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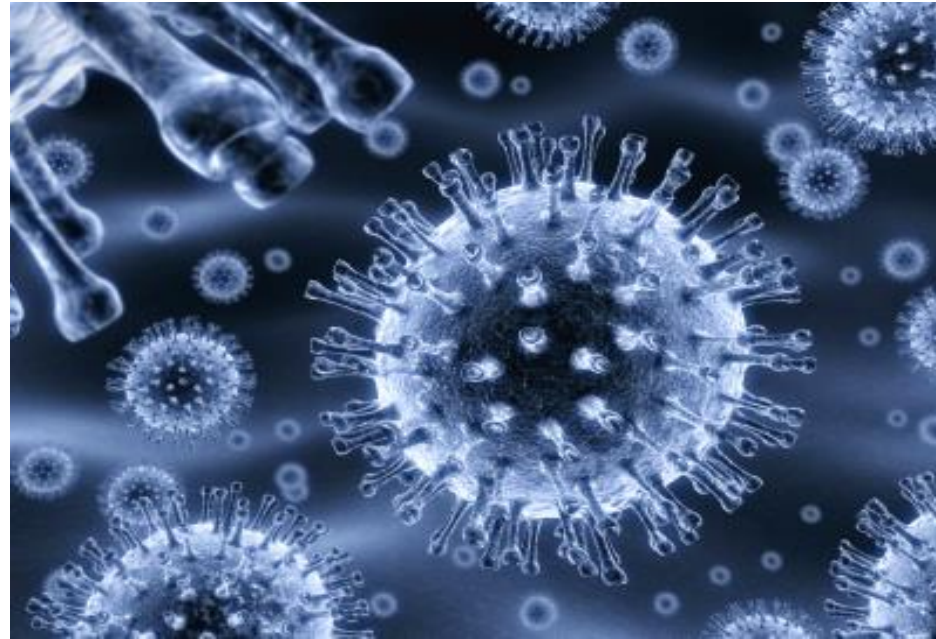


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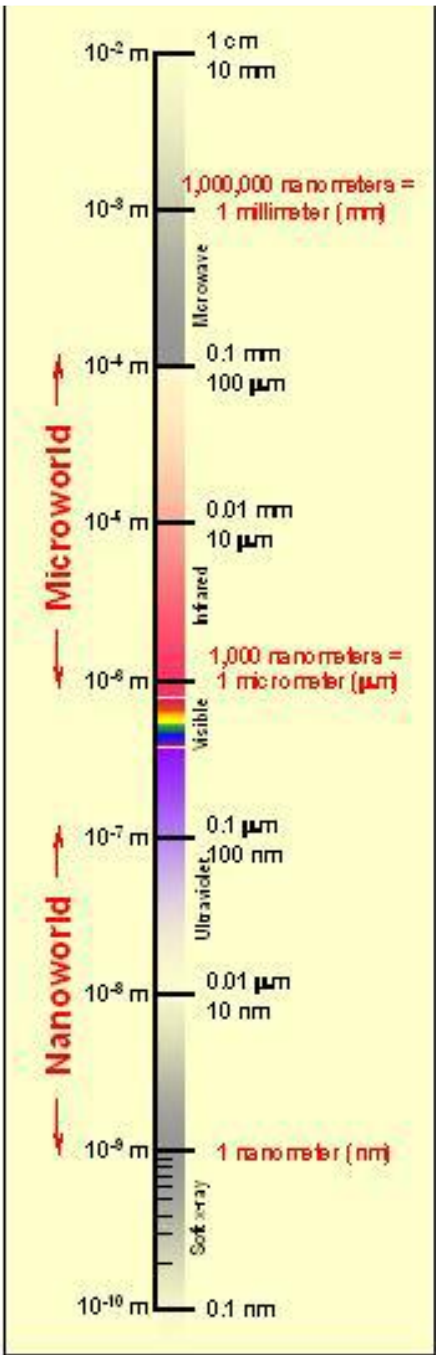
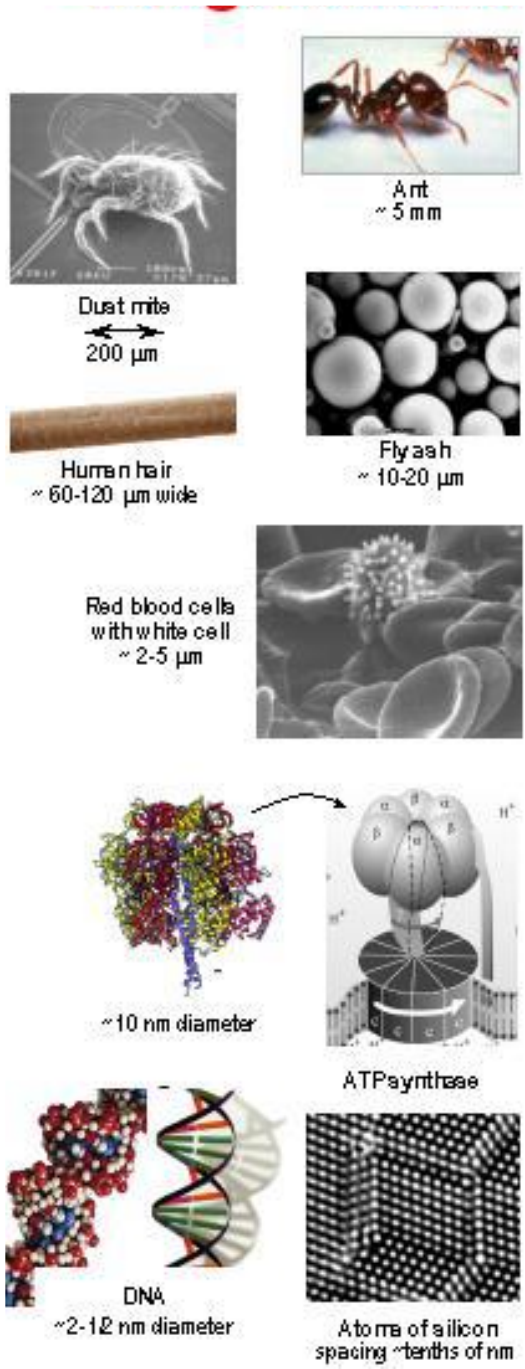
# Nanoparticles and health

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# Content

- Particle sizes
- How particles enter the body
- What might affect their toxicity?
- Likely health effects
- Investigating health effects of micro and nanoplastics



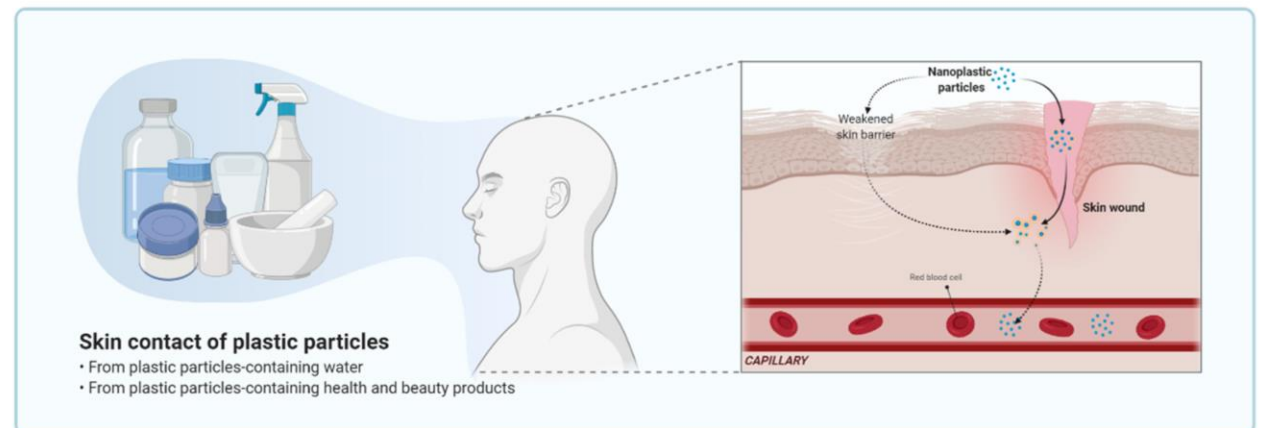
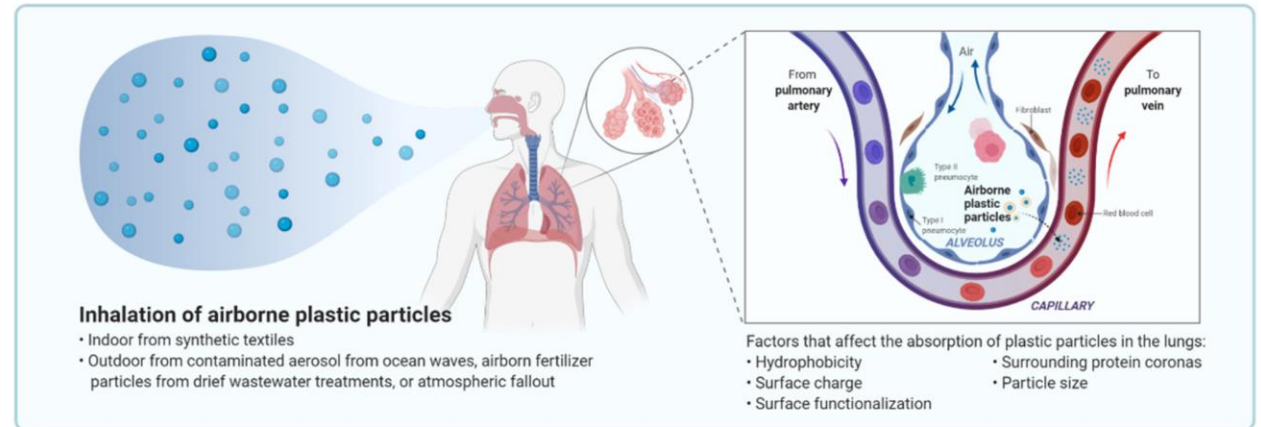
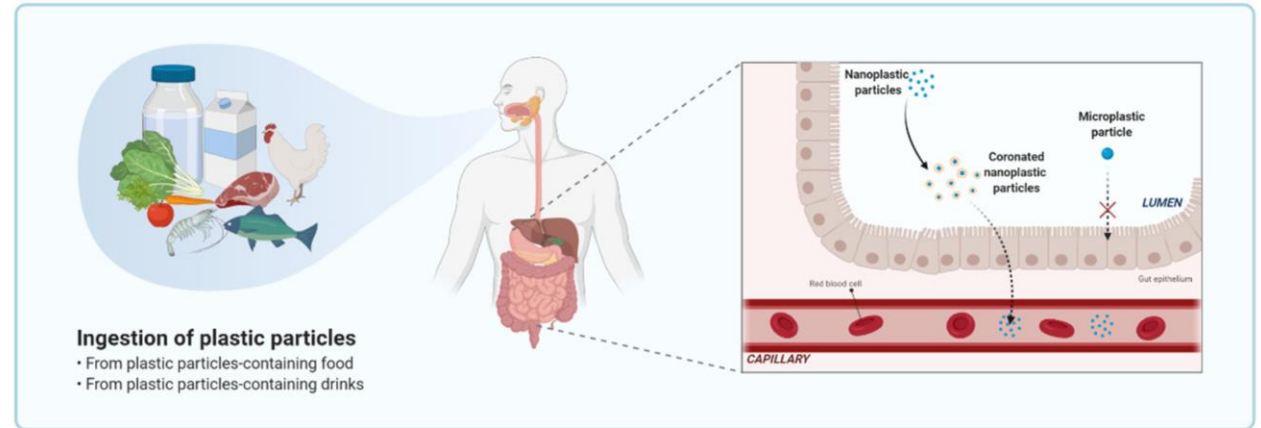
# Relative scale of micro- & nanosized objects

After Figure 1  
US EPA Nanotechnology White Paper (2007)

# Routes into the body

Ingestion  
Inhalation  
Skin

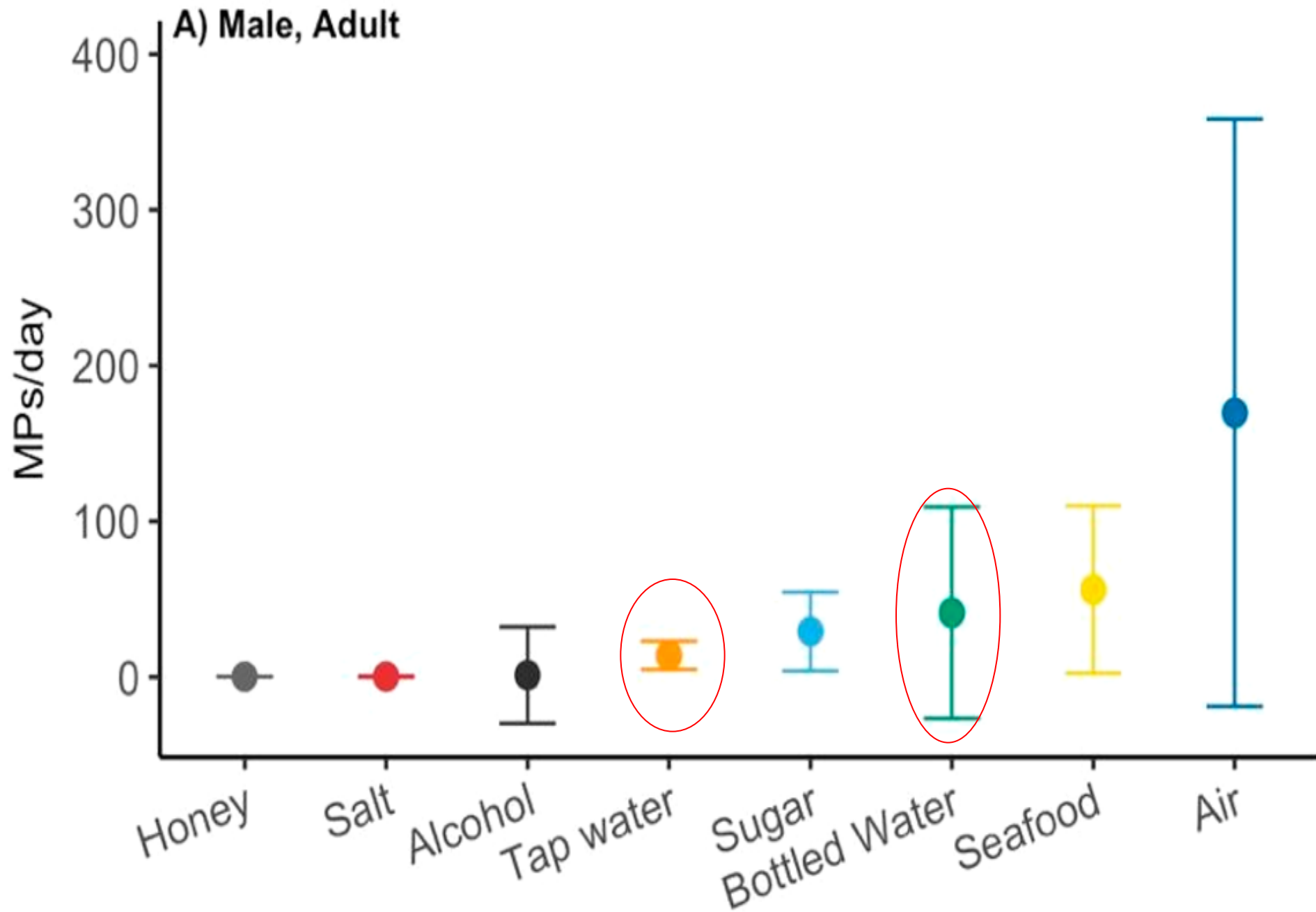
Transport in body helped by corona lipid/protein from interaction with biological fluids



Ye et al (2021)

# How much exposure?

- Micro- and nanoplastic particles has been found in:
  - honey, beer, salt, sugar, fish, shrimps, bivalves, tap, bottled & spring waters
- Human ingestion from:
  - contaminated organisms (mainly aquatic), atmospheric fallout during food and beverage production/consumption, and plastic packaging release
- Consume 39,000 to 52,000 microplastic particles per year
  - tap water 4000, bottled water 90,000
- Inhalation 35,000 to 62,000 particles per year Cox, K.D et al (2019)



after Cox, K.D et al (2019)

## Being nanosize allows:

- Inhalation, skin and gastrointestinal absorption;
- Uptake into cells including entry to the cell nucleus;
- Distribution via blood and lymph circulation can reach sensitive organs e.g. liver;
- Brain entry via nasal nerves (polio virus) can bypass the blood brain barrier;
- Recognition and processing by the immune system



## Health effects of particulate may relate to:

- Amount of exposure (dose entering the body)
  - Measurement standardisation needed esp for NPs
- Size of particles and destination in body
- Chemistry e.g. cadmium pigments, phthalates, Bisphenol A
  - PU, PVC, PS, epoxies likely more toxic than PE, PVA, PP
- Shape and bio-persistence e.g. surface area and fibres
- Charge
- Adsorbed material
- Genetic characteristics e.g. IBS, asthma
- Unknowns

# Health effects of nanoparticles

Laboratory studies, Animal studies, Human studies: lots we don't know

- Changes to gene expression, DNA damage
- Damage membranes, mitochondria
- Reactive oxygen species generation
- Inflammation and immune suppression
- Apoptosis
  
- CNTs: Lung pathologies e.g. inflammatory changes, granuloma formation and fibrosis.
- Carcinogenicity
  
- Cardiovascular system development and function
- Hepatic and renal systems
- Reproductive and developmental
- Nervous and endocrine systems
- Immune system

(Winiarska E 2024, Yee, M., et al 2021, Marfalla et al 2024)

# Monash Study of health effects of nanoparticles

- Measured nanoparticle exposure of researchers handling range of NPs:
  - very low NP levels against a background of nanoparticles in office and external air
- Measured biological changes over the day and the week.
- Exposure was insufficient to trigger measurable changes in spirometry, FeNO measurements, haemoglobin, platelet or blood cell counts.

However

- Increased cytokines sCD40, sCD62P, and sTNFR2 and CRP across a day
- Cytokines increases were significant over the week for those who handled nanoparticles compared to those who did not.
- Atopic participants showed increased in cytokines over the week

# How do we investigate the health effects

- *In vitro*
- Animal toxicology
- Mechanistic studies in humans
- Epidemiology
  
- Human studies need comparison groups preferably unexposed
  - is that possible?
- Perhaps higher exposed vs lower exposed
  - Plastic waste handlers?

# Selected References

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