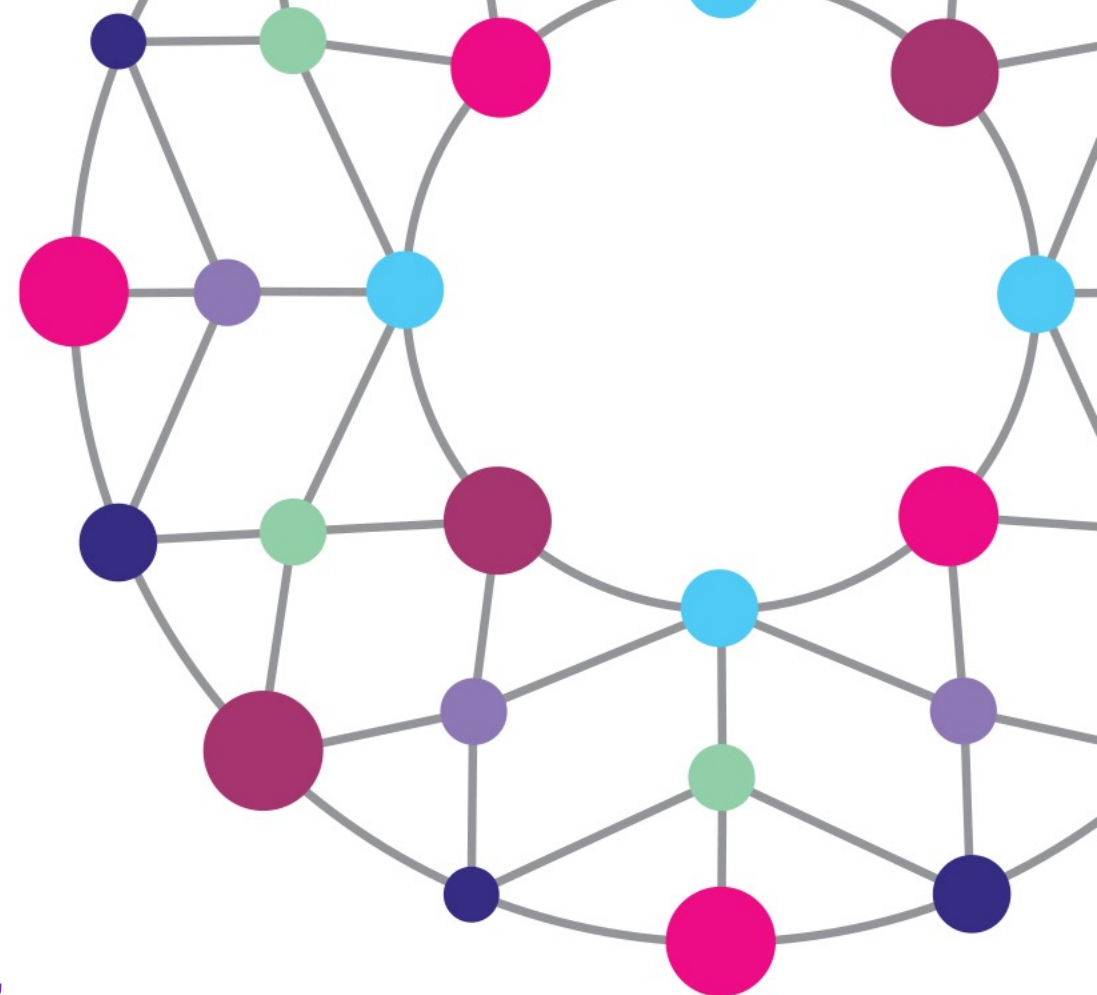# Challenges and opportunities of sampling and characterizing bioaerosols (BioPM)

Corinne Whitby, Ferguson RMW, Colbeck I, Dumbrell AJ, Nasir ZA, Marczylo E, Kinnersley R, Douglas P, Drew G, Bhui K, Lemon M, Jackson S, Tyrrel S, Coulon F

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BioAirNet

Cranfield University · DE MONTFORT UNIVERSITY LEICESTER · [dstl] · Environment Agency · UK Health Security Agency · University of Essex · UNIVERSITY OF OXFORD · UNIVERSITY OF PLYMOUTH · UKRI Natural Environment Research Council

How do I sample bioaerosols?

- Bioaerosols (BioPM) are airborne microorganisms (i.e. bacteria, fungi, archaea, viruses and their products).

- Although they may impact on human health, their role in the environment remains poorly understood.

- Although there are a wide variety of air samplers and sampling methods available, **no standardised procedures have been firmly established**.

- But more than this… the sampling strategy by the user may 'skew' the data.

- So the choice of sampling strategy depends on the Qs being addressed.

- Consequently, it is difficult for bioaerosol researchers to compare studies, and for regulators to set meaningful exposure limits.

Key Qs to consider before sampling

What is the **target analyte?**

What type of **environment?**

What type / level of **exposure?**
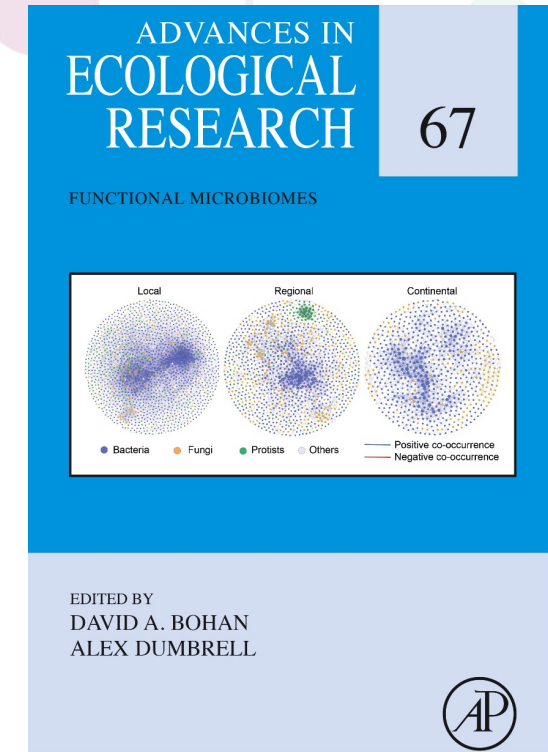
Which **air sampling method?**

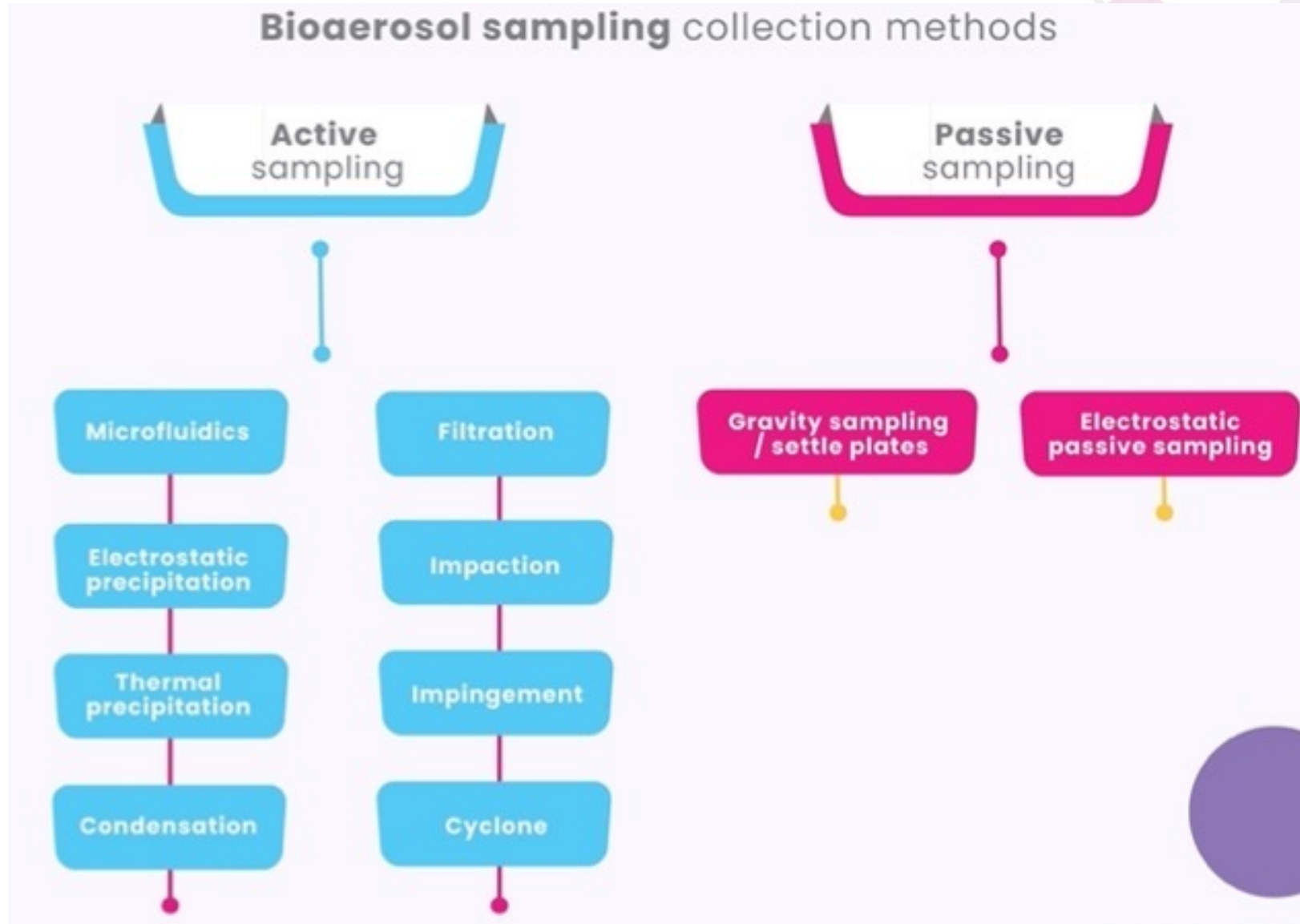Which **downstream analysis method?**

Real-time data?

High sample throughput?

Health outcome endpoint?

What is the aim of monitoring?

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FUNCTIONAL MICROBIOMES

Local   Regional   Continental

Bacteria   Fungi   Protists   Others   Positive co-occurrence   Negative co-occurrence
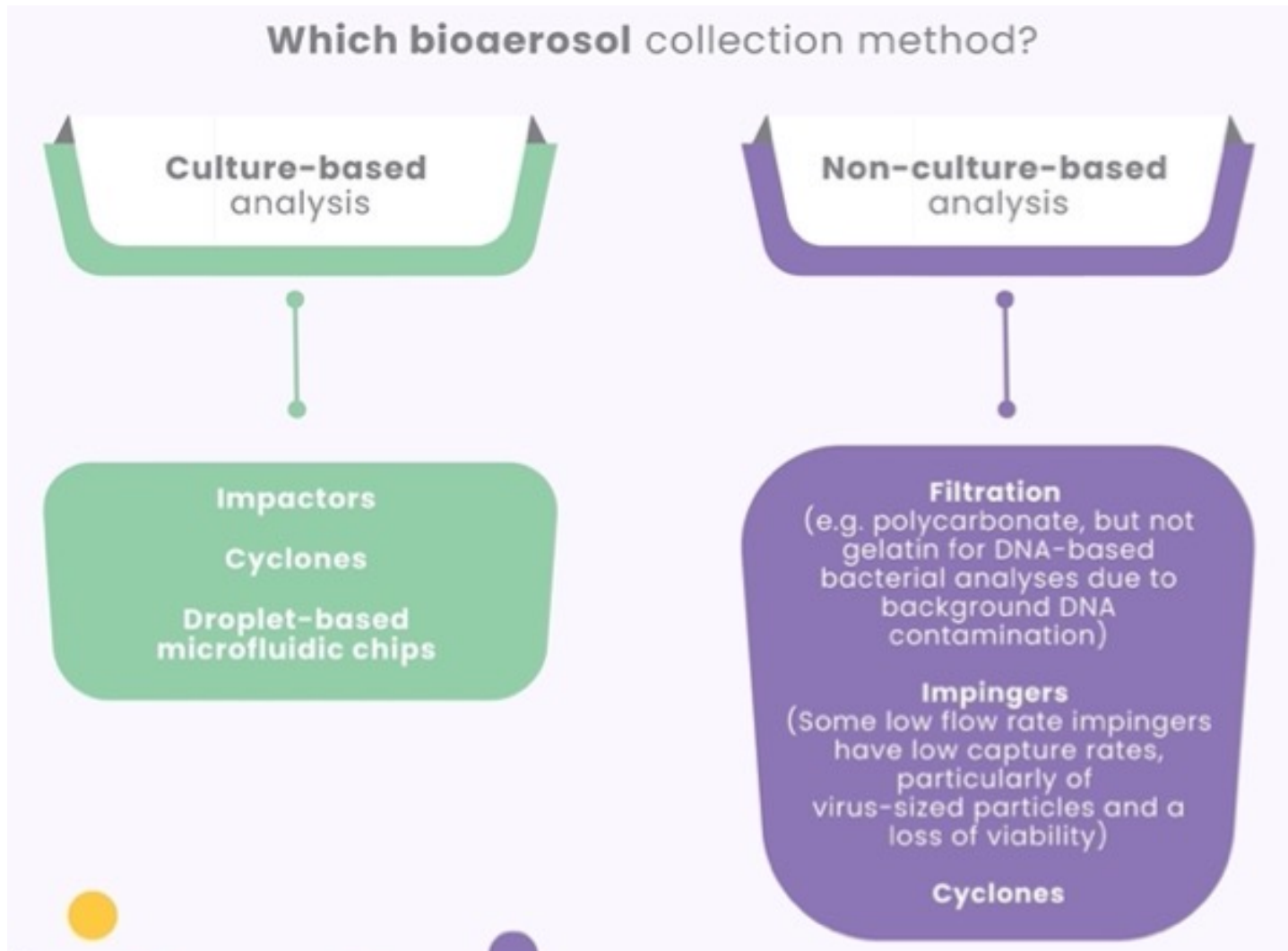
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DAVID A. BOHAN
ALEX DUMBRELL

Whitby C, et al (2022). **Compendium of analytical methods for sampling, characterization and quantification of bioaerosols.** In D. A. Bohan, & A. Dumbrell (Eds.) (Adv in Ecologl Res; Vol. 67, 101-229). Acad Press Inc.

Examples of sampling methods

Bioaerosol sampling collection methods

Active sampling
- Microfluidics
- Electrostatic precipitation
- Thermal precipitation
- Condensation
- Filtration
- Impaction
- Impingement
- Cyclone

Passive sampling
- Gravity sampling / settle plates
- Electrostatic passive sampling

Which bioaerosol collection method?

Culture-based analysis
- Impactors
- Cyclones
- Droplet-based microfluidic chips

Non-culture-based analysis
- Filtration (e.g. polycarbonate, but not gelatin for DNA-based bacterial analyses due to background DNA contamination)
- Impingers (Some low flow rate impingers have low capture rates, particularly of virus-sized particles and a loss of viability)
- Cyclones

Which sampling method is best for which biological particle?

There is currently **no standardised method** for characterizing and quantifying Bioaerosols.

Molecular tools (e.g. High Throughput Sequencing), have advanced bioaerosol research, but there is still much debate surrounding which downstream analysis methods to use.
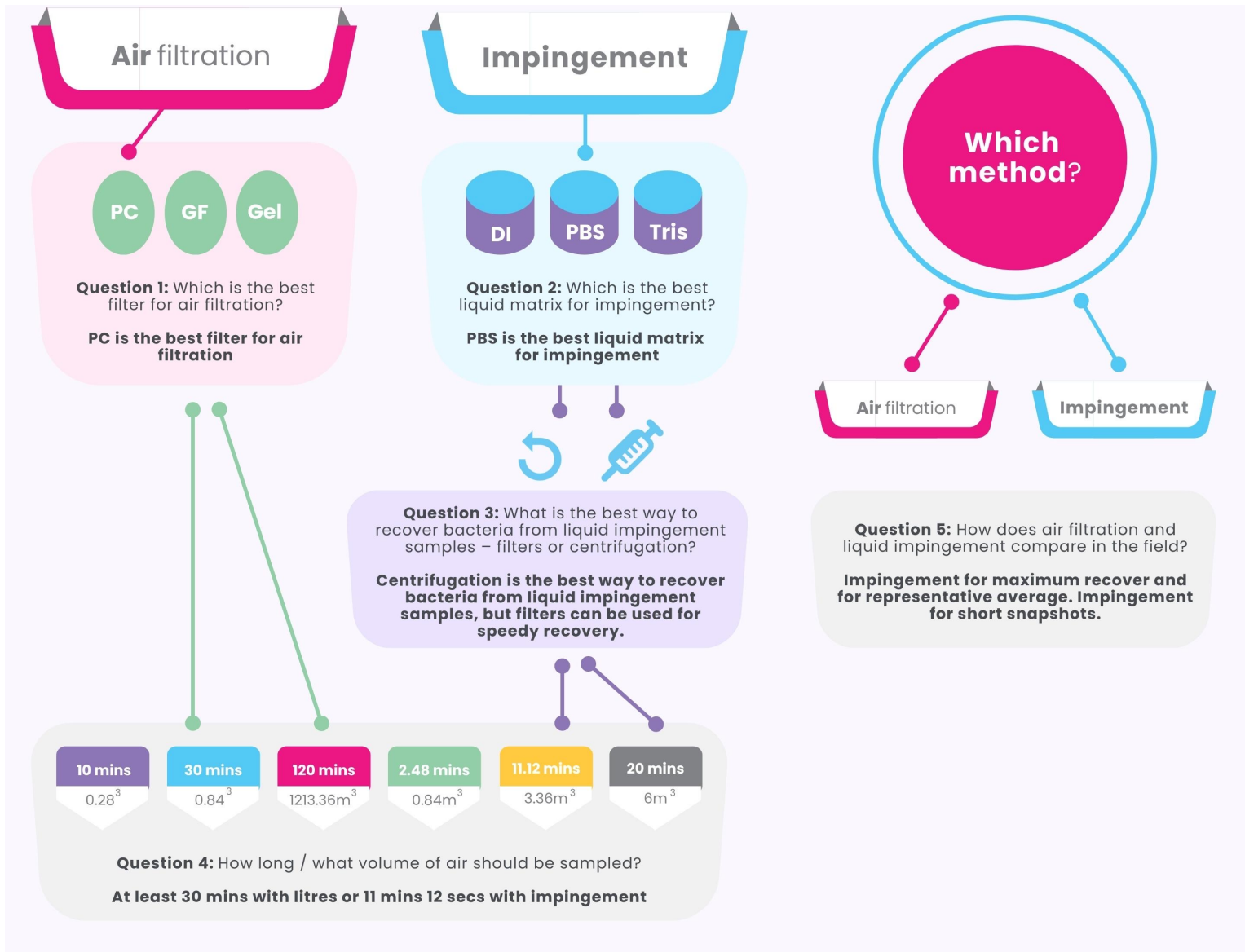
Comprehensive methods to detect, characterize and quantify airborne microorganisms are urgently needed.

BiAirNet is exploring **bespoke approaches** for specific environments to address these issues going forward.
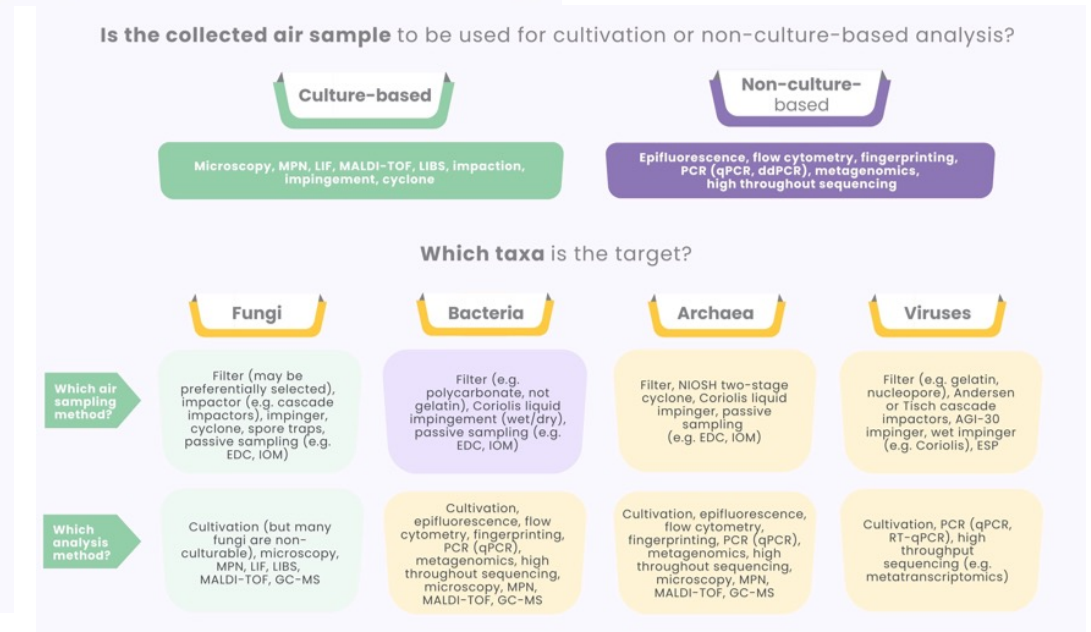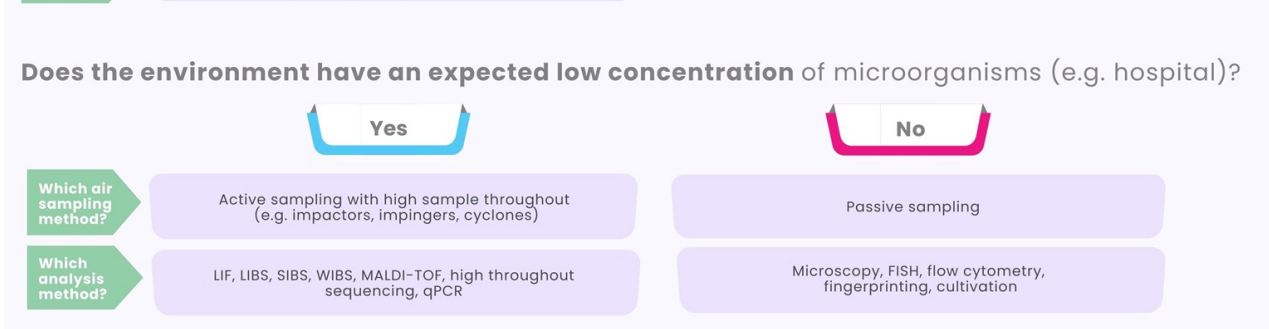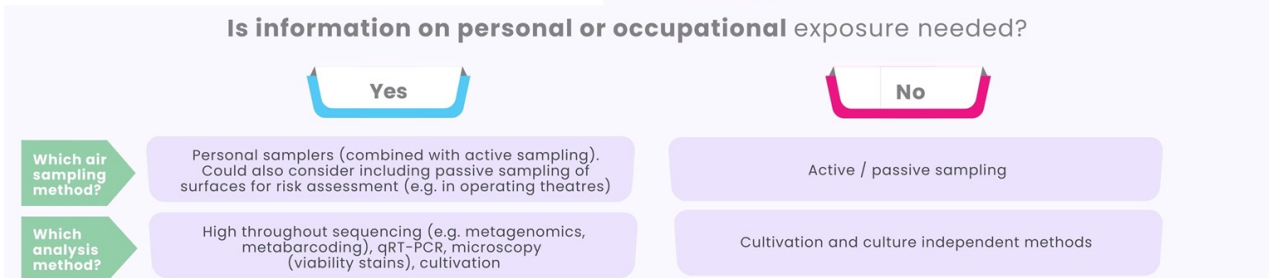
Which analysis method?
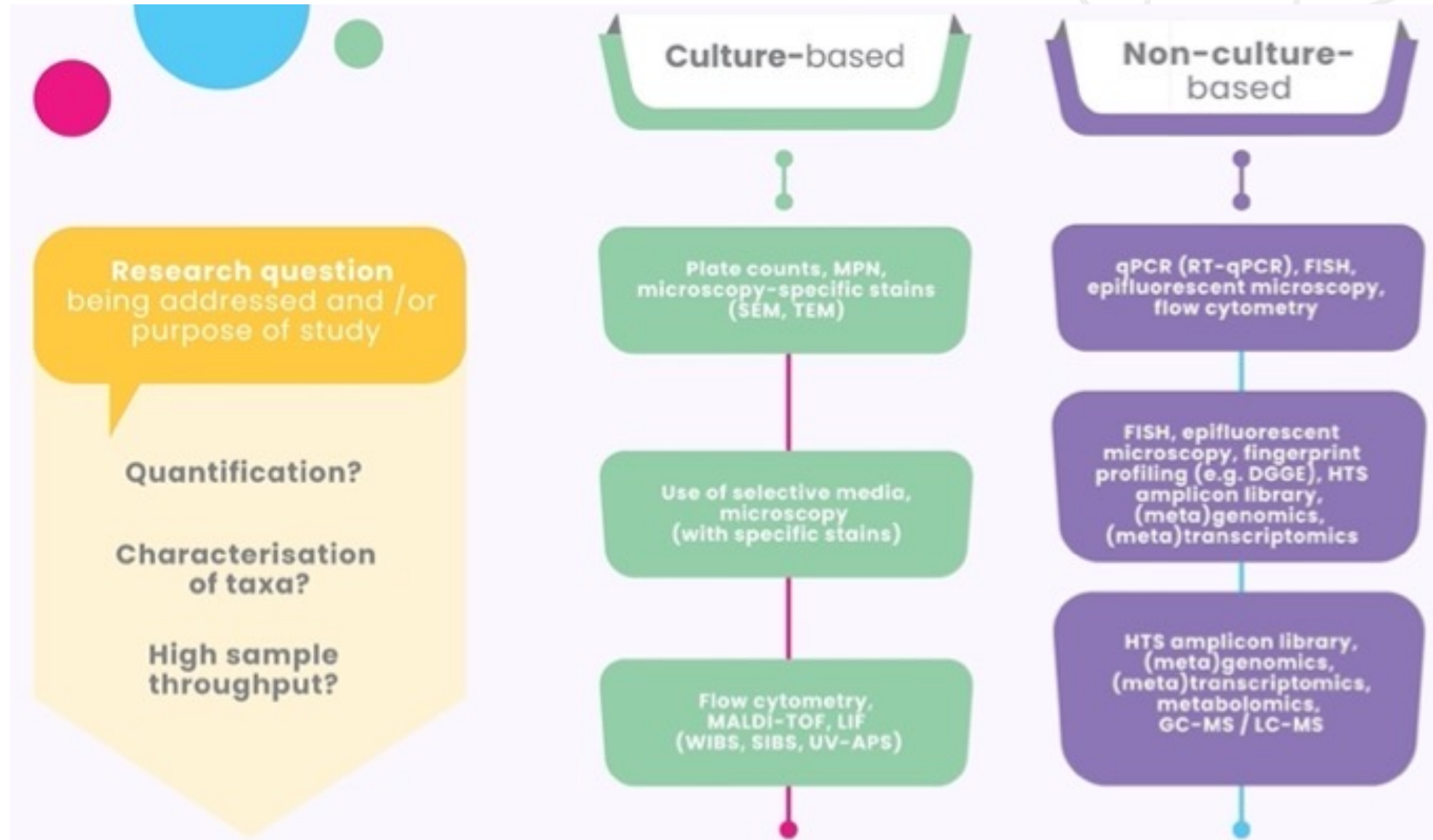
Which analysis method?

We have published a set of guidelines for different environmental scenarios.

Ferguson RMW, Garcia-Alcega S, Coulon F, Dumbrell AJ, Whitby C, Colbeck I (2019). Bioaerosol Biomonitoring: Sampling Optimisation for Molecular Microbial Ecology. Mol Ecol Res 19:672-690.

Decision framework

Decision framework summary

- **Sampling optimisation is required-** depends on the environment, regulatory context and Qs being addressed.

- Choice of **sampling method should consider analysis method** and **sample integrity**.

- Combining culture and culture-independent methods (including the microbial components as well as the microorganism itself provides a fuller image.

- More **long-term data is needed** using real-time methods.

BioAirNet Resources: Open Access Government Briefing Document

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Rapid measurement tools or fast identification of bioaerosols

Download Article (PDF)

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Why is rapid measurement tools or fast identification of bioaerosols important and, what are the challenges and opportunities?

Bioaerosols are complex mixtures of airborne particles of biological origin (BioPM), which vary in size (~0.05-100 µm) and composition (viruses, bacteria, fungi/mould, pollen, cell fragments, and endotoxins). Many bioaerosols are of inhalable size (< 100 µm), but those < 10 µm are respirable and

https://www.openaccessgovernment.org/article/rapid-measurement-tools-fast-identification-bioaerosols/153686/