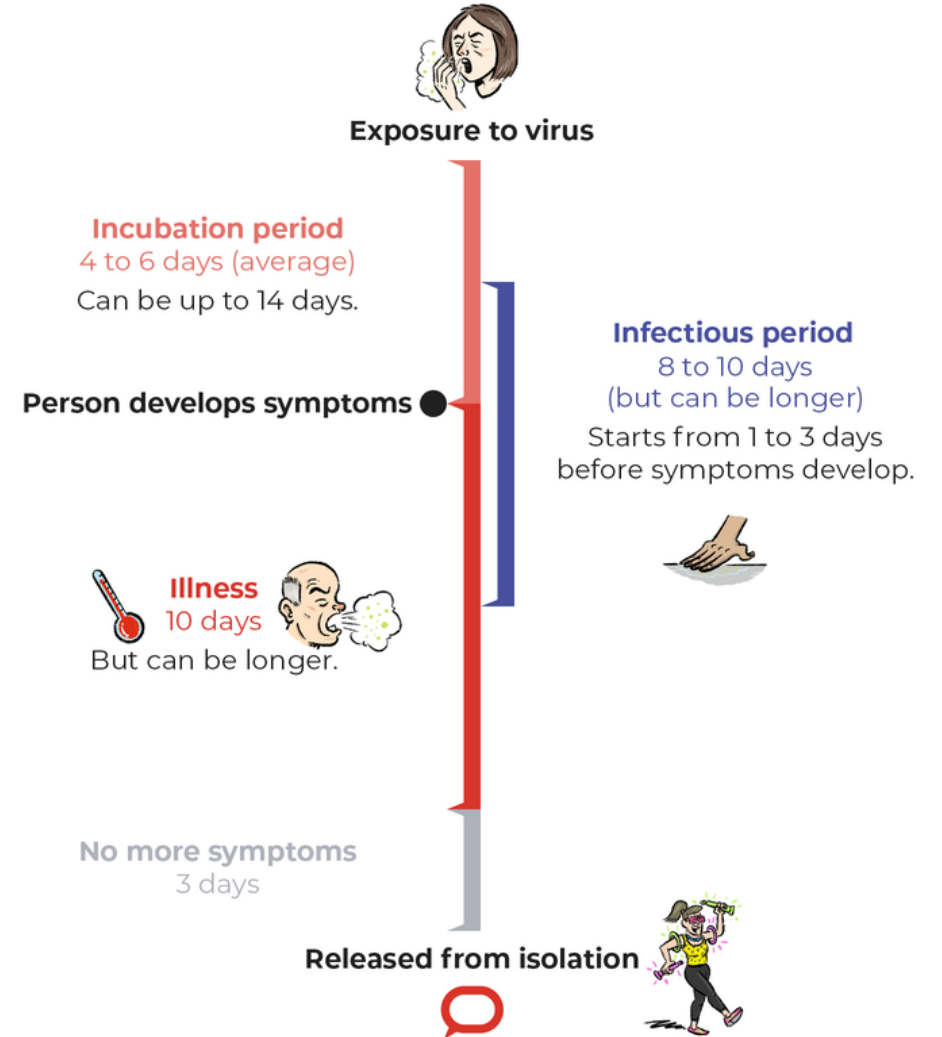
Preventing and controlling
transmission of COVID 19 infection



How does SARS-CoV-2 spread?

- Household and nosocomial transmission
- Via respiratory droplet secretions and fomites (contaminated objects and surfaces)
- Aerosol spread in special situation – ICU
- Patients infectious before symptom onset, and for a few days after recovery
- Asymptomatic infections occur

Coronavirus progression in majority of cases

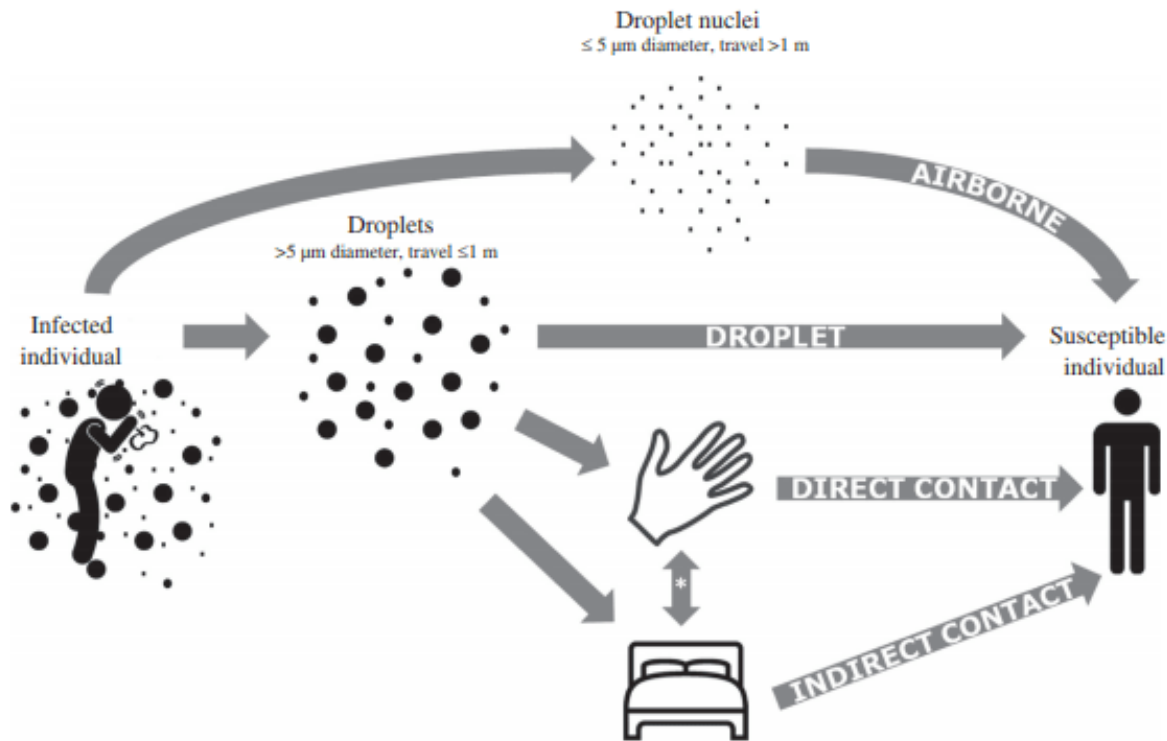


Role of the laboratory in COVID-19 diagnostics

Diagnostic intervention	Stage	Tests	Clinical laboratory
Epidemiologic surveillance	Environment, animal reservoirs	RT-PCR;	Virology
Diagnosis	Infection	RT-PCR	Virology
Staging; monitoring; therapeutic intervention	Overt disease	White cell count; albumin ; LDH; ALT; AST; Total bilirubin; creatinine; troponin; D-dimer; pro-calcitonin; c-reactive protein; blood culture; respiratory MCS; respiratory viral PCR	Haematology; Chemical Pathology; Microbiology; Virology
Epidemiologic surveillance	Recovery	Anti-SARS-CoV-2 antibodies	Virology, immunology / serology

Adapted from: Lippi et al., Clin Chem Lab Med 2020;
<https://doi.org/10.1515/cclm-2020-0240> and
<https://doi.org/10.1515/cclm-2020-0198>

SARS-CoV-2 and the laboratory worker



* Transmission routes involving a combination of hand & surface = indirect contact.

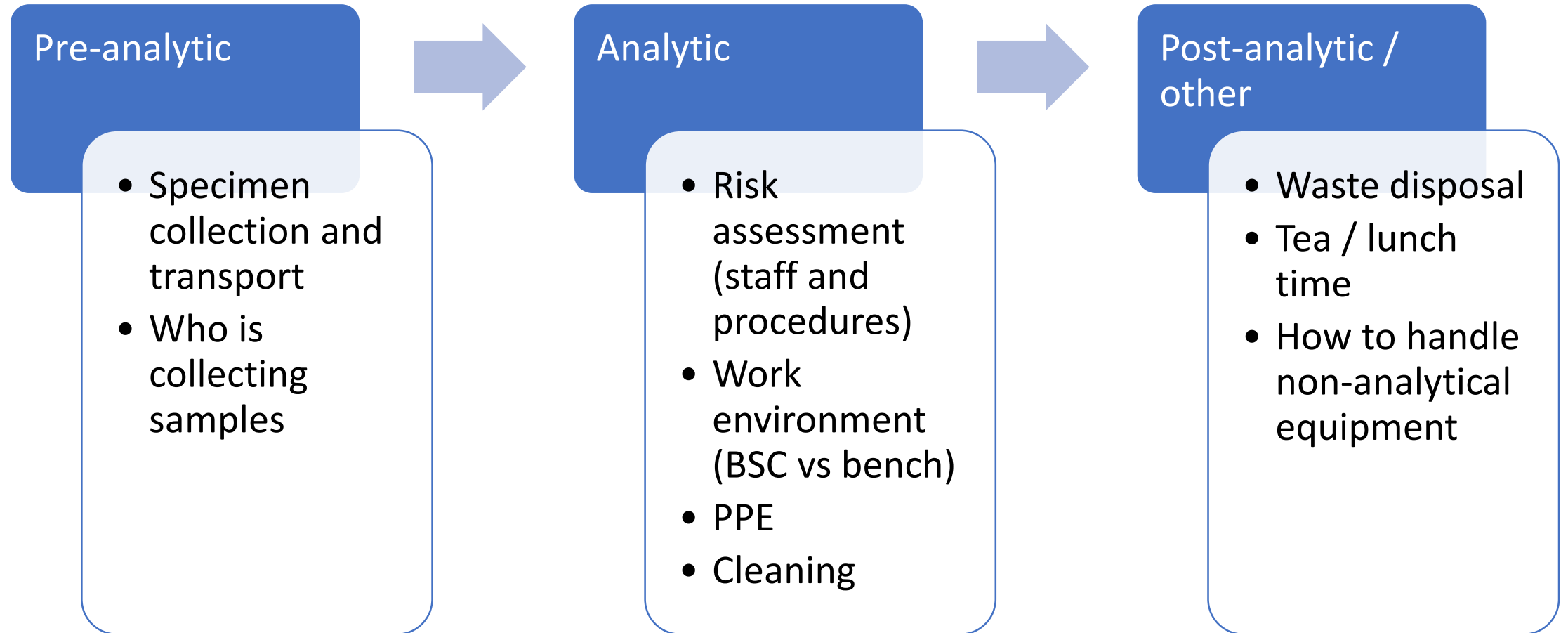


SARS-CoV-2 and the laboratory worker

- To date, no laboratory-acquired infection has been reported for SARS-CoV-2 (nor for MERS-related coronavirus)
- Laboratory-acquired infections with SARS-CoV-1 have been reported in 2003 and 2004 but only in laboratories propagating virus on cell cultures (i.e. high titres of infectious virus)

https://www.who.int/csr/don/2003_09_24/en/
https://www.who.int/csr/don/2003_12_17/en/
https://www.who.int/csr/don/2004_05_18a/en/

Laboratory flow



Pre-analytic considerations

- Mainly administrative
 - Patient specimens to be transported as UN3373, "Biological Substance Category B".
 - No pneumatic tube
 - Sorting and registration with appropriate IPC precautions
- If laboratory staff involved in specimen collection
 - Ventilated space
 - PPE – N95 or equivalent, gloves, eye protection

Analytic considerations

Sample type	Common tests	Processing precautions
Respiratory samples (NPA, sputum, tracheal aspirate etc)	Viral PCR, MCS, TB culture,	Class II BSC
Serum / blood	Antibody tests, antigen detection, chemistry, haematology	Standard precautions
Body fluids / aspirates	MCS, Chemistry, cell counts, cytology	Standard precautions
Tissue	MCS, histology	If formalin fixed – standard precautions If fresh and being crushed – Class II BSC
Stool	MCS, antigen detection, faecal fat	If aerosol potential – class II BSC Otherwise standard precautions
Urine	MCS, chemistry	Standard precautions

Debatable – some concern that virus in faeces may be a source of transmission

Analytic – COVID testing

- Non-propagative diagnostic laboratory work (e.g., nucleic acid amplification) - use Biosafety Level 2 (BSL-2) procedures
- Specimen processing in validated biosafety cabinet (BSC)
 - For specimens likely to contain SARS CoV-2
 - Preferably with N95 mask
 - RNA extraction buffers generally render virus non-infectious / inactive
- Propagative work (for example, virus culture, isolation or neutralization assays) should be conducted at a containment laboratory with inward directional airflow (BSL-3).
 - Not applicable to routine diagnostic laboratories

Analytic – non COVID-testing

- Laboratory practices and procedures that are basic to **good microbiological practices and procedures** (GMPP) should be followed.
- Specimens from cases with suspected or confirmed COVID-19 infection that are intended for additional laboratory tests should follow **standard guidelines for processing potentially infectious material**.



Post-analytic

- Waste (specimens, discarded gloves, phone wipes and surgical masks) should be treated as infectious clinical waste and handled in accordance with local facility policies and regulations.
- Use disinfectants with activity against enveloped viruses (e.g., hypochlorite, alcohol, hydrogen peroxide, quaternary ammonium and phenolic compounds).



Levels of control

Administrative

- Risk assessment
- Staff practices – hand hygiene, masks, social distancing
- Training
- Laboratory workflow



Engineering

- BSC
- Size of rooms
- Ventilation
- Workflow



Class I



Class II



Class III

PPE

- Gloves
- Masks



Administrative Staff management

- Team segregation, social distancing
- Staggered tea times
- Staggered arrival / departure times
- Reinforcement of business continuity and multi-discipline contingency plans
- Regular symptom screening
- Quarantine measures for staff who are unwell
- Use of web-based remote learning platforms for training and conferences.

Hand hygiene

- Upon completion of required tasks and before leaving the laboratory
- Immediately after removal of gloves or other personal protective equipment
- Upon contact or when there is visible contamination with blood or other potentially infectious material
- Before and after using the bathroom



Soap and water

- 1 Turn on water
- 2 Wet hands
- 3 Apply soap to palm of one hand
- 4 Scrub for 20 seconds
- 5 Rinse
- 6 Dry with paper towel
- 7 Turn off water with a clean towel



Hand sanitizer

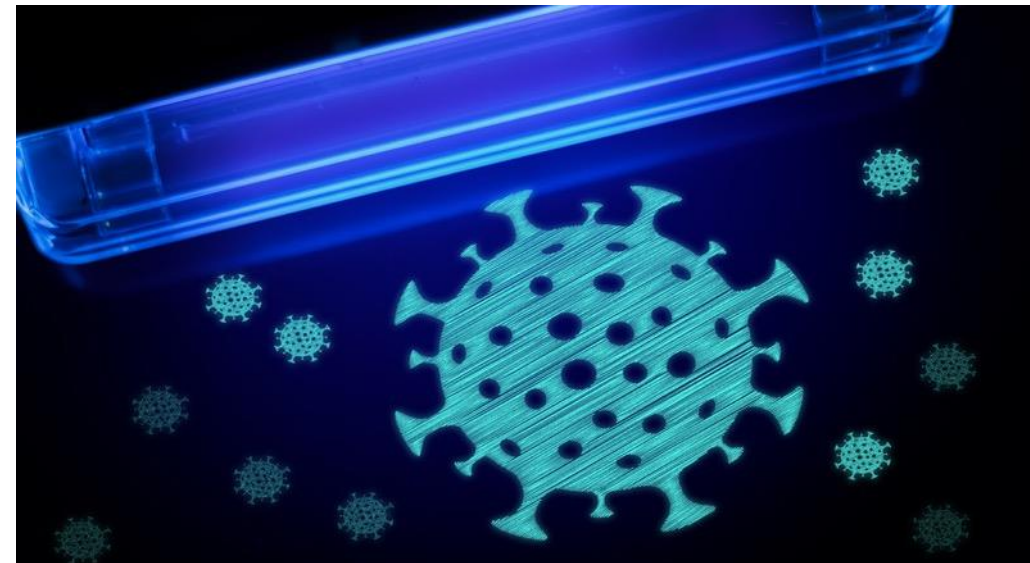
- 1 Apply to palm of one hand
- 2 Rub over both hands
- 3 Let dry

Cleaning

- Premises, surfaces, and areas potentially contaminated with SARS-CoV-2, (droplet or touching) should be cleaned thoroughly and disinfected.
- **Frequently touched areas** - cleaned and disinfected at least twice daily
- Walls, floors and windows should be cleaned as per current protocols.
- In the laboratory setting, the 2 most commonly used disinfectants are sodium hypochlorite and ethanol.
 - **0.1% sodium hypochlorite** (dilution 1:50 if household bleach at an initial concentration of 5% is used) after cleaning with a neutral detergent
 - **70% ethanol** after cleaning with a neutral detergent.
- Cleaning to be **supervised** and **documented**

Fogging and UVGI

- Fogging sometimes used as additional environmental cleaning
 - Lab must be empty – usually 3-4 hours needed
 - Value over and above standard cleaning and disinfection uncertain
- UVGI
 - Need “line of sight” to surfaces; or air circulation
 - Expensive
 - Unclear if there is any additional benefit



<https://www.ny-engineers.com/blog/uv-germicidal-irradiation-protection-against-covid-19-and-other-germs>

Spills and Laboratory Accidents

- Reported to the section supervisor.
- Restrict movement in that area.
- Contain and decontaminate. Spill kits must be available at designated sites
 - 0.1% sodium hypochlorite is recommended for general disinfection
 - 1% sodium hypochlorite is recommended for disinfection of blood spills.

Mobile phones

- Mobile phones can be a source of contact transmission.
- Options are:
 - Leave phone in locker and use it after decontaminating your hands
 - Wipe the surface of the phone with damp wipes until all marks are removed or according to manufacturer instructions
 - When dry, place in a clean Ziploc bag and close it tightly.
 - Wipe the Ziploc surface with an alcohol wipe after each use
 - Direct application of alcohol or other disinfectants to the phone is not advised

Computers and peripherals

- Hand hygiene with soap and water / ABHR before and after using keyboards and mice
- Ideally no gloves when using these devices.
 - If use of gloves is unavoidable consider marking computers as “gloves only” or “no gloves allowed”.
- If physical dirt/dust present:
 - disconnect the keyboard/mouse and turn it upside down and shake gently.
 - keyboard brush
- Wipe keyboards and mice using a wipe (e.g. 70% ethanol).
 - Studies have shown this has no effect on the mouse or keyboard. Do not spray/pour disinfectant onto the device or use cloths with excessive fluid as this may damage the electronics.
- In high risk areas, if possible use keyboard and mouse covers for devices

Engineering: BSCs

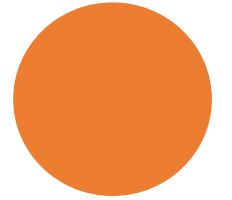
- Turn off UV lamp and turn on blower, close sash, allow fan to run for 5 minutes to purge the air.
- Disinfect BSC by wiping down interior surfaces, in straight horizontal lines.
- Place all items required in rear of BSC.
- Organise items away from air vents so as not to disrupt airflow
- Minimise movement within BSC.



- Segregate clean and dirty items within BSC.
- Minimise movements inside BSC. Exit BSC slowly. Upon reentering, wait for air to stabilise.
- When finished, remove all items slowly and decontaminate with appropriate disinfectant
- Disinfect all interior BSC surfaces as before.
- BSC maintenance: daily wiping, UV lamp, weekly smoke tests, 6-monthly servicing.

Engineering: other

- Large well ventilated rooms
 - Difficult to re-engineer existing space
- Open windows (offices; not always possible in lab space)
- Reduce number of staff sharing workbenches
- Perspex shields between benches
- Adjust work- and people-flow to reduce unnecessary mixing of staff














PPE: Masks

- N95 respirators
 - specific circumstances – aerosol generating procedures with COVID-containing samples
- Surgical (medical) mask
 - When working in proximity to others.
 - For 4-6 hours and should be disposed of appropriately.
 - Decontamination and reprocessing is not recommended
- Other forms of face mask:
 - Face shields: can reduce droplet exposure.
 - An alternative during limited supply of surgical masks and for persons who wear glasses.
 - Cloth masks
 - reducing community transmissions outside of the workplace setting.
 - May be an option in workplace if surgical masks not available



PPE: gloves

- Gloves when handling specimens
- Appropriate PPE (disposable plastic apron, mask, protective glasses and domestic gloves) for cleaning staff
- Follow correct donning and doffing of PPE
- Discard disposable PPE as potentially infectious material
- Decontaminate non-single use PPE such as domestic gloves using the available products (0.1% sodium hypochlorite or 70% ethanol).

DONNING ORDER FOR PUTTING ON PPE	DOFFING ORDER FOR TAKING OFF PPE
hand hygiene (soap or alcohol handrub) 	hand hygiene (soap or alcohol handrub) 
put on apron or gown 	remove gloves 
put on surgical mask or N95 respirator 	remove gown / apron 
put on eye cover 	remove eye cover 
put on non-sterile gloves 	remove N95 respirator 
	hand hygiene (soap or alcohol handrub) 
PERFORM HAND HYGIENE BETWEEN STEPS <u>IF</u> HANDS BECOME CONTAMINATED AND IMMEDIATELY AFTER REMOVING ALL PPE	

Summary

- Risk of contracting COVID-19 from a laboratory sample is far less than risk of contracting COVID-19 from colleagues in the workplace (or in society)
- Adherence to standard laboratory safety practices must be maintained
- Extra attention needs to be paid to ensuring social distancing, masks, hand hygiene in the laboratory setting

Guidance documents

World Health Organization (WHO). Laboratory biosafety guidance related to coronavirus disease 2019 (COVID-19).

- [https://www.who.int/publications/i/item/laboratory-biosafety-guidance-related-to-coronavirus-disease-\(covid-19\)](https://www.who.int/publications/i/item/laboratory-biosafety-guidance-related-to-coronavirus-disease-(covid-19))
- <https://www.who.int/ihr/publications/biosafety-video-series/en/>

Public Health England (PHE). Guidance. COVID-19: safe handling and processing for samples in laboratories.

- <https://www.gov.uk/government/publications/wuhan-novel-coronavirus-guidance-for-clinical-diagnostic-laboratories/wuhan-novel-coronavirus-handling-and-processing-of-laboratory-specimens>

Centers for Disease Control and Prevention (CDC). Interim Laboratory Biosafety Guidelines for Handling and Processing Specimens Associated with Coronavirus Disease 2019 (COVID-19).

- <https://www.cdc.gov/coronavirus/2019-nCoV/lab/lab-biosafety-guidelines.html>
- <https://www.cdc.gov/coronavirus/2019-ncov/lab/biosafety-faqs.html>

Other

- www.samj.org.za/index.php/samj/article/view/12876
- <https://www.who.int/csr/resources/publications/biosafety/Biosafety7.pdf>
- <https://www.cmu.edu/ehs/Laboratory-Safety/biological-safety/documents/working-safely-in-a-bsc.pdf>

General links – Africa and global

- **World Health Organization (WHO)**

www.who.int/emergencies/diseases/novel-coronavirus-2019

www.who.int/emergencies/diseases/novel-coronavirus-2019/training/online-training

- **Infection Control Africa Network (ICAN)**

<http://www.icanetwork.co.za/>

- **Africa Centres for Disease Control and Prevention**

<http://www.africacdc.org/>

- **WHO Regional Office for Africa**

<https://www.afro.who.int/health-topics/coronavirus-covid-19>

- **AFREhealth Monthly COVID-12 in Africa Webinar**

<https://www.afrehealth.org/>

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