Please refer to the following paper abstract for question 1-4

Face masks as a source of nanoplastics and microplastics in the environment: Quantification, characterization, and potential for bioaccumulation

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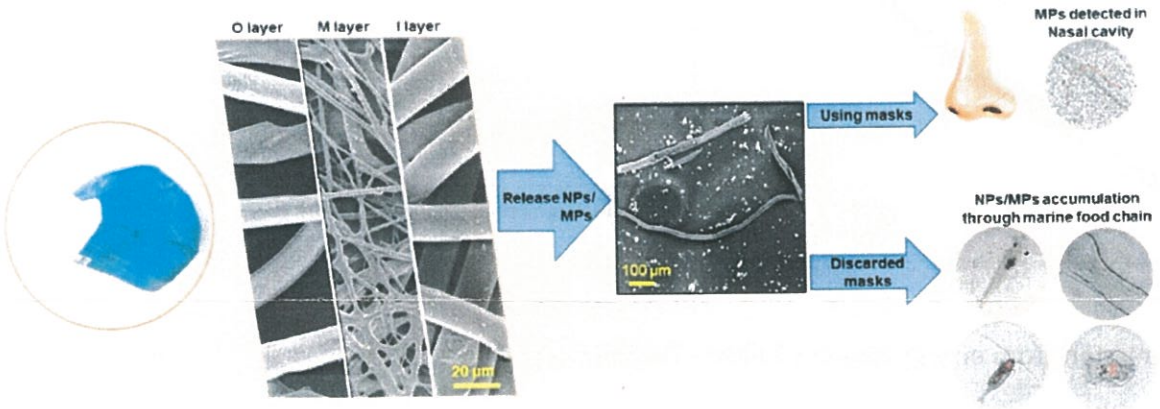
Billions of disposable face masks are consumed daily due to the COVID-19 pandemic. The role of these masks as a source of nanoplastics (NPs) and microplastics (MPs) in the environment has not been studied in previous studies. We quantified and characterized face mask released particles and evaluated their potential for accu-mulation in humans and marine organisms. More than one billion of NPs and MPs were released from each surgical or N95 face mask. These irregularly-shaped particles sized from c. 5 nm to c. 600 μm. But most of them were nano scale sized <1 μm. The middle layers of the masks had released more particles than the outer and inner layers. That MPs were detected in the nasal mucus of mask wearers suggests they can be inhaled while wearing a mask. Mask released particles also adsorbed onto diatom surfaces and were ingested by marine organisms of different trophic levels. This data is useful for assessing the health and environmental risks of face masks.



https://doi.org/10.1016/j.envpol.2021.117748

1.(10%) Which statement is incorrect?

a. Microplastics are typically defined as particles with a diameter less than 5mm.
b. Nanoplastics are smaller than microplastics.
c. Results from this paper indicate that outer layer of the face masks had released more particles than that of the middle layer.
d. Microplastics from face masks can be inhaled by us and bioaccumulated in the marine organisms.
e. N95 face mask can be a source of nanoplastics.

2.(10%) Microplastics are

a. Organic chemicals
b. Inorganic chemicals
c. Microorganisms
d. Nutrients
e. Radioactive substances

3.(10%) Nanoplastics/Microplastics are found to be adsorbed onto diatom surfaces, ingested by marine organisms and accumulate through marine food chain. Please explain what is **bioaccumulation** and **biomagnification**, and provide one example of environmental pollutant that undergoes this mechanism. For example, DDT.

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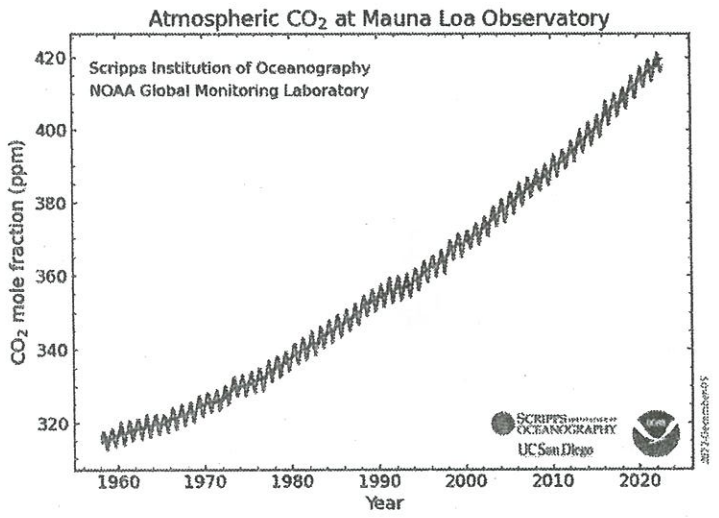
4.(20%) Tons of face masks are being used and disposed daily, and the microplastics/ nanoplastics released have further contaminant our aqueous environments. In your opinion (as a scientist/engineer), what can we do to mitigate this pollution situation other than using less masks? Be as specific as you can. Provide your explanation/reasoning/logic **based on science** and state the assumptions you make.

Please refer to the following descriptions for question 5-8

The monthly average CO_2 concentration in the atmosphere from 1958-2022 measured by NOAA at Mauna Loa Observatory is shown in the figure below.



https://gml.noaa.gov/ccgg/trends/

It is known that anthropogenic carbon emission from energy sources follows the Kaya identity:

$$\text{Carbon emission rate (GtC/yr)} = (\text{population}) \times \left(\frac{\text{GDP}}{\text{Person}}\right) \times \left(\frac{\text{Energy}}{\text{GDP}}\right) \times \left(\frac{\text{Carbon}}{\text{Energy}}\right)$$

It is also known that the relationship between global mean surface temperature change (ΔT_e, °C) and the concentration of CO_2 is:

$$\Delta T_e = \frac{3}{\ln 2} \ln\left[\frac{(CO_2)}{(CO_2)_0}\right]$$

Consider the following: (1) population grows at 1.3% annually, (2) GDP per person grows at 1.2% annually, (3) energy required per dollar of GPD decreases at the same exponential rate as it did between 1995 and 2005. In 1995, (energy/GPD) =13000 Btu/$; In 2005, (energy/GPD)= 11500 Btu/$. (4) Carbon intensity (carbon/energy) decreases at 0.22% annually, (5) the total carbon emission in 2005 was 8.7 GtC/yr and (6) the airborne fraction of anthropogenic carbon emission remains constant and is equal to 38%

5. (10%) Explain how greenhouse gases can serve as a thermal blanket to raise the global average temperature.

6. (10%) What is the cause of oscillations in CO_2 concentration within each year shown in the figure?

7. (10%) Use 2005 as the starting point. If the rates of changes in population, GDP per person, energy required per dollar of GPD and carbon intensity remains constantly, what would be the carbon emission rate in 2030?

8. (20%) The global average temperature in 2005 is 14.4°C and 1 GtC in the atmosphere can contribute to 0.472 ppm CO_2. What would be the projected temperature in 2030 due to the accumulated anthropogenic CO_2 emission?

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