Project Notes:

Project Title: The Effect of Microplastic Type on the Heart Rate of filial Generation *D. magna*

Name: Darawcheh, Donya

Knowledge Gaps:

This list provides a brief overview of the major knowledge gaps for this project, how they were resolved and where to find the information.

Knowledge Gap	Resolved By	Information is located	Date resolved
What is a mass spectrometer and how is it used?	November 1, 2025	Cospheric fluorescent beads (decided to use UV instead)	November 30, 2025
How can second generation daphnia be isolated?	November 1, 2025	Professional Email 1	October 9, 2025
What are the most common microplastics?	November 1, 2025	Article 7, identified by ****___****	October 9, 2025
How do microplastics interact with the body?	November 1, 2025	Throughout project notes	October 9, 2025
What is an easier way to calculate daphnia's heart rate?	November 1, 2025	Informal Meet for B Term, Professional email 3	October 27, 2025
What are copepods?	December 20, 2025	Article 15	December 18, 2025
Can copepods kill *D. magna*?	December 20, 2025	Article 16-17	December 18, 2025
How do I safely dispose of MPs once I am done using them?	December 1, 2025	MSEF forms, WPI disposal of hazardous waste guidelines, Dr C meeting notes	November 30, 2025

Literature Search Parameters:

These searches were performed between 8/26/2025 and 12/19/2025.
List of keywords and databases used during this project.

Database/search engine	Keywords	Summary of search
WPI Gordon Library Database	Planaria regeneration microplastics	Mostly peer reviewed search articles about how microplastics disrupted regeneration and altered behavior of planaria.
WPI Gordon Library Database	Daphnia heart rate microplastics	Peer reviewed articles about toxicity of microplastics to daphnia, different sources of microplastics, how they affect the aquatic food chain, how global warming plays an effect, and then how other organisms are affected by microplastics.
WPI Gordon Library Database	Daphnia second generation	Mostly nothing of value for this project. Mainly talked about the second generation of the independent variables, the second-generation genetic makeup of daphnia, or daphnia reproduction.
WPI Gordon Library Database	Daphnia offspring	Peer reviewed journal articles that either talk about testing an Independant Variable on daphnia to test offspring fitness/effects on offspring or the overall ecological behaviors of how offspring are affected from stressors.
WPI Gordon Library Database	Microplastic heart rate	Gave a lot of microplastics results, but not specific to heart rate.
WPI Gordon Library Database	Microplastics Cardiovascular	Gave a lot of results that discuss microplastics and nanoplastics with how they contribute to cardiovascular risk.

Google Scholar	Ethanol on Daphnia Heart Rate	A lot of studies where they had ethanol as part of a broader test, whether that be adding it to another mixture or having it as part of other heart rate changers (like caffeine).
WPI Gordon Library	daphnia heart rate changes on other functions in daphnia magna	Studies looking at the mortality, heart rate, and gene response of daphnia due to various independent variables. Unfortunately, was not too helpful.
WPI Gordon Library	Daphnia egg predation	The top two studies are ideal, the rest talk about predation of organisms or hatching eggs in Daphnia

Tags:

Tag Name	
#Tables	#Discussion
#Conclusions	#Results
#Arteries	#Difficulties
#6	#2
#2.1	#2.2
#3.2	#3.3
#Methods	#Introduction
#Abstract	#Contamination

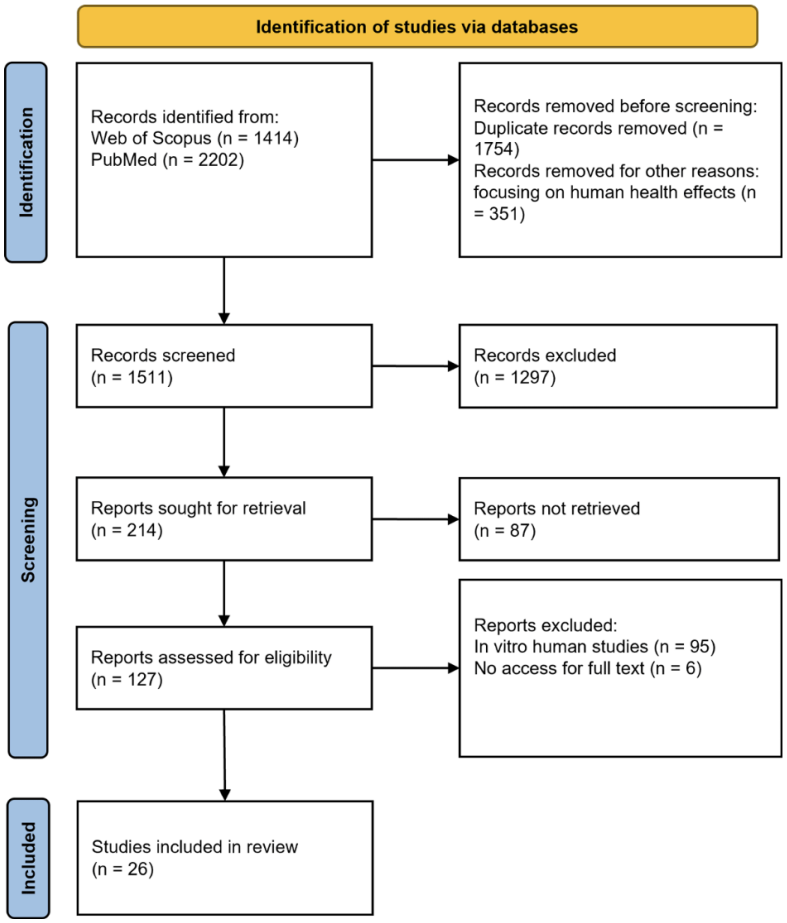
#Health	#Figure
#3	

Article #1 Notes: “Detection of microplastics in human tissues and organs: A scoping review”

Source Title	Detection of microplastics in human tissues and organs: A scoping review
Source citation (APA Format)	Roslan, N. S., Lee, Y. Y., Ibrahim, Y. S., Tuan Anuar, S., Yusof, K. M., Lai, L. A., & Brentnall, T. (2024). Detection of microplastics in human tissues and organs: A scoping review. *Journal of Global Health*, *14*. https://doi.org/10.7189/jogh.14.04179
Original URL	https://jogh.org/2024/jogh-14-04179
Source type	Journal Article
Keywords	N/A
#Tags	#Tables, #Discussion, #Conclusions
Summary of key points + notes (include methodology)	Research on microplastics is mainly focused on the environment and aquatic life, however, there is a gap in knowledge for microplastic interactions with humans, which is what the article aims to answer. They compiled 26 research journals (originally found 3616, but used predetermined criteria to reduce the number down to 223 and finally to 26), all of which looked at the effects of microplastics on different organ tissues and human samples (urine, semen, stool, breastmilk, etc); along with size, shape, color, and type of the microplastics. Overall, microplastics were found in 8/12 systems in the body, each organ and system having distinct microplastic particle characteristics, as well has inhalation and eating/drinking being identified as two different ways for microplastics to enter the body, however more research needs to be done on the long term health risks of microplastics on the human body, along with strict regulations to prevent airborne microplastic contamination.
Research Question/Problem/ Need	How do microplastics enter and interact with the human body, specifically in tissues and organs?

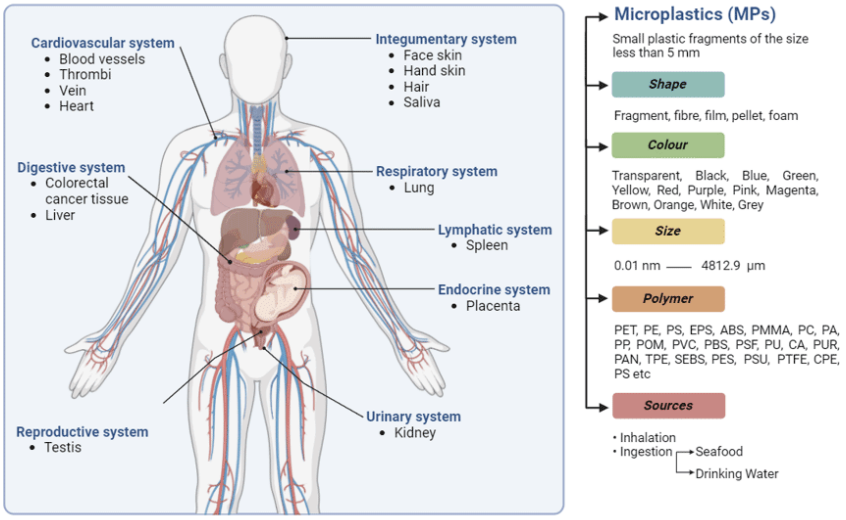
Important Figures

Figure 1. Literature screening flow.



This figure depicts how the article went through their method to select their studies.

Figure 2. Summary of presence of microplastics in human body systems including their characteristics and possible pathway of microplastics into the body. Schematic representations were generated by BioRender.com. ABS – Acrylonitrile Butadiene Styrene, CA – Cellulose Acetate, CPE – Chlorinated Polyethylene, EPS – Expanded Polystyrene, mm – millimetre, PA – Polyamide, PAN – Polyacrylonitrile, PBS – Phosphate-buffered Saline, PES – Polyethersulfone, PE – Polyethylene, PET – Polyethylene Terephthalate, PC – Polycarbonate, PMMA – Polymethyl Methacrylate, POM – Polyoxymethylene, PP – Polypropylene, PS – Polystyrene, PSF/PSU – Polysulfone, PU/PUR – Polyurethane, PTFE – Polytetrafluoroethylene, PVC – Polyvinyl Chloride, TPE – Thermoplastic Elastomers, SEBS – Styrene-Ethylene-Butylene-Styrene, µm – micrometre.



This is the overall figure for where microplastics were found and what types were found.

Table 1. Abundance of microplastics in human organ systems

System	Organ	Sample Size	Abundance of microplastics	Size of Microplastics	Shape of Microplastics	Colour of microplastics	Polymer of Microplastics	References
Cardiovascular system	Blood vessels	22	1.6 ug/mL	>700 nm	NA	NA	PET, PE, PS, EPS, ABS, PMMA	[17]
	Thrombi	26	87 particles	2.1–26.0 µm	Block shaped	Yellow, green, red	LDPE, Pigment, Chromium Oxide, Phthalocyanine	[18]
	Vein	5	20 particles or 14.99 ± 17.18 microplastic/g of tissue	16–1074 µm	Fragment, fibre	NA	Alkyd Resin, Poly(vinyl propionate), Nylon-ethylene-vinyl acetate, nylon-EVA, tie layer	[19]
	Heart	15	NA	20–500 µm	NA	NA	PET, PVC, PMMA	[20]
Digestive system	Colorectal cancer tissue	11	331 Microplastics per individual or 28.1–15.4 particles/g tissue	0.8–1.6 mm	Fibre	Transparent, black, red, green, blue, brown, purple, and yellow	PC, PA, PP	[21]
	Liver	11	0–13 particles per sample or 3.2 particles/g tissue	4–30 µm	Fragment, microbead	NA	PS, PVC, PET, PMMA, POM, PP	[22]
Endocrine system	Placenta	NA	12 particles	>5 µm	Fragment	Blue, purple, pink, orange, red	PP	[23]
	Placenta		NA	>50 µm	NA		PE, PP, PU	[24]
	Placenta	17	149 microplastics particles	20.34–307.24 µm	Fragment, fibre, film, subspherical particle	NA	PVC, PP, PBS, PET, PC, PS, PA, PE, PSF	[25]
	Placenta	18	NA	20–500 µm	NA	NA	PU, PA, PE, PET, PC	[26]

Integumentary system	Face skin	2000	4265 microplastics particles	100–500 μm	Spheres fragment, film, fibre	Blue, red, yellow, transparent, black	PE, PET, PS, PVC	[27]
	Hand skin	2000	4051 microplastics particles	100–500 μm	Sphere, fragment, film, fibre	Blue, red, yellow, transparent, black	PE, PET, PS, PVC	[27]
	Hair	2000	7462 microplastics particles	100–500 μm	Sphere, fragment, film, fibre	Blue, red, yellow, transparent, black	PE, PET, PS, PVC	[27]
	Saliva	2000	645 microplastics particles	100–500 μm	Sphere, fragment, film, fibre	Blue, red, yellow, transparent, black	PE, PET, PS, PVC	[27]
Lymphatic system	Spleen	3	4 particles per sample or 1.1 particles/g tissue	5–25 μm	Fragment, Microbead	NA	PS, PVC, PET, PMMA, POM, PP	[22]
Respiratory system	Lung tissues	20	31 particles	1.6–16.8 μm	Fragment, fibre	Transparent, white, blue, grey, yellow, brown, orange	PP, PE, Cotton, PVC, CA, PA, PS, PU	[28]
	Lung granule nodules	100	65 particles	>20 μm	Fibre	Purple, blue, transparent, yellow, red	Cotton, PA, Polyester, Denim, Phenoxy resin,	[29]
	Lung tissue	13	39 particles	12–2475 μm	Fibre, fragment, film	NA	PP, PET, Resin, PE, PTFE, PS, PAN, PES, PMMA, PUR, SEBS, TPE	[30]
Reproductive system	Testis	6	31 particles in 4 of 6 testis samples	20–100 μm	Fragment, fibre, film, subspherical	NA	PS, PVC, PE, PP	[31]
Urinary system	Kidney	3	0 particle per sample	10–20 μm	NA	NA	NA	[22]

This is the table for the systems found with microplastics, the organs, sample size, and the specifications of what microplastics were found.

VOCAB: (w/definition)

Meconium: Dark green stool composed of cells, protein, fat, and bile that is passed by a newborn during the first few hours and days after birth.
Thrombi: Blood clots found in veins or arteries.
Sputum: A combination of saliva and mucus coughed up as a result from infection or disease.
Microbiota: Range of microorganisms found in/on plants or animals.
BPA: Compound commonly used in the production of some plastics.

Cited references to follow up on

- L Zhu, J Zhu, R Zuo, Q Xu, Y Qian, and AN Lihui. Identification of microplastics in human placenta using laser direct infrared spectroscopy. Sci Total Environ. 2023;856:159060. DOI: 10.1016/j.scitotenv.2022.159060. [PMID:36174702]
- T Braun, L Ehrlich, W Henrich, S Koppel, I Lomako, and P Schwabl. Detection of microplastic in human placenta and meconium in a clinical setting. Pharmaceutics. 2021;13:921 DOI: 10.3390/pharmaceutics13070921. [PMID:34206212]
- Y Yang, E Xie, Z Du, Z Peng, Z Han, and L Li. Detection of Various

	Microplastics in Patients Undergoing Cardiac Surgery. Environ Sci Technol. 2023;57:10911-8. DOI: 10.1021/acs.est.2c07179. [PMID:37440474] - J Duan, N Bolan, Y Li, S Ding, T Atugoda, and M Vithanage. Weathering of microplastics and interaction with other coexisting constituents in terrestrial and aquatic environments. Water Res. 2021;196:117011. DOI: 10.1016/j.watres.2021.117011. [PMID:33743325] - K Yin, Y Wang, H Zhao, D Wang, M Guo, and M Mu. A comparative review of microplastics and nanoplastics: Toxicity hazards on digestive, reproductive and nervous system. Sci Total Environ. 2021;774:145758. DOI: 10.1016/j.scitotenv.2021.145758 - H Çobanoğlu, M Belivermiş, E Sıkdokur, and Ö Kiliç. C Çayır A. Genotoxic and cytotoxic effects of polyethylene microplastics on human peripheral blood lymphocytes. Chemosphere. 2021;272:129805. DOI: 10.1016/j.chemosphere.2021.129805. [PMID:35534956] - NP Mortensen, LM Johnson, KD Grieger, JL Ambroso, and TR Fennell. Biological interactions between nanomaterials and placental development and function following oral exposure. Reprod Toxicol. 2019;90:150-65. DOI: 10.1016/j.reprotox.2019.08.016. [PMID:31476381] - W Xu, Y Yuan, Y Tian, C Cheng, Y Chen, and L Zeng. Oral exposure to polystyrene nanoplastics reduced male fertility and even caused male infertility by inducing testicular and sperm toxicities in mice. J Hazard Mater. 2023;454:131470. DOI: 10.1016/j.jhazmat.2023.131470. [PMID:37116333] - W Shengchen, L Jing, Y Yujie, W Yue, and X Shiwen. Polystyrene microplastics-induced ROS overproduction disrupts the skeletal muscle regeneration by converting myoblasts into adipocytes. J Hazard Mater. 2021;417:125962. DOI: 10.1016/j.jhazmat.2021.125962. [PMID:33979708]
Follow up Questions	• How do microplastics affect the second generation of originally afflicted people? • How do microplastics cause behavioral issues? Do they somehow interact with the brain? Is it because of microplastics being found in the blood? • Can microplastics clog blood vessels if deposits of them build up? How do microplastics contribute to diabetes?

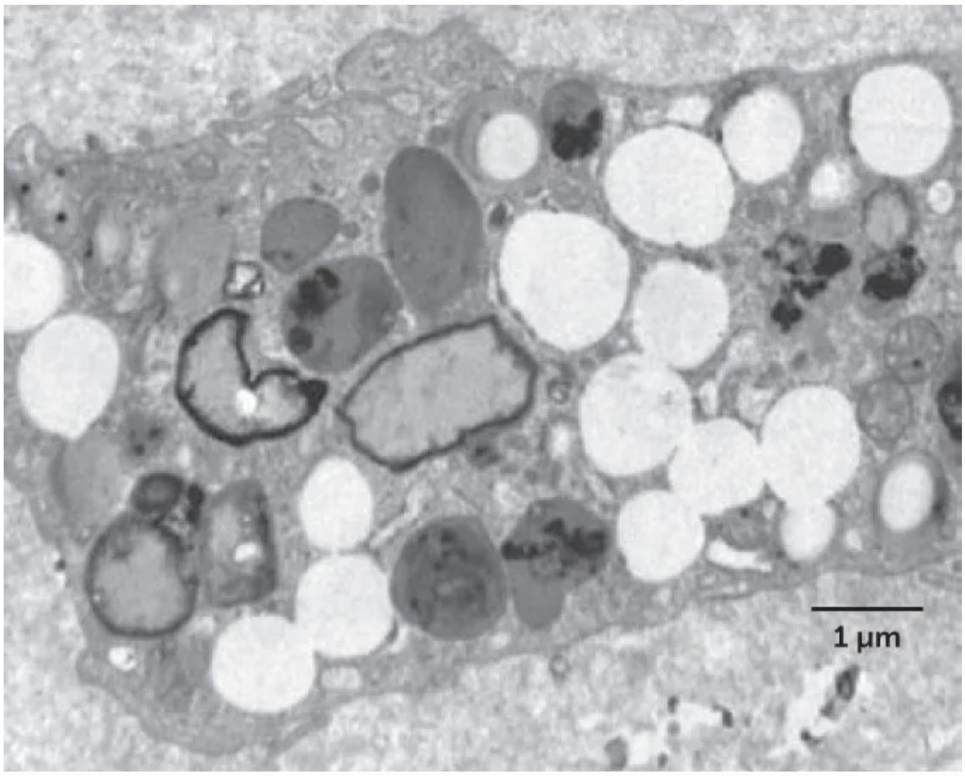
Article #2 Notes: "'Very concerning': Microplastics can accumulate in cancer cells and may help them spread, study hints"

Source Title	'Very concerning': Microplastics can accumulate in cancer cells and may help them spread, study hints
Source citation (APA Format)	Khedkar, S. (2024, March 21). 'Very concerning': Microplastics can accumulate in cancer cells and may help them spread, study hints. *Live Science*. https://www.livescience.com/health/cancer/very-concerning-microplastics-can-accumulate-in-cancer-cells-and-may-help-them-spread-study-hints
Original URL	https://www.livescience.com/health/cancer/very-concerning-microplastics-can-accumulate-in-cancer-cells-and-may-help-them-spread-study-hints
Source type	News Article
Keywords	N/A
#Tags	#Results
Summary of key points + notes (include methodology)	This article is a newsletter from LiveScience that talks about a study that was conducted that supports the idea that microplastics can accumulate in cells and contribute to cancer metastasizing. The article first started with background on how microplastics are introduced into the body and how smaller microplastics that are released from single use water bottles can penetrate cell membranes and cause buildup, which causes cellular stress. Then, the article goes into the study that was conducted between colorectal cancer cells and polystyrene, where the polystyrene microplastics were tracked in the cancer cells. The polystyrene was found to not only penetrate and accumulate in the cells at a smaller size mainly in the lysosome, but it was also found to divide between the cancer cells (found my using microscopy techniques). The cancer cells were also shown to be more active when exposed to the microplastics and have an easier time metastasizing. Finally, the article talks about further research and how different types and shapes of microplastics should be tested to resemble effects on the environment more. This article is important to my project because I was thinking, for one of my ideas, to do a project on the effect of different types of nanoplastics on the regeneration of planaria or heart rate of daphnia magna, so this article would suggest that the planaria should regenerate faster when exposed to nanoplastics as they do not degrade in cells and they stimulate cancer cell activity.

Research Question/Problem/ Need	How are microplastics involved with cancer and overall cell division?
Important Figures	N/A
VOCAB: (w/definition)	Lysosome – Organelle in the cytoplasm of eukaryotic cells containing degradative enzymes. Microscopy techniques – 3 different types, being optical microscopy, electron microscopy, and scanning probe microscopy. It allows for observation and analysis of small objects or materials. Metastasize – A cancer cell's ability to migrate and spread.
Cited references to follow up on	Brynzak-Schreiber, E., Schögl, E., Bapp, C., Cseh, K., Kopatz, V., Jakupec, M. A., Weber, A., Lange, T., Toca-Herrera, J. L., del Favero, G., Wadsak, W., Kenner, L., & Pichler, V. (2024). Microplastics role in cell migration and distribution during cancer cell division. Chemosphere (Oxford), 353, Article 141463. https://doi.org/10.1016/j.chemosphere.2024.141463
Follow up Questions	- Have there been any other tests done using different polymers? - What were the difficulties of the study? - Have there been any other tests using different microplastic types? - How do the microplastics affect healthy cells? - Do the microplastics have different effects on different cancer cells? - How do the microplastics affect the cells of different organisms?

Article #3 Notes: “A new study linked microplastics to heart attacks and strokes. Here’s what we know”

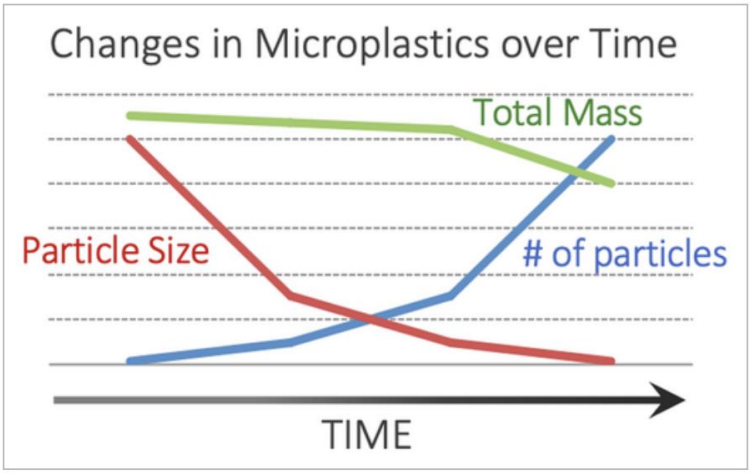
Source Title	“A new study has linked microplastics to heart attacks and strokes. Here’s what we know”
Source citation (APA Format)	Rosen, M. (2024, April 2). A new study has linked microplastics to heart attacks and strokes. Here’s what we know. *Science News*. https://www.sciencenews.org/article/microplastics-nanoplastics-heart-attacks-strokes-health
Original URL	https://www.sciencenews.org/article/microplastics-nanoplastics-heart-attacks-strokes-health
Source type	News Article
Keywords	N/A
#Tags	#Arteries, #Difficulties
Summary of key points + notes (include methodology)	This article was a science news article from ScienceDirect that talked about how microplastics could be linked to cardiovascular disease. First, the article discusses what microplastics and nanoplastics are, being smaller than 5 millimeters and how they can spread, being able to be carried in the wind or in the water. Then, the article goes into how microplastics can be absorbed into the skin or even inhaled into the body from breathing, and how it was found in plaque in arteries, in the brain, in testicular tissue, and in placenta. Next, the article talks about how plaque in the arteries was found containing PVC and polyethylene plastics, and how people with plaque containing microplastics seem to have a higher death rate than those who do not, as well as how the plaque with microplastics have many more inflammatory molecules than plaque that does not. Finally, the article discusses how microplastics can be hard to research, as they can be carried in through the air or on the researcher's glove, so keeping a controlled environment can be very hard. This article is useful to my research as I want to look at regenerative and heart related issues for microplastics, so this article shows evidence for how microplastics can lead to the clogging up of blood vessels and subsequent heart disease. However, if I cannot do more than one organism in my research project, then this article is helpful in giving backgrounds to how microplastics can spread, which microplastics could be most commonly found in the body,

	and how hard it is to maintain a controlled environment, therefore the importance of a lab and non-plastic equipment.
Research Question/Problem/ Need	How do microplastics affect cardiovascular health?
Important Figures	 Researchers found jagged-looking particles (irregular shapes with dark outlines above) in plaques cleared from some patients' arteries. These particles may be microscopic bits of plastic. R. MARFELLA *ET AL./NEW ENGLAND JOURNAL OF MEDICINE* 2024 This is the figure for what researchers found in the plaque. They are jagged and irregular and are dark outlined.
VOCAB: (w/definition)	Placenta – A temporary organ that develops during pregnancy to give oxygen and nutrients other the baby while removing waste products from the blood. Carotid Arteries – Blood vessels that give blood to the brain, face, and neck. Ubiquitous – Found everywhere. Inflammatory molecules – Occur when tissues are injured, causing blood vessels to leak fluid into tissues, causing swelling.
Cited references to follow up on	- Garcia, M. A., Liu, R., Nihart, A., El Hayek, E., Castillo, E., Barrozo, E. R., Suter, M. A., Bleske, B., Scott, J., Forsythe, K., Gonzalez-Estrella, J., Aagaard, K. M., & Campen, M. J. (2024). Quantitation and identification of microplastics

	accumulation in human placental specimens using pyrolysis gas chromatography mass spectrometry. Toxicological Sciences, 199(1), 81–88. https://doi.org/10.1093/toxsci/kfae021 - Marfella, R., Prattichizzo, F., Sardu, C., Fulgenzi, G., Graciotti, L., Spadoni, T., D'Onofrio, N., Scisciola, L., La Grotta, R., Frigé, C., Pellegrini, V., Municinò, M., Siniscalchi, M., Spinetti, F., Vigliotti, G., Vecchione, C., Carrizzo, A., Accarino, G., Squillante, A., … Paolisso, G. (2024). Microplastics and Nanoplastics in Atheromas and Cardiovascular Events. The New England Journal of Medicine, 390(10), 900–910. https://doi.org/10.1056/NEJMoa2309822 - Leslie, H. A., van Velzen, M. J. M., Brandsma, S. H., Vethaak, A. D., Garcia-Vallejo, J. J., & Lamoree, M. H. (2022). Discovery and quantification of plastic particle pollution in human blood. Environment International, 163, Article 107199. https://doi.org/10.1016/j.envint.2022.107199 - Cox, K. D., Covernton, G. A., Davies, H. L., Dower, J. F., Juanes, F., & Dudas, S. E. (2019). Human Consumption of Microplastics. Environmental Science & Technology, 53(12), 7068–7074. https://doi.org/10.1021/acs.est.9b01517
Follow up Questions	- Do the microplastics transfer/are still found in the arteries of children? - How much do microplastic amounts vary between different types of arteries? - How difficult was it to get a controlled lab as the one described in the article? How controlled does everything need to be?

Article #4 Notes: “A Global Perspective on Microplastics”

Source Title	A Global Perspective on Microplastics
Source citation (APA Format)	Hale, R. C., Seeley, M. E., La Guardia, M. J., Mai, L., & Zeng, E. Y. (2020). A Global Perspective on Microplastics. *Journal of Geophysical Research Oceans*, *125*(1). https://doi.org/10.1029/2018jc014719
Original URL	https://agupubs.onlinelibrary.wiley.com/doi/10.1029/2018JC014719
Source type	Research Article
Keywords	N/A
#Tags	#6, #Conclusions, #2
Summary of key points + notes (include methodology)	This article was a research article by JGR oceans about the products that yield microplastics, where they end up, the subsequent health effects, and the potential solutions for the issue. First, the article goes into the basics of microplastics, like how they can be found in spheres, fragments, and fibers, and how the spherical microplastics can generate >10^14 times greater numbers of nanoplastics. The article also talks about primary versus secondary plastics, and how primary plastics are the industrial use micro pellets while secondary plastics are the more common, worn-down from plastic microplastics. The article then goes to talk about how plastics are long chains of polymers, and how synthetic polymers are more resistant to biodegradation. There are also some organisms that can break down plastics, like mealworms and some bacterias, though there are residual substances from the mealworms and the bacteria only works with polyethylene terephthalate. The article agrees with the previous article in the sense that lab settings make it hard to work with microplastics due to the sheer abundance of plastic in a lab setting. Some methods have been used to detect microplastics, one being Raman micro spectroscopy (detects down to 1 micrometer), and another being lipophilic fluorescent dye along with fluorescence microscopy, which can distinguish between polar and lipophilic polymers based on fluorescence intensity. Some microplastics from different materials are also denser than others, which results in the

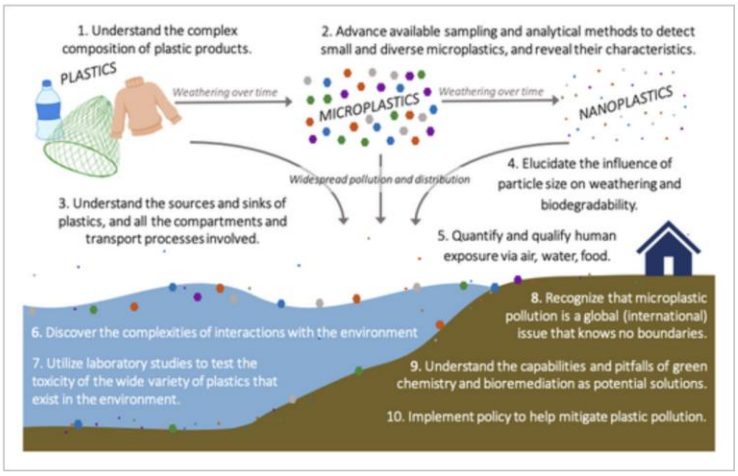
	denser microplastics being found in aquatic sediments, while lighter microplastics are found in beach sediments. Microplastic debris can come from land, wastewater, tire wear, paints, textiles, and littering at sea, and can be spread through the air, water, and soil, which can be found in food and ingested. Similar to what most articles have been saying about the topic, particle size <20 micrometers can go through cell membranes, which can cause issues with metabolism, reproduction, behavior, etc. Most of the microplastics found in marine organisms are the fiber types, and the microplastics have been shown to travel in the food chain. Microplastics have also been found in the blood, intestines, liver, etc. of aquatic animals. Overall, polyethylene, polypropylene, butadiene, polystyrene, and the micro pellets might be the best plastics to try out for the experiment. This article gave good insight into which plastics to use, as well as why a marine based project would be important, as planaria and daphnia are indicator species so they would affect the entire rest of the food chain if the microplastics had significant effects on them. Also, the evidence supporting reproductive impairment would make an interesting reproductive study to see how badly microplastics impair the reproduction of daphnia, as well as if the second generation contain any microplastics.
Research Question/Problem/ Need	The article intends to tie all focus areas of microplastics to overall show their connections as well as identifying the key issues of microplastics and the challenges of combining fields.
Important Figures	 **Figure 2** Open in figure viewer | PowerPoint Proposed relationship between microplastic size, particle number, and total mass over time. We postulate that as particle size decreases and surface area increases, environmental reactivity will increase. This may result in a decrease in total mass due to enhanced biodegradation. This is the figure for how microplastic size, particle #, and total mass relate. The total mass decreases, the number of particles increases, and the

particle size also decreases.

Figure 6 Open in figure viewer | PowerPoint

Image of polyurethane microplastics (<53 µm) ingested by brine shrimp nauplii (*Artemia sp.*, length ~500 µm). Microplastics were present at a concentration of 100 mg L^{-1}. Fluorescent microplastics (pink) are evident at a high density within the shrimp's digestive tract. These were egested within 48 hr after cessation of exposure. Some of the additives within the microplastics likely leached out of the plastic during its residence in the digestive tract and exposure water (see Figure 8). Imaged on an Olympus FV1200 laser scanning confocal microscope. Credit: Hamish Small (VIMS) and Virginia Worrell (Virginia Governor's School).

This figure depicts microplastics (purple) present in the digestive tract of a brine shrimp.

	 **Figure 9** Open in figure viewer | PowerPoint Challenges for the study and reduction of microplastic pollution are illustrated here. Note that microplastics and nanoplastics have been simplistically illustrated here as hexagonal, colored particles. In actuality, their sizes and shapes are extremely variable and include fibers. Challenges 1–4 stem from the nature of the plastics and their weathering with time. Challenges 5–7 involve determining their distribution throughout the environment results and delineation of their effects. Finally, Challenges 8–10 involve mitigating the global health risks that microplastics pose. This figure depicts challenges overall. Each point depicts what needs to be understood in order to move forward in the field to try and reach a solution.
VOCAB: (w/definition)	Photooxidization: The degration of a polymer surface from light and oxygen. Labile tissues: Tissues composed of labile cells which continuously divide and regenerate. Phthalates: Esters of phthalic acid that are used in plastics to make them more flexible and durable. Biofilm: A community of microorganisms which stick together and create a sticky, slimy surface. Biota: Plant and animal life of a particular place.
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Follow up Questions	- Out of all the microplastics which ones are most common to find overall? - How do microplastics affect reproduction? - Do second generation organisms of affected organisms display similar affects as after the parent organism was exposed?

Article #5 Notes: "Metabolomics reveals the mechanism of polyethylene microplastic toxicity to Daphnia magna"

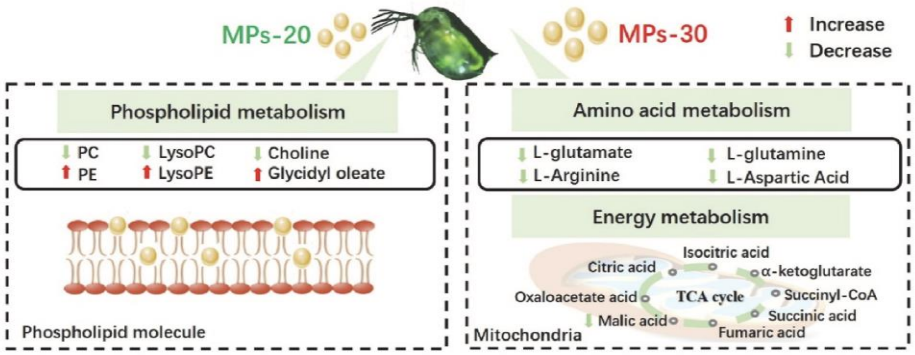
Source Title	Metabolomics reveals the mechanism of polyethylene microplastic toxicity to Daphnia magna
Source citation (APA Format)	Wang, P., Li, Q.-Q., Hui, J., Xiang, Q.-Q., Yan, H., & Chen, L.-Q. (2022). Metabolomics reveals the mechanism of polyethylene microplastic toxicity to Daphnia magna. *Chemosphere (Oxford), 307(*Pt 2*),* Article 135887. https://doi.org/10.1016/j.chemosphere.2022.135887
Original URL	https://www-sciencedirect-com.ezpv7-web-p-u01.wpi.edu/science/article/pii/S0045653522023803
Source type	Journal Article
Keywords	Microplastics, Daphnia magna, Toxicity, Metabolites, Energy metabolism
#Tags	#2.1, #2.2, #3.2, #3.3
Summary of key points + notes (include methodology)	• Effects of microplastics on metabolic processes/toxicity is unclear. • 20 micrometers and 30 micrometers accumulated into the gut of D. magna and increased mortality and also decreased heart rate. • The study utilized metabolomics and traditional toxicology techniques (non-targeted liquid chromatography-mass spectrometry (LC-MS)) • The microplastics had different effects on different metabolites.

	• The smaller the microplastic, the more toxic effects it has on marine organisms.
	• Small polystyrene microplastics reduce body length in D. magna as well as # of offspring.
	• The article used yellow polyethylene microplastics (20 micrometers and 30 micrometers) from Cospheric and suspended in deionized water.
	  ○ Shape and size was found using transmission electron microscopy.
	  ○ Particle size was found using nanomeasurer 1.2 software.
	  ○ Absorption spectra of chemical bons was found using Fourier transform infrared spectrometer (Nicoletis10).
	  ○ Hydrodynamic size was measured after being exposed to varying level of hours using a Zetasizer Nano ZS instrument.
	• Daphnia magna were incubated in an artificial climate, however pregnant daphnia magna were incubated separately until they produced offspring, which after they were removed.
	• Daphnia magna were exposed to varying levels of microplastic solutions and mortality was recorded. After 24 hours, 5 of the surviving daphnia were selected to have heart rate recorded.
	• For Statistical Analysis, all data was expressed in mean and standard deviation, and all cases were recorded to be statistically significant ($p<0.05$).
	• In terms of results, the 20 micrometer and 30 micrometer microplastics were shown to be spherical and uniformly dispersed in solutions, mainly composed of polyethylene, and remaining relatively stable (not breaking down too much) for the exposure cycles.
	• The different microplastic sizes and the different concentrations all had significant buildup in the D. Magna gut.
	• The MP-30 group had more of a decrease in mortality and heart rate than the MP-20 group, however concentration did not have too big of an effect except that it decreased slightly. T-80 also decreased the heart rate and mortality percentage significantly, just less than the microplastics.
	• MP-20 affected lipid metabolism, MP-30 mainly affected amino acid metabolism (since smaller microplastic sizes have a larger surface area and are more likely to make contact with the cell membrane, they are more likely to change the lipid metabolism there).

Research Question/Problem/ Need	How do different sizes of microplastics affect the metabolic functions of D. magna?

Important Figures

GRAPHICAL ABSTRACT



The visual representation of the article.

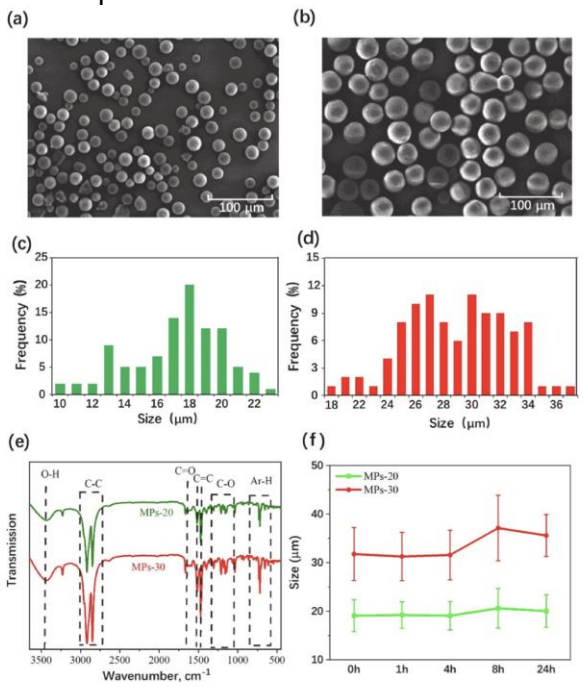


Fig. 1. Physicochemical characterization of microplastics (MPs). (a, b) Representative TEM images of MPs-20 and MPs-30. (c, d) Diameter distribution of MPs-20 and MPs-30. (e) Fourier transform infrared (FTIR) spectra of MPs. (f) Hydrodynamic diameter distribution of MPs.

How the study classified microplastics based on imaging, diameter, Fourier transform, and hydrodynamic diameter. This helped gather the size and polymer for the microplastics.

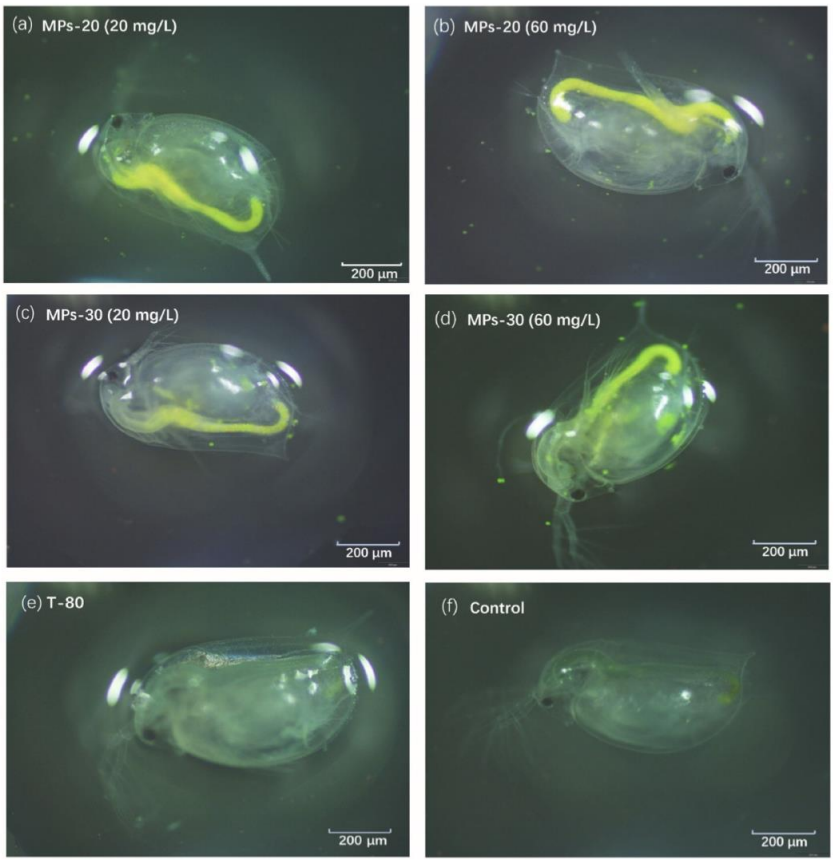


Fig. 2. Representative images of *Daphnia magna* after exposure to MPs and T-80 for 24 h. (a, b) MPs-20 group, (c, d) MPs-30 group, (e) T-80 group and (f) Control group.

A visual for the amount of microplastics found in the gut of the daphnia magna for each solution.

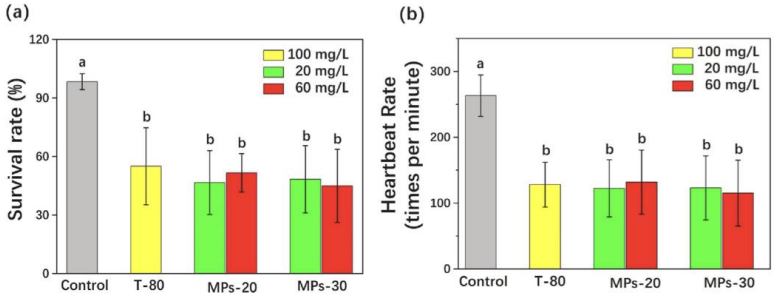
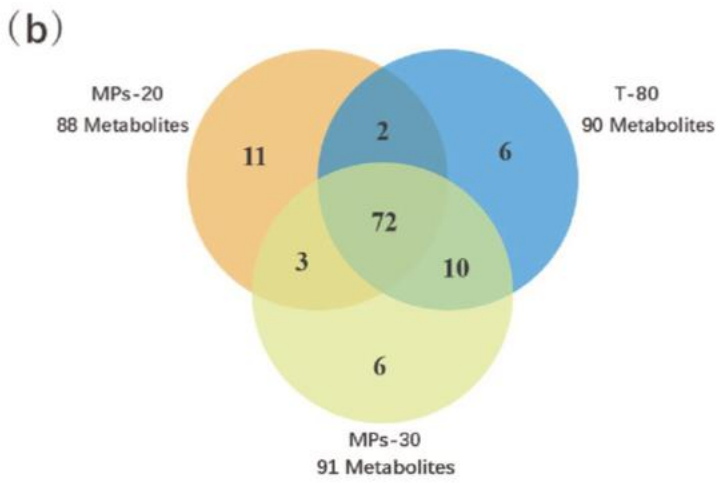


Fig. 3. Behavior variations (mean ± SD, n = 4) of *Daphnia magna* after 24 h of exposure to four treatments. (a) Survival rate and (b) Heartbeat rate. Different letters indicate significant differences among treatments through one-way ANOVA.

Visual representation for the heart rates and mortality of the exposed daphnia magna compared to the control.

	 The overall representation of how many metabolites each IV change affected.
VOCAB: (w/definition)	Metabolites – Substances that are made or used when the body breaks down substances. Metabolomics – The study of metabolites. Surfactant – Substance that reduces surface tension of liquids. Heatmap – A method of data visualization that corresponds color to magnitude. It helps visualize relationships and changes in data. Lipid metabolism – The process of the creation, storage, and breaking down of lipids and lipoids (fats). Amino acid metabolism – The process of creating and breaking down amino acids for utilization purposes. Phosphatidylcholine (PC) - Class of phospholipids that have choline as a headgroup (major component of membranes). Phosphatidylethanolamine (PE) - Class of phospholipids used in membranes.
Cited references to follow up on	- An, D., Na, J., Song, J., Jung, J., 2021. Size-dependent chronic toxicity of fragmented polyethylene microplastics to Daphnia magna. Chemosphere 271, 129591. https://doi:10.1016/j.chemosphere.2021.129591. - Chen, Q., Lackmann, C., Wang, W., Seiler, T.-B., Hollert, H., Shi, H., 2020. Microplastics lead to hyperactive swimming behaviour in adult zebrafish. Aquat. Toxicol. 224, 105521. https://doi:10.1016/j.aquatox.2020.105521. - Ding, J., Huang, Y., Liu, S., Zhang, S., Zou, H., Wang, Z., Zhu, W., Geng, J., 2020. Toxicological effects of nano- and micro-polystyrene plastics on red tilapia: are larger plastic particles more harmless? J. Hazard Mater. 396, 122693. https://doi:10.1016/j.jhazmat.2020.122693. - Kim, D., Kim, H., An, Y.-J., 2021. Effects of synthetic and natural microfibers on Daphnia magna-Are they dependent on microfiber type? Aquat. Toxicol. 240, 105968. https://doi:10.1016/j.aquatox.2021.105968. - Schwarzer, M., Brehm, J., Vollmer, M., Jasinski, J., Xu, C., Zainuddin, S., Frohlich, T., Schott, M., Greiner, A., Scheibel, T., Laforsch, C., 2022. Shape, size, and polymer dependent effects of microplastics on Daphnia

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Follow up Questions	- Are there connections between the deposits of microplastics in the gut of D. magna and heart health? - Do microplastics transfer from parent to offspring? - Would different sizes of microplastics correspond to a different effect on the health of the daphnia as a whole (example: one size affects the cardiovascular system more while another size affects the digestive system)? - Were microplastics found in the area on female daphnia that hold the eggs?

Article #6 Notes: “Potential toxicity of polystyrene microplastic particles”

Source Title	Potential toxicity of polystyrene microplastic particles
Source citation (APA Format)	Hwang, J., Choi, D., Han, S., Jung, S. Y., Choi, J., & Hong, J. (2020). Potential toxicity of polystyrene microplastic particles. *Scientific Reports, 10*(1), Article 7391. https://doi.org/10.1038/s41598-020-64464-9
Original URL	https://www.nature.com/articles/s41598-020-64464-9.pdf
Source type	Journal Article
Keywords	N/A
#Tags	#Methods, #Introduction

Summary of key points + notes (include methodology)	• Microplastics are accepted to be not typically harmful to human health, however issues may arise when coming into direct contact at the cellular level.
	• Primary microplastic particles (1-5micrometers and uniform) are usually made of Polypropylene, Polystyrene, and polyethylene.
	• Plastic particles and fibers have been found in over 20% of shellfish and the GI tracts of fish.
	• Only 25% of primary microplastics are filtered out of water (primary microplastics are used in scrubs, soaps, toothpastes, etc).
	• Microplastic particles can cause gastrointestinal obstruction/dysmotility.
	• Polystyrene nanoplastics have been found to group together with an increase of salt concentration.
	  ○ Could cause side effects in aquatic animals and humans.
	• Microplastics and nanoplastics <1.5micrometers can damage cells.
	• 1% to 4% of polystyrene particles in the intestine are thought to go into the blood.
	• Polystyrene catalysts, emulsifiers, and stabilizers are all considered environmental contaminants and when accumulated in the food chain build up in fatty tissues.
	• Polystyrene is a colorless, transparent polymer made up of styrene monomers.
	  ○ Soluble in organic solvents.
	  ○ Resistant to acids, alkalis, salts, mineral oils, organic acids, alcohols.
	• Hypothesized that humans could ingest polystyrene particles from food, biomedical products, containers, water, and other everyday objects.
	• 6 different types of polystyrene particles were tested on Human Dermal Fibroblasts, Human Peripheral Blood Mononuclear Cells, and the Human Mast Cell Line.
	  ○ HDF are cells located in stromal tissue which help in wound healing and protect against absorption of polystyrene particles.
	  ○ Human mast cells were selected due to their ability to indicate a close relationship between polystyrene, human immune system, and hypersensitivity.

	○ BMCs provide a look at the immune response to polystyrene particles. • Cells were coated with particles. • No cells showed significant effects to the particles up to the 500migrograms/mL concentrations, but for 3micrometers at a concentration of 1000micrograms/mL the viability of the HDF cells were decreased by 40%, which was statistically significant by $p<0.001$. The results overall showed that PS particles are not cytotoxic to HDFs and PBMCs unless in extreme cases. • Polymers are generally harmful to cells, however to what extent depends on the concentration of particles, how long the cells have been exposed, and how unresponsive the polymers are. • Polystyrene particles <5 micrometers changed the surface charges and aggregation of red blood cells. • Polystyrene particles >10micrometers cannot penetrate blood vessels. • The destruction of red blood cells only depended on microplastic size, as smaller microplastics were more cytotoxic than larger microplastics due to the large surface areas. • The article also studied cytokine release profiles to determine if inflammation could be triggered by polystyrene, and if it was based off of size or concentration. ○ Interleukin 2 is a cytokine that is part of controlling cell tolerance and immunity. ○ TNF-a is a pro-inflammatory cytokine and immune mediator for cell movement, death, the formation of new blood vessels from existing ones, and adhesion. ○ Both Interleukin 2 and TNF-a are indicators for immune responses and inflammation. ○ IL-6 is a pro-inflammatory cytokine and an anti-inflammatory myokine (another version of cytokine). ○ IL-10 is an anti-inflammatory cytokine. • TNF-a increased when polystyrene particles <1micrometer in diameter and concentration of 500micrograms/mL significantly, with a p value of <0.03, while IL-6 changed at <10micrometes for the same concentration at a p value of <0.04. ○ Indicates that small polystyrene particles could trigger inflammation by the innate immune system. ○ Polystyrene particles could have been identified as pathogens. ○ The inflammation was size and concentration dependent. • Overall, polystyrene particles are not toxic; however direct contact with red blood cells caused the red blood cells to break down, and higher concentrations of polystyrene particles induced early-stage inflammation.
Research Question/Problem/ Need	What is the toxicity of polystyrene microplastics in humans?

Important Figures

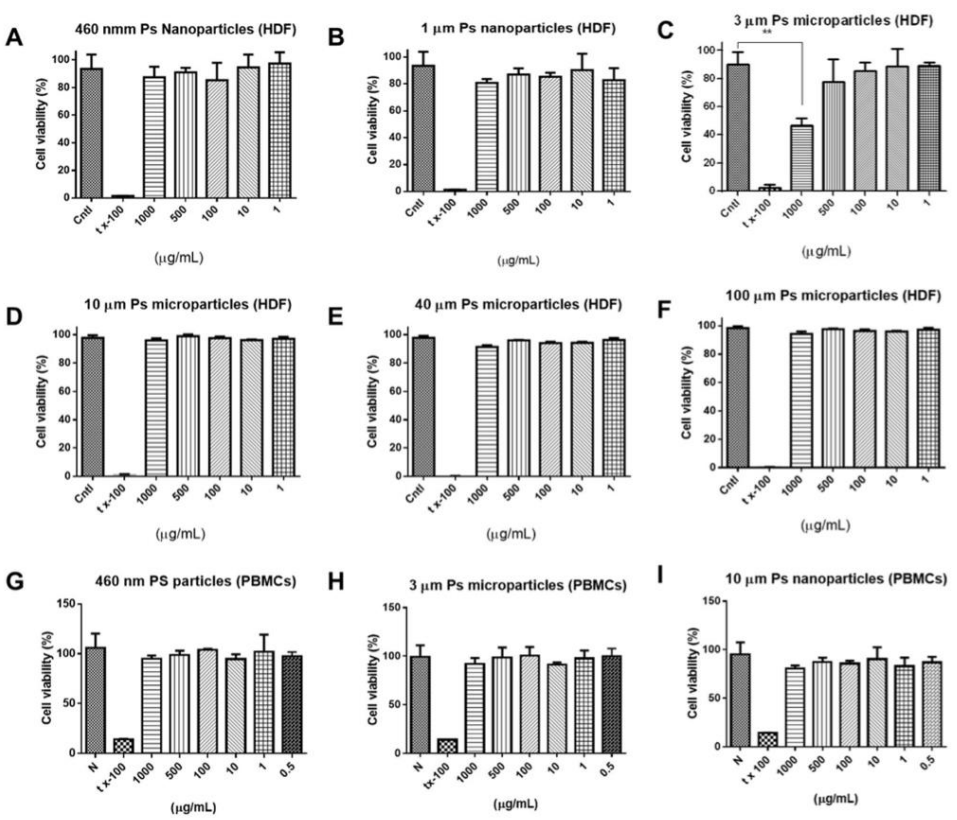


Figure 3. Cytotoxicity of PS particles. (**A**) 460 nm PS nanoparticles on HDFs. (**B**) 1 μm PS particles on HDFs. (**C**) 3 μm PS particles on HDFs. (**D**) 10 μm PS particles on HDFs. (**E**) 40 μm PS particles on HDFs. (**F**) 100 μm PS particles on HDFs. (**G**) 460 nm PS nanoparticles on PBMCs. (**H**) 3 μm PS particles on PBMCs. (**I**) 10 μm PS particles on PBMCs.

The results for the test with the HDFs and PBMCs. The high concentration of 3 micrometers (C) was the only statistically significant value.

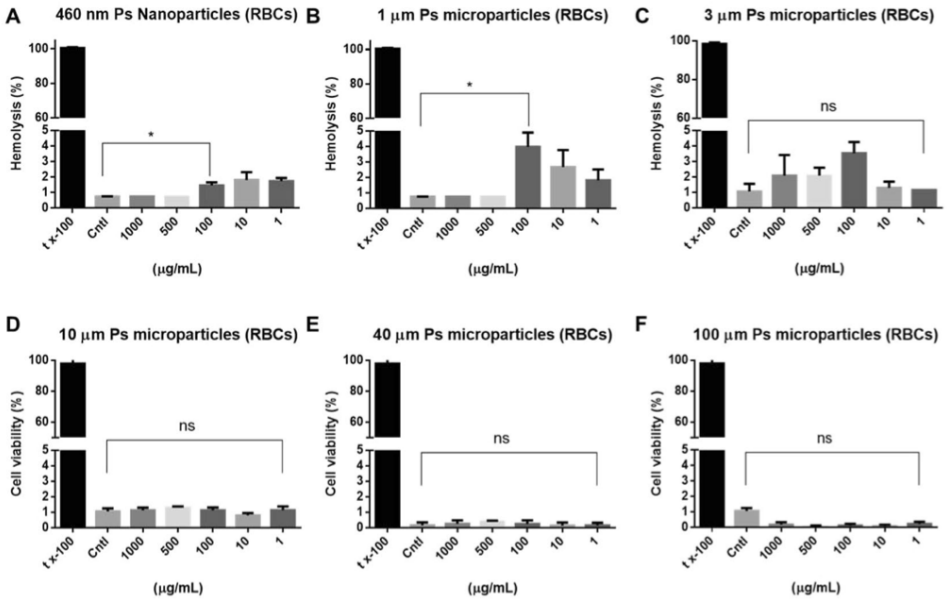


Figure 5. Hemolysis of RBCs after contact with PS particles. (**A**) 460 nm PS nanoparticles. (**B**) 1 μm PS particles. (**C**) 3 μm PS particles. (**D**) 10 μm PS particles. (**E**) 40 μm PS particles. (**F**) 100 μm PS particles. 5% tx-100 served as the positive control. Cntl indicates no treatment. Absorbance was measured at 540 nm.

Different concentrations and sizes of particles on the percentage of red blood cell death. The smallest sizes at 100micrometers/mL had significant cell death increase while the rest did not.

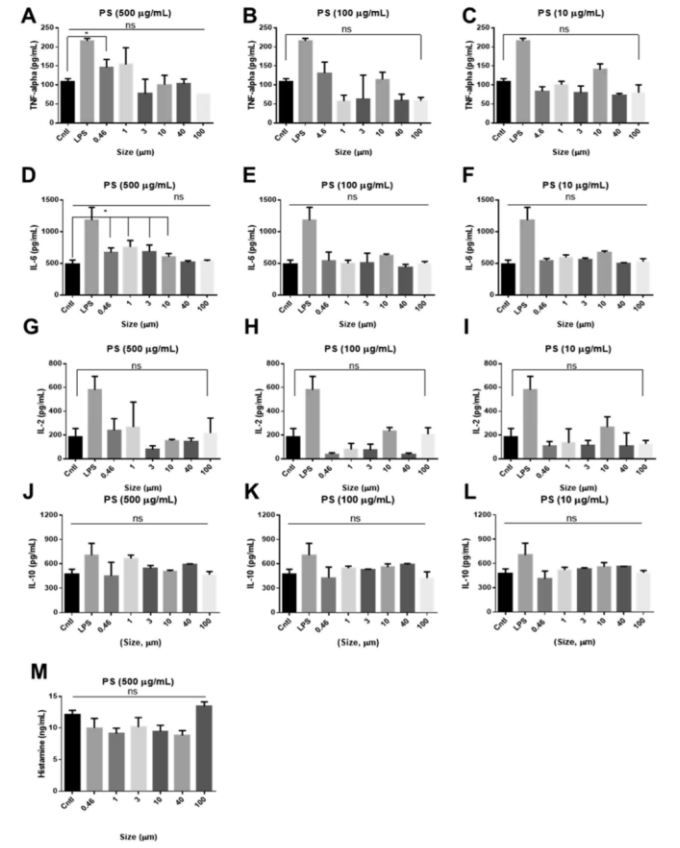


Figure 6. Cytokine profiles of TNF alpha, IL-2, IL-6, IL-10, and histamine. TNF-α secretion induced by PS particles of various sizes at concentrations of (**A**) 500 µg/mL, (**B**) 100 µg/mL, and (**C**) 10 µg/mL. IL-2 secretion induced by PS particles of various sizes at concentrations of (**D**) 500 µg/mL, (**E**) 100 µg/mL, and (**F**) 10 µg/mL. IL-6 secretion induced by PS particles of various sizes at concentrations of (**G**) 500 µg/mL, (**H**) 100 µg/mL, and (**I**) 10 µg/mL. IL-10 secretion induced by PS particles of various sizes at concentrations of (**J**) 500 µg/mL, (**K**) 100 µg/mL, and (**L**) 10 µg/mL. (**M**) Histamine profiles after treatment with 500 µg/mL PS particles of different sizes. Cntl: no treatment. LPS: 2.5 µg/mL.

All of these graphs are the data for the cytokine tests, as well as M being for Histamine.

VOCAB: (w/definition)

Cytotoxicity: The ability for a substance to cause biological damage.
In-Vitro: A process or test formed outside the living organism.
Aggregate: When substances clump together.
Hydrodynamic diameter: When compared to the given particle, it is the amount of drag force for a sphere in water that is the same as the given particle.
Azobisisobutyronitrile: An organic compound that is a white powder and is soluble in organic substances but not water.
Ketone: Acids your body makes when it is burning fat rather than glucose.
Esters: Mainly located in essential oils, formed when an acid is combined with an alcohol and water is removed.
Aromatic hydrocarbons: compounds composed of hydrogen and carbon and have at least one aromatic ring.
Human Dermal Fibroblasts: connective tissue cells found in the dermis that help with wound healing and skin structure.
Human Peripheral Blood Mononuclear Cells: blood cells with round nucleus.
Human Mast Cell Line: Cultured population of immune white blood cells in the connective tissue that mainly control allergic reactions.
Endocytosis: When a cell uses its outer membrane to take in outside material.
Blood Lumen: The inner tube of a blood vessel.

	Cytokine: Proteins that control inflammation.
Cited references to follow up on	- Sharma, S. & Chatterjee, S. Microplastic pollution, a threat to marine ecosystem and human health: a short review. Environmental Science and Pollution Research 24, 21530–21547 (2017). - Tanaka, K. & Takada, H. Microplastic fragments and microbeads in digestive tracts of planktivorous fish from urban coastal waters. Scientific reports 6, 34351 (2016). - Smith, M., Love, D. C., Rochman, C. M. & Neff, R. A. Microplastics in seafood and the implications for human health. Current environmental health reports 5, 375–386 (2018). - Sussarellu, R. et al. Oyster reproduction is affected by exposure to polystyrene microplastics. Proceedings of the National Academy of Sciences 113, 2430–2435 (2016). - Sass, W., Dreyer, H.-P. & Seifert, J. Rapid insorption of small particles in the gut. American Journal of Gastroenterology 85 (1990). - Von Moos, N., Burkhardt-Holm, P. & Köhler, A. Uptake and effects of microplastics on cells and tissue of the blue mussel Mytilus edulis L. after an experimental exposure. Environ. Sci. Technol. 46, 11327–11335 (2012). - Chen, H.-T., Neerman, M. F., Parrish, A. R. & Simanek, E. E. Cytotoxicity, hemolysis, and acute in vivo toxicity of dendrimers based on melamine, candidate vehicles for drug delivery. J. Am. Chem. Soc. 126, 10044–10048 (2004). - Hwang, J., Choi, D., Han, S., Choi, J. & Hong, J. An assessment of the toxicity of polypropylene microplastics in human derived cells. Science of The Total Environment 684, 657–669 (2019).
Follow up Questions	- Do inflammatory responses have an effect on heart rate? - Did the microplastics found in the blood veins contribute to narrowing of blood vessels? - Are there any more connections that can be made between human processes? - Do different polymers and types of microplastics change the results at all?

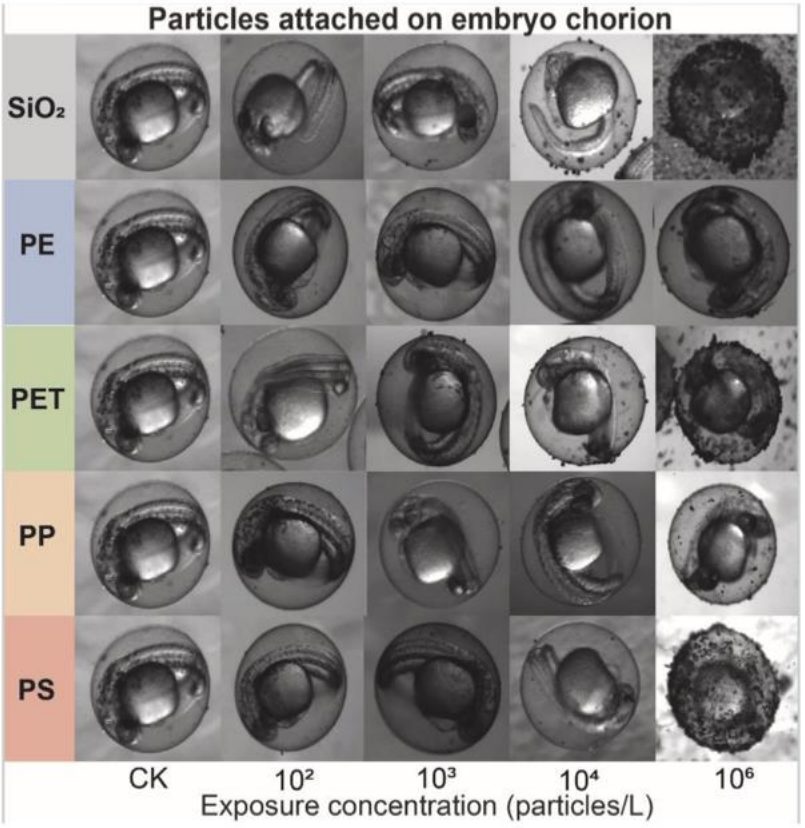
Article #7 Notes: "Multi-biomarkers hazard assessment of microplastics with different polymers by acute embryo test and chronic larvae test with zebrafish (Danio rerio)"

Source Title	Multi-biomarkers hazard assessment of microplastics with different polymers by acute embryo test and chronic larvae test with zebrafish (*Danio rerio*)
Source citation (APA Format)	Chen, Y., Duan, M., Xu, X., & Wu, C. (2023). Multi-biomarkers hazard assessment of microplastics with different polymers by acute embryo test and chronic larvae test with zebrafish (Danio rerio). *Aquatic Toxicology, 260,* Article 106595. https://doi.org/10.1016/j.aquatox.2023.106595
Original URL	https://www-sciencedirect-com.ezpv7-web-p-u01.wpi.edu/science/article/pii/S0166445X23001984
Source type	Journal Article
Keywords	Microplastics, Component, Zebrafish, Toxicity effects, Natural particles
#Tags	#Abstract, #Introduction, #Conclusions

Summary of key points + notes (include methodology)	- Influence of polymer types on toxicity of microplastics is unclear.
	- Polymers polyethylene, polyethylene terephthalate, polypropylene, and polystyrene were studied on Zebra fish.
	  ○ Acute embryo test, chronic larvae test
	  ○ Silicon dioxide was control
	- The microplastic polymers had no effect on embryonic development, but Polyethylene and polystyrene increased heart rate and embryonic death at high concentrations.
	- Larvae movement could be inhibited at 10^4 particles/L concentration of microplastics.
	- Microplastic shapes can be in films, fragments, spheres, and fibers.
	
	****Common microplastics are composed of **polyethylene (PE)**, **polypropylene (PP)**, **polyethylene terephthalate (PET)**, **polystyrene (PS)**, polyvinyl chloride (PVC), or polyamide (PA)****
	
	- Analysis of microplastics in environmental samples is time consuming, there are many methods/ no standardized method of testing, and identification of small microplastics is difficult.
	- The toxicity of microplastics can be affected by morphology and

	components.
	- Small microplastics can build up in the circulatory system, big microplastics can build up on the body's surface and digestive tract.
	- Microfibers are more likely to remain in the intestines.
	- Irregular shapes may cause more issues than spheres.
	- Polystyrene is considered to be one of the most hazardous microplastic types.
	- Hypothesized that polymer is independent of toxicity (plastics are not reactive)
	- Multiple biomarkers used for study:
	  o Embryonic development
	  o Growth and feeding
	  o Energy reserve
	  o Locomotion levels
	  o Oxidative stress
	- Sizes of microplastics were measured using a laser particle size analyzer.
	- Morphology of microplastics were found using scanning electron microscope.
	- Hydrophobicity of microplastics was determined using Fourier Transform Infrared.
	- Microplastic solutions were given to the embryos 4hrs after fertilization.
	- Exposure experiment lasted 5 days, dead and hatched were recorded each day.
	- One larva was taken for heart rate, blood flow, deformity rate, and total body length to determine toxicity.
	- Locomotion was measured 5 days after exposure.
	- 8 larvae were selected from each group and moved to a clean well where they were recorded for 10 minutes at 25 frames/s.
	- 100 larvae were taken 10 days post fertilization and exposed to microplastics for 28 days.
	- At the end, 5 larvae from each treatment was analyzed for body weight, length, and peristaltic capacity of the intestine.
	- An ANOVA was used to analyze the data, as well as the integrated biomarker response index.
	- Microplastics sticking to the chorion depended on concentration, hydrophobicity, and density.
	- Heart rate was increased at 10^6 particles/L of polystyrene.
	- Polyethylene and polystyrene were lethal at high concentrations, as well as lower hatching rate.
	- Polymers had no effect on embryonic development.
	- PET and polystyrene changed blood flow and heartbeat rate.
	- Higher concentration = greater embryonic death.
	- Control SiO2 and microplastic particles did not affect feeding or peristalsis.
	- Different polymers did not have an effect on energy reserve and growth of larvae.
	- Polymers did not affect behavioral development at the expected

	environmental level.
	- PET and PP inhibited locomotion at high concentrations.
	- In terms of 28-day long exposure (chronic):
	  o Polymers led to changes in locomotion
	  o Polymers led to neurotoxicity in high doses
	- Conclusion of it is not worth it to identify polymers.

Research Question/Problem/ Need	Can polymer types of microplastics lead to toxic effects in organisms?
Important Figures	 **Fig. 1.** Particles adsorbed on embryonic chorion. The figure depicts each polymer of microplastic on the "y axis" and their concentrations on the "x axis". The pictures are used to show the microplastics attaching to the chorion of the embryo. The higher concentrations had the most microplastics attached however SiO2 (the control, also not a microplastic), Polystyrene, and PET.

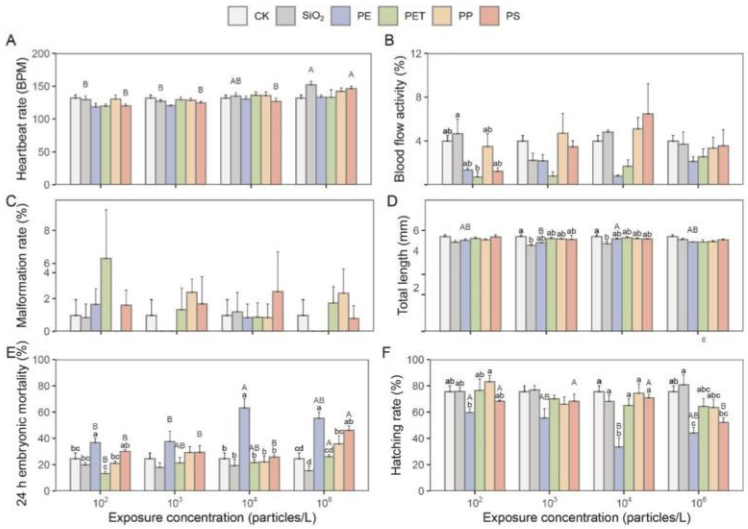


Fig. 2. Development toxicity of embryos under different exposure conditions: (A) Heartbeat rate; (B) Blood flow activity; (C) Malformation rate; (D) Total length; (E) Embryonic mortality after 24 h exposure; (F) Hatching rate at 120 hpf (Error bars stand for standard error. Lowercase letters indicated a significant difference for the different groups and capital letters indicated a significant difference for particles of different concentrations).

Each graph depicts a data point used for the overall development toxicity test. Each x axis used the concentrations of the microplastics, while each color represented a different polymer. A measured heartbeat rate (bpm), B measured Blood Flow Activity (%), C measured malformation rate (%), D measured total length (mm), E measured mortality (%), and F measured hatching rate (%). Lowercase letters were significant differences compared to the other polymers while uppercase letters were significant differences compared to other concentrations.

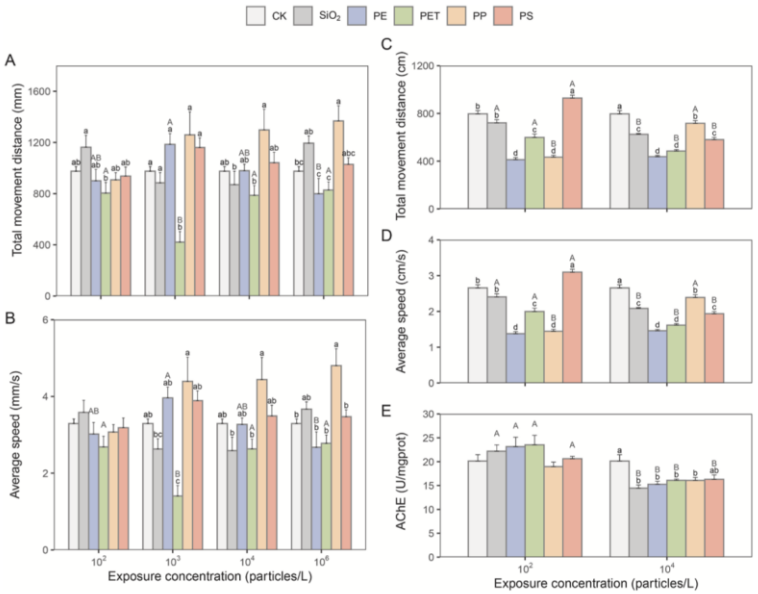


Fig. 4. Larvae' locomotion levels after 5-day acute exposure for zebrafish embryos (A: total movement distance; B: average speed). Larvae' locomotion levels and neurotoxicity after 28-day chronic exposure for zebrafish larvae (C: total movement distance; D: average speed); E: AChE in brain). (Error bars meant standard error. Lowercase letters indicated a significant difference for the different groups and capital letters indicated a significant difference for particles of different concentrations).

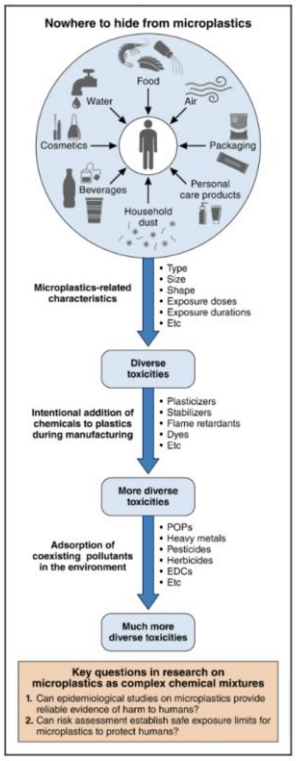
The tables in Figure 4 have the same x-axis, bar color, and letter meaning as the tables in Figure 2, however the tables in Figure 4 depict locomotion. A and C were total movement distance, while B and D were

	average speed, however A and B were from 5 day exposure while C and D were from 28 day exposure. Table E discusses the acetylcholinesterase activity.
VOCAB: (w/definition)	Acetylcholinesterase activity: Process where acetylcholinesterase breaks down acetylcholine (neurotransmitter) into acetic acid and choline. Locomotion: movement Chemically inert: not reactive Peristaltic capacity: contraction and relaxation of muscles in tube organs. Chorion: outermost membrane for embryos.
Cited references to follow up on	- Arias-Andres, M., Rojas-Jimenez, K., Grossart, H.P., 2019. Collateral effects of microplastic pollution on aquatic microorganisms: an ecological perspective. Trends Anal. Chem. 112, 234–240. - Cunningham, E.M., Sigwart, J.D, 2019. Environmentally accurate microplastic levels and their absence from exposure studies. Integr. Comp. Biol 59 (6), 1485–1496. - Frydkjær, C.K., Iversen, N., Roslev, P., 2017. Ingestion and egestion of microplastics by the cladoceran Daphnia magna: effects of regular and irregular shaped plastic and sorbed phenanthrene. Bull. Environ. Contam. Toxicol. 99 (6), 655–661. - Frydkjær, C.K., Iversen, N., Roslev, P., 2017. Ingestion and egestion of microplastics by the cladoceran Daphnia magna: effects of regular and irregular shaped plastic and sorbed phenanthrene. Bull. Environ. Contam. Toxicol. 99 (6), 655–661.
Follow up Questions	- Would it be worthwhile to do polymer microplastic testing in terms of long term exposure? - How do the polymers affect different organisms if at all? - Same test but on polymer size and shape?

Article #8 Notes: "Microplastics and Cardiovascular Diseases: Importance of Coexisting Environmental Pollutants"

Source Title	Microplastics and Cardiovascular Diseases: Importance of Coexisting Environmental Pollutants
Source citation (APA Format)	Lee, D.-H. (2024). Microplastics and Cardiovascular Diseases: Importance of Coexisting Environmental Pollutants. *Circulation (New York, N.Y.), 150(12), 908–910.* https://doi.org/10.1161/CIRCULATIONAHA.124.069801
Original URL	https://www.ahajournals.org/doi/10.1161/CIRCULATIONAHA.124.069801
Source type	Journal Article
Keywords	Cardiovascular diseases, environmental pollutants, epidemiology, humans, microplastics
#Tags	

Summary of key points + notes (include methodology)	- 4.5x risk of lack of blood flow to heart, stroke, or death in patients with asymptomatic high-grade carotid artery narrowing who had microplastics in the plaque compared to without.
	  o Also high inflammatory markers
	- Researchers do not understand the differences between experimental studies and human studies, makes interpreting findings difficult.
	- Experimental studies --> microplastics applied directly to the desired subject (cells, organs, animals)
	  o Microplastic properties, administration, and exposure dose and duration can vary, however results can be looked at based off of what is happening in the experiment.
	- Human Studies
	  o Contaminants of other outside substances --> human studies are more so microplastic affects with other outside pollutants.
	- Microplastics can carry contaminants in two ways:
	  o Absorb pollutants through transport in environment
	  o Additives incorporated intentionally that have toxicity risks.
	- Nanoplastics could carry more pollutants than microplastics.
	- Microplastics in carotid artery plaque could mainly be nanoplastics.
	- The challenge of the overall microplastics and pollutant contamination for epidemiological studies is that pollutants can change results, and though some can be measured with the microplastics, not all of them can be.

	○ Contaminants can vary between regions. ○ Consistent findings in human studies could be difficult. - Human studies on low-dose chemical mixtures can have problems with unpredictable effects, nonlinear dose vs. Response, absences of a "control", and unreliable exposure assessment. - The article took information from other articles to overall report on the risks with human testing in microplastics.
Research Question/Problem/ Need	How do human microplastic experiments differ from more specific microplastic studies? What are the risks associated?
Important Figures	EPUB  **Figure. Limitations in conventional approaches to understanding microplastics as a typical example of complex chemical mixtures.** EDC indicates endocrine-disrupting chemicals; and POP, persistent organic pollutants. The overall summary of the article (visual representation of the article).
VOCAB: (w/definition)	Myocardial infarction: Lack of blood flow to heart muscle Stenosis: abnormal narrowing of blood vessels or other bodily tubes. Epidemiological: Branch of medicine that deals with the incidence, distribution, and control of diseases. Lipophilic: Combine with or dissolve in lipids. Adipose tissue: Tissue used for fat storage. Lipolysis: lipid triglycerides are combined into glycerol and free fatty acids.
Cited references to follow up	

on	- Marfella R, Prattichizzo F, Sardu C, Fulgenzi G, Graciotti L, Spadoni T, D'Onofrio N, Scisciola L, La Grotta R, Frige C, et al. Microplastics and nanoplastics in atheromas and cardiovascular events. *N Engl J Med*. 2024;390:900–910. doi: 10.1056/NEJMoa2309822 Crossref. PubMed.
Follow up Questions	- What are the risks of contamination with cell, organ, and animal testing in terms of microplastics? - What is the best way to make human testing more accurate for microplastics?

Article #9 Notes: “Microplastics and Nanoplastics in Atheromas and Cardiovascular Events”

Source Title	Microplastics and Nanoplastics in Atheromas and Cardiovascular Events
Source citation (APA Format)	Marfella, R., Prattichizzo, F., Sardu, C., Fulgenzi, G., Graciotti, L., Spadoni, T., D’Onofrio, N., Scisciola, L., La Grotta, R., Frigé, C., Pellegrini, V., Municinò, M., Siniscalchi, M., Spinetti, F., Vigliotti, G., Vecchione, C., Carrizzo, A., Accarino, G., Squillante, A., … Paolisso, G. (2024). Microplastics and Nanoplastics in Atheromas and Cardiovascular Events. *The New England Journal of Medicine, 390*(10), 900–910. https://doi.org/10.1056/NEJMoa2309822
Original URL	https://www.proquest.com/docview/2938507066?accountid=29120&parentSessionId=FZiQdFCWu8uF4lPlwNhh2rUMb1AQDcO%2BwOgOsCs8B%2Bk%3D&pq-origsite=primo&sourcetype=Scholarly%20Journals
Source type	Journal Article
Keywords	N/A
#Tags	#Results, #Conclusions

Summary of key points + notes (include methodology)	- Observational study on patients who are going through carotid endarterectomy for asymptomatic carotid artery disease.
	  - Pyrolysis-gas chromatography-mass spectrometry
	  - Stable isotope analysis
	  - Electron microscopy
	- End point was a myocardial infarction, stroke, or death for patients who had evidence of microplastics in plaque.
	- 304 patients were enrolled
	  - 150 patients were detected to have polyethylene in the plaque.
	  - 31 patients had polyvinyl chloride in the plaque.
	  - The plaque contained foreign jagged-edged particles (some particles included chlorine).
	- Methodology:
	  - Study approached 447 patients --> 312 agreed to go through screening.
	  - Asymptomatic disease patients were selected for likelihood of survival post procedure.
	  - Clinical examinations and health records were evaluated.
	  - Blood samples obtained for biochemical variables.
	  - Follow up visits were scheduled to monitor nonfatal myocardial infarction,

	stroke, and death. o Interim analysis for first 100 patients for sample size. o Shapiro-Wilk test for the distribution of variables when the patients were divided into MNP and non-MNP. o TTest o Mann-Whitney U test for non-normally distributed data o Fisher's exact test for categorical variables. o Linear regression for association of burden of MNPs. o Cox regression for presence of MNPs and end point. - Patients with MNPs were: o Younger o More likely to be make o Not likely for hypertension o More likely to have diabetes, cardiovascular disease, and dyslipidemia o More likely to smoke o Higher creatine values - The foreign particles in the plaque had jagged edges, <1micrometer, possibly nanometers in size. - Patients with MNPs in plaque were more likely to reach the end-point even than without MNPs in plaque. - People who are exposed to plastic pollution could have an increased risk of cardiovascular disease. - MNP larger than 150 micrometers cannot be absorbed into the blood and larger than 10 micrometers cannot penetrate blood vessels. - Polyethylene has shown up in plaque, breast milk, urine, and lung tissue. - Polyvinyl chloride has shown up in plaque, breast milk, urine, and the liver. - Microplastics with an aerodynamic diameter of <=2.5 micrometers can be transported by the wind and inhaled. - The study could have had laboratory contamination, which could have varied the results. o Cleaner, microplastic free rooms. - The study did not have income and education values. - Patients selected do not represent the general population.
Research Question/Problem/ Need	Do micro and nano plastics cause an effect in cardiovascular disease?

Important Figures

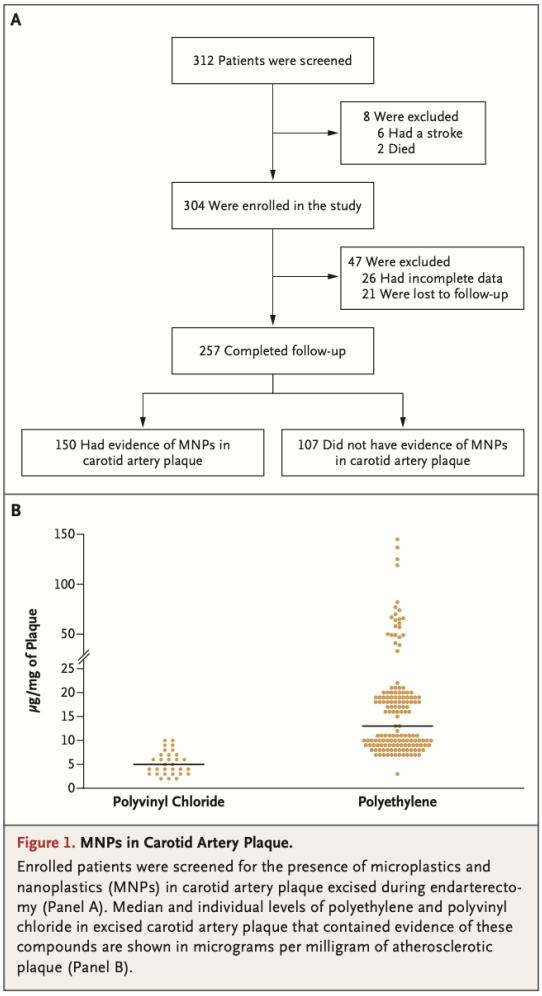


Figure 1. MNPs in Carotid Artery Plaque.

Enrolled patients were screened for the presence of microplastics and nanoplastics (MNPs) in carotid artery plaque excised during endarterectomy (Panel A). Median and individual levels of polyethylene and polyvinyl chloride in excised carotid artery plaque that contained evidence of these compounds are shown in micrograms per milligram of atherosclerotic plaque (Panel B).

This grouping of tables depicts how the study narrowed down its patient sampling, as well as how many patients had Polyvinyl chloride and polyethylene in their artery plaque.

Table 1. Characteristics of the Patients at Baseline.*

Variable	MNPs Present (N=150)	MNPs Not Present (N=107)
Age (IQR) — yr	71 (65–75)	73 (67–77)
Male sex — no. (%)	116 (77.3)	79 (73.8)
Body-mass index (IQR)†	28 (27–29)	28 (26–29)
Hypertension — no. (%)	78 (52.0)	69 (64.5)
Systolic blood pressure (IQR) — mm Hg	124 (118–130)	127 (118–129)
Diastolic blood pressure (IQR) — mm Hg	78 (75–83)	77 (75–85)
Heart rate (IQR) — beats/min	85 (79–91)	81 (76–86)
Stenosis severity (IQR) — %	77 (73–83)	78 (73–83)
Diabetes — no. (%)	36 (24.0)	32 (29.9)
Cardiovascular disease — no. (%)‡	50 (33.3)	35 (32.7)
Dyslipidemia — no. (%)	55 (36.7)	40 (37.4)
Total cholesterol (IQR) — mg/dl	150 (145–158)	147 (139–158)
LDL cholesterol (IQR) — mg/dl	77 (69–84)	74 (69–82)
HDL cholesterol (IQR) — mg/dl	42 (40–43)	42 (40–44)
Triglycerides (IQR) — mg/dl	178 (165–192)	182 (163–193)
Creatinine (IQR) — mg/dl	1.00 (0.90–1.10)	0.96 (0.96–1.06)
Smoker — no. (%)	24 (16.0)	17 (15.9)
Medication use — no. (%)		
Beta-blockers	48 (32.0)	35 (32.7)
ACE inhibitors	75 (50)	53 (49.5)
ARBs	35 (23.3)	31 (29.0)
Calcium-channel blockers	13 (8.7)	8 (7.5)
Diuretics	17 (11.3)	16 (15.0)
Heparin	12 (8.0)	10 (9.3)
Antiplatelet drugs	146 (97.3)	105 (98.1)
Statin	143 (95.3)	101 (94.4)
Ezetimibe	26 (17.3)	20 (18.7)

* ACE denotes angiotensin-converting enzyme, ARBs angiotensin II–receptor blockers, HDL high-density lipoprotein, IQR interquartile range, LDL low-density lipoprotein, and MNPs microplastics and nanoplastics.
† Body-mass index is the weight in kilograms divided by the square of the height in meters.
‡ Cardiovascular disease is defined as a history of acute coronary syndrome.

This table depicts the average characteristics of a person who had MPE's in their system versus who did not have MPE's in their system. The average characteristics do not correlate with the MPE's, it's just what "the typical patient" looked like for each group out of the entire sample size.

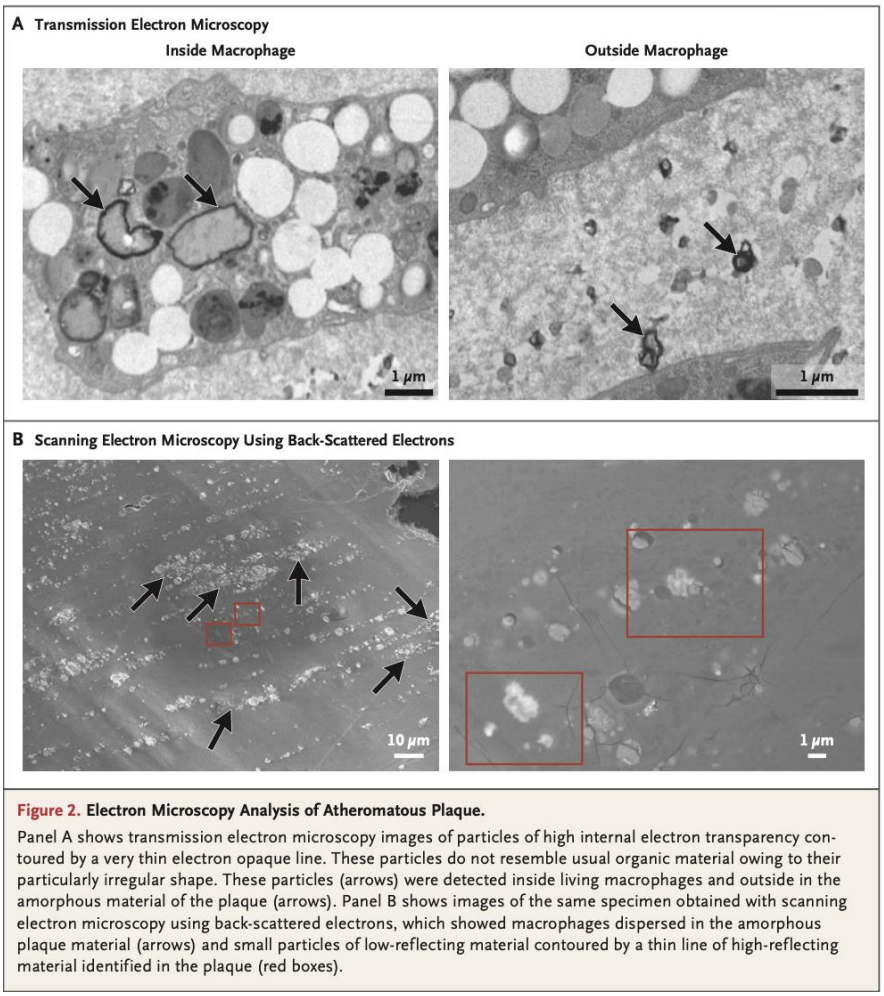


Figure 2. Electron Microscopy Analysis of Atheromatous Plaque.

Panel A shows transmission electron microscopy images of particles of high internal electron transparency contoured by a very thin electron opaque line. These particles do not resemble usual organic material owing to their particularly irregular shape. These particles (arrows) were detected inside living macrophages and outside in the amorphous material of the plaque (arrows). Panel B shows images of the same specimen obtained with scanning electron microscopy using back-scattered electrons, which showed macrophages dispersed in the amorphous plaque material (arrows) and small particles of low-reflecting material contoured by a thin line of high-reflecting material identified in the plaque (red boxes).

The images above depict close up images of the plaque taken using two different methods. The image on the left in A depicts inside the tissue immune cell while the image on the right depicts outside the tissue immune cell. The irregular, jagged-edged particles could be the microplastics. B takes overall images of the plaque and how the microplastics looked.

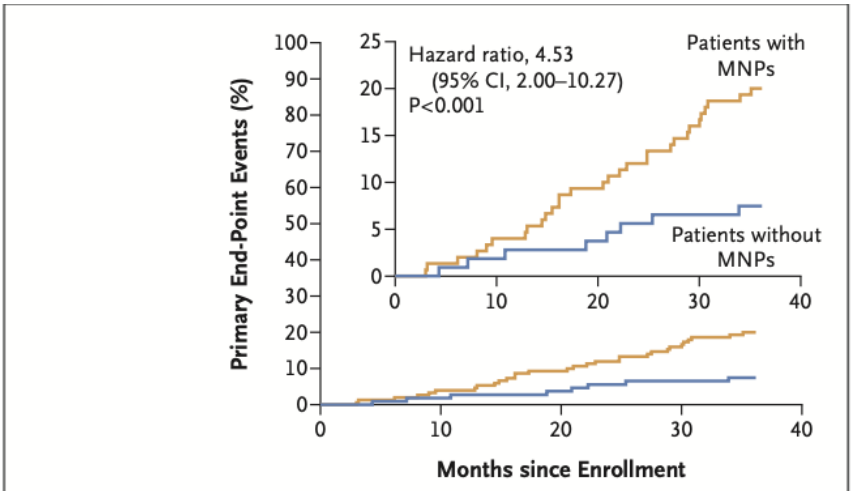


Figure 4. Associations between the Presence of MNPs and Cardiovascular Events.

Shown is the cumulative incidence curve of the composite outcome — nonfatal stroke, nonfatal myocardial infarction, or death from any cause. The results were estimated with the use of Cox regression analysis with adjustment for age, sex, body-mass index, total cholesterol, high-density lipoprotein cholesterol, low-density lipoprotein cholesterol, triglycerides, creatinine, diabetes, hypertension, and previous cardiovascular events in the group of patients with evidence of MNPs in plaque and the group of patients with no evidence of MNPs in plaque. The inset shows the same data on an expanded y axis.

The graph above (one graph as the second graph is just the bigger graph but with a smaller range of y values) depicts the months since enrollment versus the % chance of getting the primary end goal event. The patients with microplastics were more likely to hit the end-point event than without.

VOCAB: (w/definition)

Endarterectomy: A procedure where plaque is removed from arteries.
Macrophage: Immune cells that live in tissues.
Atherosclerotic: Build up of fat, cholesterol, etc. on the artery wall.
Neoplasm: Tumor
Dyslipidemia: Abnormal amount of fat in the blood
Creatine: provides energy to muscles during exercise

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Follow up Questions	- How would microplastics affect other organ systems? Could microplastics induce similar negative effects but effects respective to the organ system? - Are microplastics present in the organs of offspring if the parents have been exposed to microplastics? - How much would a clean, outside micro plastic free environment change results?

Article #10 Notes: "The Impact of Maternal Nanoplastic and Microplastic Particle Exposure on Mammal's Offspring"

Source Title	The Impact of Maternal Nanoplastic and Microplastic Particle Exposure on Mammal's Offspring
Source citation (APA Format)	Yu, H.-R., Sheen, J.-M., & Tiao, M.-M. (2024). The Impact of Maternal Nanoplastic and Microplastic Particle Exposure on Mammal's Offspring. *Cells (Basel, Switzerland), 13*(16), 1380. https://doi.org/10.3390/cells13161380
Original URL	https://www.mdpi.com/2073-4409/13/16/1380
Source type	Journal Article
Keywords	Prenatal, nanoplastics, microplastics, mammal, offspring, health
#Tags	

Summary of key points + notes (include methodology)	- The study focuses on how nanoplastic and microplastic exposure affects mammal offspring, specifically in the CNS, liver, intestines, reproduction, and skeletal muscles.
	- 400 million tons of plastic produced annually, only 9% of it is recycled.
	- 5 trillion plastic pieces (250,000 tons) in the ocean.
	- Plastic polymers are classified as permanent organic pollutant substances due to their additives:
	  ○ Antioxidants
	  ○ Lubricants
	  ○ Corrosion inhibitors
	  ○ Plasticizers
	  ○ Adhesives
	  ○ Heat stabilizers
	  ○ Flame retardants
	- We consume ~74,000-121,000 microplastics a year.
	  ○ The majority is removed from the body.
	  ○ If the microplastics are small enough, they could be absorbed.
	- Microplastics ranging from 0.1micrometer-10micrometers can cross blood brain barrier.

	- Maternal exposure to 0.5 micrometer nanoplastics or 5 micrometer microplastics can affect the energy and lipid metabolism of offspring.
	- There is a theory that physical fetus changes due to environment stress could increase the chances of disease.
	- Methodology:
	  o Data collection used PubMed and Google Scholar to collect articles based on key words such as “microplastic” or “fetus”
	  o Review articles, conference abstracts, and book chapters were excluded.
	  o 3110 articles were identified, but were then filtered down to 20 articles.
	  o Duplicate entries, model studies, nanoplastic/microplastic studies not in mammals, studies that do not mention offspring, studies that did not mention functional impacts, and studies that did not focus on microplastics on offspring were all filtered out.
	- Prenatal and postnatal exposure to polystyrene resulted in them building up in brain regions in mice.
	- Polystyrene nanoplastics went into the fetal hypothalamus in mice.
	  o On the 8th week of testing, the mice experienced anxiety-like behavior due to the reduced levels of GABA in the brain.
	- The polystyrene nanoplastic exposure in pregnant mice suppressed brain development genes in offspring, as well as anxiety and depression behaviors.
	  o Cognitive function fine.
	- Polyethylene microplastics exposed to mice (prenatal) led to behaviors that were like autism spectrum disorder behaviors.
	- In mice, after the parent mice were exposed to polystyrene microplastics, the presence of polystyrene microplastics was found in the brain, liver, lungs, heart, and kidneys of the fetus.
	- Exposing pregnant rats to a high-fat diet as well as polystyrene microplastics led to fatty liver disease in offspring.
	  o Other adverse affects to offspring such apoptosis, oxidative stress, decreased levels of glucose, acetate, TC, and GC, decreased TC levels in liver, etc.
	- Prenatal microplastic exposure has been linked to gut damage in mice.
	- Polyethylene microplastic exposure resulted in reduced oocyte maturation, fertilization, and embryo development in female offspring.
	- Polystyrene is the go-to microplastic for research as it is said to be a good representative microplastic.
	- Limited number of human studies into how microplastics effect offspring.

Research Question/Problem/ Need	When pregnant mammals are exposed to microplastics, how do those microplastics affect their offspring?

Important Figures

Table 1. The impact of prenatal NPl/MPl exposure on the central nervous system of mammalian offspring.

Material	Design	Size	Species/Stage	Effects	Ref.
PS	Prenatal oral ingestion	0.1 μm NPl + 1 μm MPl	• C57BL mice • PND 8 W	• Anxiety-like behavior • Reduced GABA level in the prefrontal cortex and amygdala	[49]
PS	Prenatal and postpartum oral ingestion	0.05 μm NPl	• C57BL/6J mice • PND 1 and 8–10 W	• Impact on the function of neural stem cells and the neuronal cells • Induced brain dysfunction	[38]
PS	Prenatal and postpartum oral ingestion	0.193 μm MPl and 0.04 μm NPl	• C57BL/6J mice • PND 16 W	• Downregulated the expression of genes related to brain development in the embryonic brain • Reduced *Gabra2* expression in both embryonic and adult brains • Offspring mice exhibited anxiety-like and depressive behaviors as well as adverse social behavior	[48]
PE	Prenatal oral ingestion	10–20 μm MPl	• C57BL/6J and CD-1 mice • PND 5–6 W	• ASD-like behavioral traits • Decreased social interaction, social novelty, and spatial working memory • Increased repetitive and compulsive behavior	[50]
PS	Prenatal and lactation oral ingestion	0.05 μm NPl	• SD rats • PND 3 W (22 day)/7 W	• Changes in monoamine neurotransmitters (cortex) and amino acid neurotransmitters (hippocampus) • Cortical plate thickness reduced, excessive proliferation of superficial layer neurons, decreased number of deep-layer neurons • Anxiety behaviors and deficits in spatial memory (PND 7 W)	[51]
The impact of prenatal NPl/MPl exposure on the retina of mammalian offspring					
PS	Prenatal and lactation oral ingestion	0.1 μm NPl	• C57BL/6 mice • PND 3 W	• PS-NPl deposition in retina • Developmental defects in neural retina and vascular retina, abnormal ERG responses, increased oxidative stress • Dysregulations in amino acid metabolism and gene expression; Fos-mediated pathway may serve as a key target	[52]

Abbreviations: ASD, autism spectrum disorder; ERG, electroretinogram; GABA, γ-aminobutyric acid; MPl, microplastics; NPl, nanoplastics; PE, polyethylene; PND, postnatal day, PS, polystyrene; SD, Sprague Dawley.

Table 2. The impact of prenatal NPl/MPl exposure on the liver and metabolism of mammalian offspring.

Material	Design	Size	Species/Stage	Effects	Ref.
PS	Prenatal oral ingestion	0.5 μm NPl and 5 μm MPl	• ICR mice • PND 6 W	• Fatty acid metabolism dysregulation	[41]
PS	Prenatal oral ingestion	5 μm MPl	• SD rats • PND 1 W	• Liver steatosis, apoptosis, inflammation, ROS increase, and villi atrophy • Combination with a high-fat diet during pregnancy may exacerbate certain pathologic changes	[53]
PS	Prenatal intra-tracheal ingestion	0.02 μm NPl	• SD rats • Fetus	• NPls were detected in the placenta, fetal liver, lungs, heart, and kidneys.	[37]
PS	Prenatal and postpartum oral ingestion	0.1 μm NPl	• Kunming mice • PND 3 W & 8 W	• Liver weight ↓, hepatic ROS ↑, inflammatory cell infiltration ↑, and proinflammatory cytokine expression ↑ • Disturbance in hepatic glycometabolism	[44]
PS	Prenatal and postpartum oral ingestion	5 μm MPl	• ICR mice • F1 generation at PND 6 W and PND 40 W. • The F2 generation at PND 6 W	• Reduced levels of glucose, pyruvate, total cholesterol and triglyceride in F1 female offspring • Altered hepatic cholesterol in F1 generation offspring • Alteration in mRNA expressions of gene related to glycolipid metabolism • Changes in the gut microbiome	[34]
PS	Prenatal inhalation	≈0.07 μm NPl	• C57BL mice • PND 12 W	• Hepatic steatosis in adult female offspring but not male offspring • Elevated expression of genes related to fatty acid uptake and tri-glycerol synthesis in the G3P pathway	[54]

Abbreviation: G3P, glycerol 3-phosphate; MPl, microplastics; NPls, nanoplastics; PND, postnatal day; PS, polystyrene; ROS, reactive oxygen species; SD, Sprague Dawley.

Table 3. The effects of prenatal NPl/MPl exposure on the intestines of mammalian offspring.

Material	Design	Size	Species/Stage	Effects	Ref.
PS	Prenatal oral ingestion	0.08 µm NPl	• C57BL/6J mice	• Histological changes in small intestine • Upregulation of ROS • Downregulation of GPx4, FTH1, and FTL protein levels, indicating initiation of ferroptosis	[55]
PS	Prenatal oral ingestion	5 µm MPl	• SD rats • PND 1 W	• Decrease in villi length of offspring ileum upon high prenatal MPl exposure	[53]

Abbreviation: FTL, ferritin light chain; FTH1, ferritin heavy chain 1; GPx4, glutathione peroxidase 4; MPl, microplastics; NPl, nanoplastics; PND, postnatal day; PS, polystyrene; ROS, reactive oxygen species; SD, Sprague Dawley.

Table 4. The effects of prenatal NPl/MPl exposure on the reproductive system of mammalian offspring.

Material	Design	Size	Species/Stage	Effects	Ref.
PS	Prenatal and postpartum oral ingestion	0.5 µm NPl	• ICR mice • PND 5 W & 10 W	• Testicular development and sperm production impacted through the Hippo signaling pathway and an imbalance in the immune microenvironment in F1 male offspring	[59]
PS	Prenatal and postpartum oral ingestion	0.1 µm NPl	• Kunming mice • PND 3 W & 8 W	• F1 male offspring showed a reduction in testicular weight, disruption in the seminiferous epithelium, and decreased sperm count	[44]
PE	Prenatal and postpartum oral ingestion	10–150 µm MPl	• Kunming mice • PND 8 W	• F1 female offspring showed a reduction in the oocyte maturity, fertilization rate, and embryo development	[60]
PS	F0 exposure at lactational stage	1 µm MPl	• ICR mice	• Epididymal semen concentration and sperm viability decreased in F1 male offspring • Downward trend in sperm counts in F2 male offspring	[61]

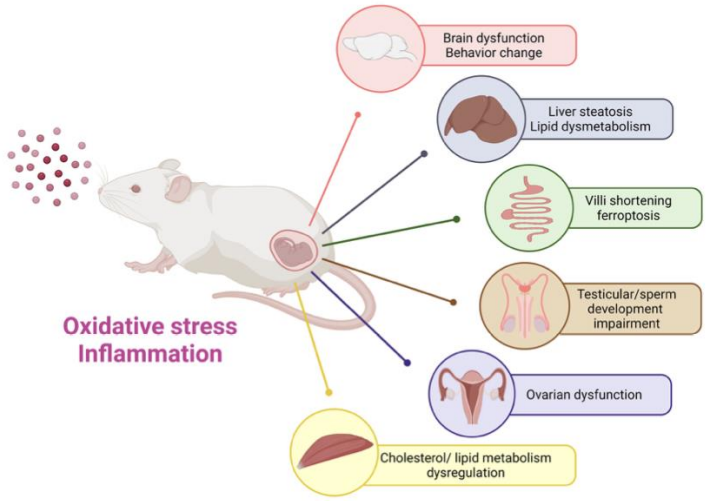
Abbreviation: MPl, microplastics; NPl, nanoplastics; PE, polyethylene; PND, postnatal day; PS, polystyrene.

Table 5. The impact of prenatal NPl/MPl exposure on the skeletal muscle of mammalian offspring.

Material	Design	Size	Species/Stage	Effects	Ref.
PS	Prenatal oral ingestion	0.1 µm NPl	• C57BL/6J • fetus	• Dysregulated expression of genes regulating cholesterol and lipid metabolism, muscle tissue development, and skin formation	[45]

Abbreviation: NPl, nanoplastics; PS, polystyrene.

All tables reflect summaries of the data that was found in the other articles. It is divided into microplastic material, how the microplastics were administered, the microplastic size, the species of mice and how many weeks since fertilization, the effects shown, and the reference. Each table is for a different group of tests, for example table 4 depicts effects on the reproductive system while table 1 depicts effects on the central nervous system.

	 **Figure 1.** The impact of prenatal microplastic exposure on various organs of the offspring, including the brain, liver, intestine, reproductive system, and skeletal muscle. This diagram emphasizes the potential risks linked to maternal exposure to nanoplastics and microplastics, highlighting the necessity of further research to comprehensively clarify long-term effects on the health of offspring. This is the visual summary of the article, depicting how the microplastics affected the offspring mice.
VOCAB: (w/definition)	Hypothalamus: Part of the forebrain that controls important body systems and is also involved in emotional activity. Y-aminobutyric acid (GABA): Inhibitory neurotransmitter for the CNS. Prefrontal cortex: Part of the forebrain that controls decision making, planning, problem solving, etc. Amygdala: Almond shaped gray matter that helps with experiencing emotions. Monoamine: Neurotransmitters like dopamine, norepinephrine, and serotonin. Hepatic Steatosis: Fatty liver disease Oocyte: cell in ovary that divides into ovum
Cited references to follow up on	- Rotchell, J.M.; Jenner, L.C.; Chapman, E.; Bennett, R.T.; Bolanle, I.O.; Loubani, M.; Sadofsky, L.; Palmer, T.M. Detection of microplastics in human saphenous vein tissue using muFTIR: A pilot study. PLoS ONE 2023, 18, e0280594. - Cox, K.D.; Covernton, G.A.; Davies, H.L.; Dower, J.F.; Juanes, F.; Dudas, S.E. Human Consumption of Microplastics. Environ. Sci. Technol. 2019, 53, 7068–7074. - Abbasi, S.; Turner, A. Human exposure to microplastics: A study in Iran. J. Hazard. Mater. 2021, 403, 123799. - Ragusa, A.; Notarstefano, V.; Svelato, A.; Belloni, A.; Gioacchini, G.; Blondeel, C.; Zucchelli, E.; De Luca, C.; D'Avino, S.; Gulotta, A.; et al. Raman Microspectroscopy Detection and Characterisation of Microplastics in Human Breastmilk. Polymers 2022, 14, 2700. - Ragusa, A.; Svelato, A.; Santacroce, C.; Catalano, P.; Notarstefano, V.; Carnevali, O.; Papa, F.; Rongioletti, M.C.A.; Baiocco, F.; Draghi, S.; et al. Plasticenta: First evidence of microplastics in human placenta. Environ. Int.

	2021, 146, 106274. - Luo, T.; Zhang, Y.; Wang, C.; Wang, X.; Zhou, J.; Shen, M.; Zhao, Y.; Fu, Z.; Jin, Y. Maternal exposure to different sizes of polystyrene microplastics during gestation causes metabolic disorders in their offspring. Environ. Pollut. 2019, 255, 113122. - Huang, T.; Zhang, W.; Lin, T.; Liu, S.; Sun, Z.; Liu, F.; Yuan, Y.; Xiang, X.; Kuang, H.; Yang, B.; et al. Maternal exposure to polystyrene nanoplastics during gestation and lactation induces hepatic and testicular toxicity in male mouse offspring. Food Chem. Toxicol. Int. J. Publ. Br. Ind. Biol. Res. Assoc. 2022, 160, 112803. - Chen, G.; Xiong, S.; Jing, Q.; van Gestel, C.A.M.; van Straalen, N.M.; Roelofs, D.; Sun, L.; Qiu, H. Maternal exposure to polystyrene nanoparticles retarded fetal growth and triggered metabolic disorders of placenta and fetus in mice. Sci. Total Environ. 2023, 854, 158666.
Follow up Questions	- What other organs do microplastics transferred from parent to offspring affect? - How do different polymers affect the results? Would they go and affect different systems? - Would a smaller size of microplastic worsen the effects in offspring?

Article #11 Notes: "Microplastic fiber-induced transgenerational epigenetic disruption impairs fitness in *Daphnia Magna*"

Source Title	Microplastic fiber-induced transgenerational epigenetic disruption impairs fitness in *Daphnia Magna*
Source citation (APA Format)	Shim, B. S., Yoon, H. M., An, J.-H., Chen, Q., Kim, G. J., Lee, J.-S., Park, H. G., & Lee, Y. H. (2025). Microplastic fiber-induced transgenerational epigenetic disruption impairs fitness in Daphnia magna. *Aquatic Toxicology, 289,* Article 107579. https://doi.org/10.1016/j.aquatox.2025.107579
Original URL	https://www.sciencedirect.com/science/article/pii/S0166445X25003431?via%3Dihub
Source type	Journal Article
Keywords	Microplastic fibers, *Daphnia*, DNA methylation, Transgenerational effects, epigenetics
#Tags	#Methodology, #Abstract, #Conclusion
Summary of key points + notes (include methodology)	- Effects of plastic pollution on organisms have been studied a lot, not intergenerational effects. - Transgenerational toxicity of microplastic fibers (MPFs) on reproduction and molting frequency over 3 generations (negatively impacted). - Microplastic fibers lead to adverse epigenetic effects through epigenetic modifications. - Ingestion and accumulation of MPFs lead to negative impacts on the physiology of aquatic species, and along with other stressors like heavy metals, organic pollutants, and ocean acidification can lead to a negative toxic effect. - MPFs impair fertility in freshwater zooplankton (long term population declines). - Intergenerational effects and underlying mechanisms of MPF exposure is unknown. - Stressors can cause epigenetic modifications in aquatic metazoans, which can effect gene expression in offspring.

	- Stressors can be linked to behavioral, physiological, and molecular changes in later generations. - D. magna are indicator species for water pollution. - Well suited for study due to sensitivity, short life cycle, and fully sequenced genome. - DNA methylation identified as key mechanism for responding to environment stress. - Fluorescent polyester fibers --> Prof Qiqing Chen - Generated by compound spinning process, having polypropylene core with fluorescent microcapsules, polyester sheath. - Enables fibers to glow under ultraviolet (385nm) while minimizing dye release. - Cut into 6 micrometer microfibers using cryotome protocols. - Morphology, length, surface potential analyzed by electron microscopy. - MPF concentrations 2-72 particles/L. - D. magna were exposed to 10 particles/L and 100 particles/L. - Made sure that no dyes leaked. - D. magna (KIT strain) sourced from Carolina Science and Math. - Cultured in artificial Daphnia medium at 23 degrees Celsius in a half light half dark cycle. - They were fed Chlorella vulgaris (3.2x10^8 cells/L) daily. - Selected healthy females and maintained 5 generation inbred line to minimize genetic variation. - Offspring exposed to MPFs of control or treatment. - Transgenerational toxicity evaluated using the 3rd round of newborns on day 22 from parents exposed to 21 days. - In chronic toxicity, D. magna exposed to M4 medium with or without MPFs in 500-mL Duran bottles maintained under same conditions. Solutions renewed every 2 days for 21 days. - Stock solutions prepared and homogenized by sonication. - Molting rate and reproduction analyzed over 21 days. - Molted exoskeletons were collected and counted, newborns were counted. - Used a polulation net reproductive rate from a projected age-structured Leslie matrix using survival and fecundity data from a study. - Daily survival monitored with survival probabilities calculated. - Fecundity calculated as #neonates/adult. - Derived a Leslie matrix, standard errors derived from that. - Fitness effects --> differences between treatment fitness values and control fitness values. Negative effects --> fitness reduction. - Preformed whole-genome bisulfite sequencing, with DNA extracted from each D. magna with quality and quantity assessed using agarose gel electrophoresis. - Adult D. magna homogenized in genomic DNA extraction buffer using Teflon homogenizer and left overnight before being extracted using phenol-chloroform-isopropanol method and precipitation with ammonium acetate for 10 minutes. - DNA pellet washed with 70% ethanol and dried before being resuspended in

	TE buffer. - DNA quantity and quality measured using NanoDrop spectrophotometer. - DNA converted using sodium bisulfite treatment, and was used to make sequencing libraries. - Trip Galore was used to filter out not ideal reads. - Processed reads aligned to reference genome, duplicates were removed, methylation scores and nucleotide-level coverage determined. - Global methylation rates determined using Kendall's rank correlation method. - Methylation levels to cytosine site were expressed in a ration of 0 to 1. - Differentially methylated gens with a false discovery rate of <0.05 were considered significant. - Several genes selected from DMGs to look at methylation patterns and function. - All data expressed as mean values with standard deviation. - Paired Student's t-tests used to compare groups to control. - Normality of variance (SPSS and R) using Shapiro-Wilk and Kolmogorov-Smirnov tests. - Correlation and regression conducted for zeta potential and pH. - Fluorescence analyzed using one-way ANOVA and Duncan's tests ($p<0.05$). - MP exposure impaired growth and reproductivity across generations. - MPFs were uniform. - Surface charge on MPFs greater than microbeads. - Plastic fragments were not present beyond F1 generation, body size was reduced. - Negative impacts on total offspring, release of 1st brood, and molt amount in F0, especially with 100 particles/L --> concentration dependent. - F2 generation when exposed to 100 particles/L led to infertility. - Reproduction issues persisted even when not exposed to the solution. - Not related to intergenerational transfer, as for filial generations not exposed to MPs still had declines in growth and reproduction. - Possible need for time to recover - Transgenerational effects can be induced by biotic (+) abiotic stress. - Delay in molting from MPFs possibly linked to decreased reproduction. - Compared to F0, MPF exposed groups showed a 42.34% reduction compared to control. - Most fibers left D. magna systems within 24hrs. - Fibers are longer than beads, leading to more mechanical stress. - F1 --> fitness reduced by 204.48% in multigenerational and 122.42% in transgenerational. - Negative effects persist even after direct exposure stopped.
Research Question/Problem/ Need	How do microplastic fibers impact freshwater organisms intergenerationally, as well as what are the underlying mechanisms involved?

Important Figures

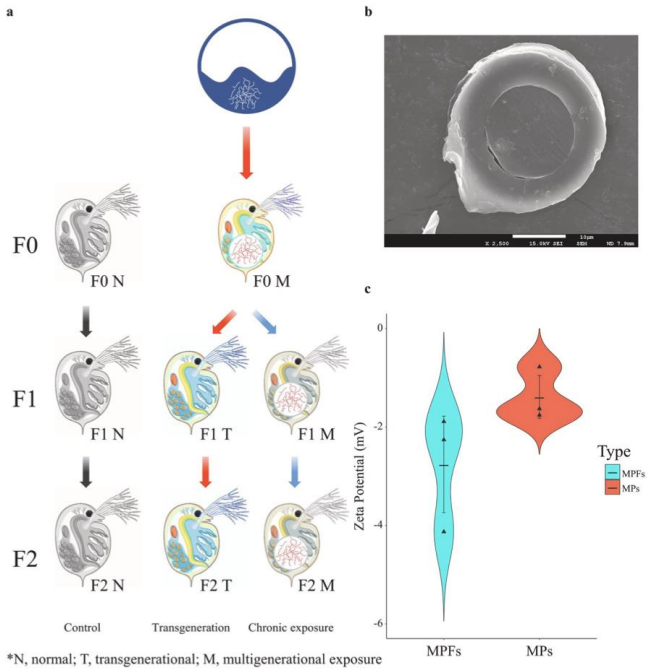


Fig. 1. Overview of the experimental design and characteristics of MPFs. (a) Schematic representation of the experimental setup. *D. magna* were exposed to MPFs (6 μm, 10 and 100 particles/L) across three generations (multigenerational and transgenerational groups), after which life history parameters and DNA methylation profiles were analyzed. (b) Scanning electron microscope images of MPFs. (c) Surface zeta potential values of MPFs and microplastic beads (MPs) in M4 media.

The graphical methodology and characterization of the MPFs. A shows the graphical methodology and how they conducted the experiment, b and c show the construction and zeta potentials of the MPFs respectively. The zeta potential of the MPF is more spread out than microbeads.

Table 1
Transgenerational and multigenerational effects of plastic pollution on aquatic organisms.

Generation	Species	Exposure time	Types of plastics	Condition		Endpoints	Main results	References
				Size (μm)	Conc. (mg/L)			
Trans-generation	*Daphnia magna* (Cladocera)	F0-F3	Polyethylene	17.35 ± 5.50	4.32, 5	Survival, fecundity, DNA methylation.	Maternal exposure to polyethylene microplastics containing BP-3 caused transgenerational reproductive and growth impairments in *D. magna*.	Song et al., 2022
		F0-F3	Thermoset amino formaldehyde polymer	2	0.1	Transgenerational recovery, mortality, first brood, total broods, growth.	Up to the F3 generation, reduced growth, reproduction, and population growth rate were observed.	Martins and Guilhermino, 2018
	Danio rerio (Zebrafish)	F0-F1	Polystyrene	0.042	0.3	Oxidative stress markers, larval behavior, mitochondrial function.	Dietary exposure to polystyrene nanoparticles in adult zebrafish led to maternal transfer to offspring and altered antioxidant activity in both adults and larvae.	Pitt et al., 2018
	Macrobrachium nipponense (Freshwater prawn)	F0-F1	Polystyrene	5	2, 20	Survival, hatching success, steroidogenic gene expression, immunity related enzyme activity.	Transgenerational immune and developmental toxicity were observed in oriental river prawns, affecting offspring despite their lack of direct exposure.	Sun et al., 2022
	Paracyclopina nana (Copepod)	F0-F2	Polystyrene	0.05	10	Reproductive impairments, DNA methylation patterns.	Significant decrease in reproduction were observed in F1 and F2 transgenerational groups.	Lee et al., 2023a
Multi-generation	*Daphnia magna* (Cladocera)	F0-F3	Polystyrene	0.2	0.1, 1	Mortality, development, offspring, fecundity, body length.	Reduced survival, decreased body size and lipid content in F3 offspring were observed.	Heinlaan et. al., 2023
	Daphnia pulex (Cladocera)	F0-F2	Polystyrene	0.071	0.001	Survival, growth, reproduction, transcriptome.	Impaired growth and reproduction in F2 generation were observed despite partial recovery, with transcriptional changes of reproduction and stress defenses related genes.	Liu et al., 2020
	Paramisgurnus dabryanus (Large scale loach)	F0-F1	Polyethylene	8-15	0, 1, 10	Gonad damage, reproductive toxicity, Cross-generational.	Parental exposure to polyethylene microplastics in loach enabled transgenerational transfer to embryos, leading to increased mortality and malformations, reduced hatching success, and impaired larval development in the F1 generation.	Xia et al., 2023
	Tigriopus japonicus (Copepod)	F0-F1	Polystyrene	0.05, 0.5, 6	0.125-25	Survival, development, and fecundity	Reduced survival and fecundity were observed in the F1 generation, particularly with smaller bead sizes.	Lee et al., 2013
		F0-F2	Polystyrene	0.05	0.023	Accumulation, life history, transcriptomic response.	Exposure to polystyrene nanoplastics and mercury over three generations in *T. japonicus* led to increased mercury accumulation, reduced survival and reproduction, and molecular damage.	Xie et al., 2023

This table looks at different aquatic organisms with their exposure time, plastic type, size and concentration, goals, and results. It also divides the studies between trans-generation and multi-generation.

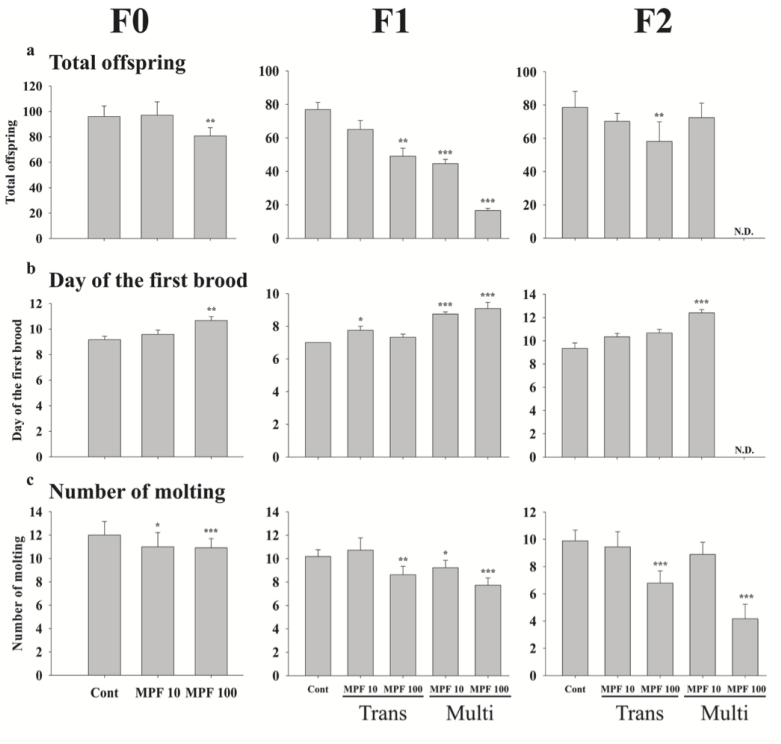
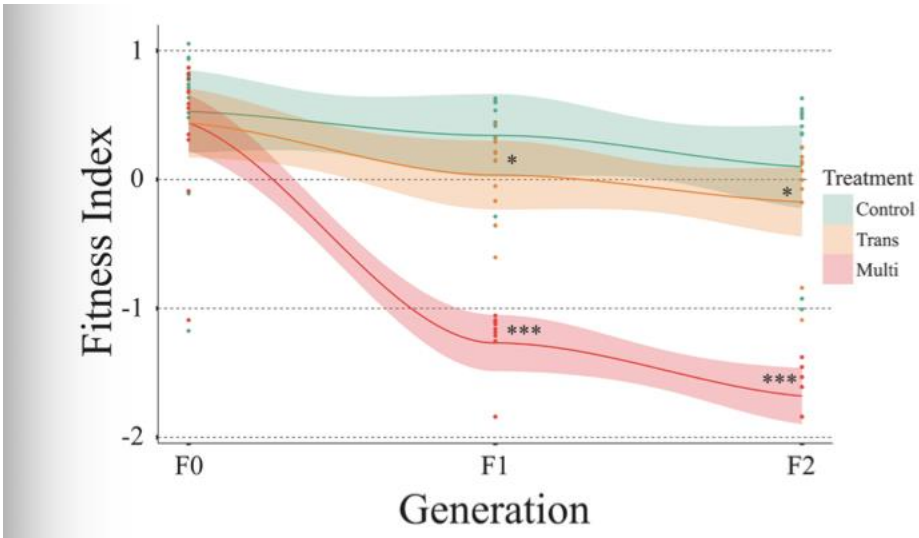


Fig. 2. *In vivo* life history parameters of *D. magna* in response to MPFs exposure. (a) Total offspring, (b) day of the first brood, and (c) number of molts in the multigenerational and transgenerational groups (F0, F1, and F2 generations). Significant differences among test groups were analyzed using one-way analysis of variance (ANOVA) followed by Tukey's post hoc test ($P < 0.05$). Asterisks indicate statistically significant differences.

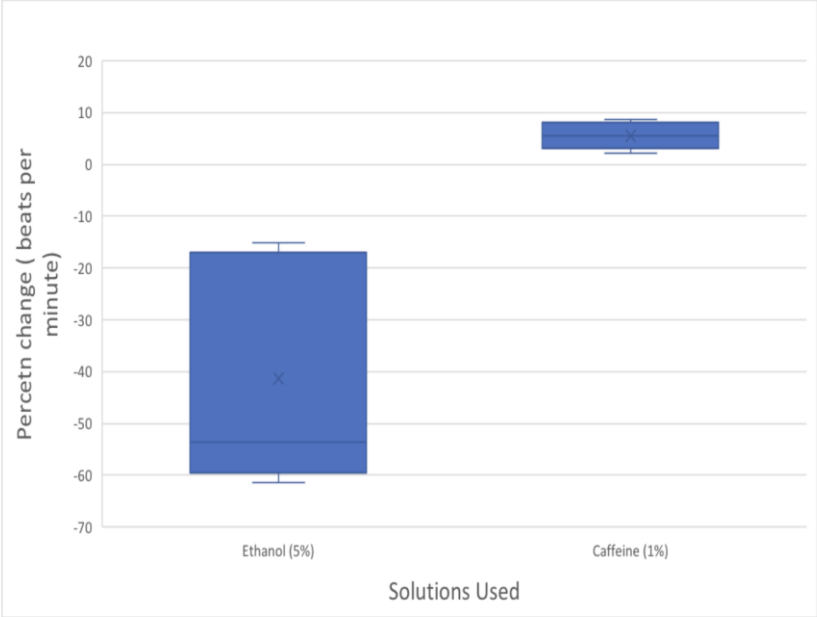
This figure looks at the responses to different MPF exposures in terms of total offspring, day of first brood, and molt number. It divides the data between F0, F1, and F2, and divides those subsections into control, MPF 10, and MPF 100, with F1 and F2 also being divided into transgenerational and multi-generational.

	 **Fig. 3.** Multigenerational and transgenerational effects of MPFs on *D. magna* fitness. The plot represents the relative fitness of *D. magna* exposed to MPFs across generations compared to control conditions. Error bars represent 95% confidence intervals around the mean. Asterisks indicate significant decreases relative to control groups (*$P < 0.05$, **$P < 0.01$, ***$P < 0.001$; *t*-test). This figure looks at the fitness of D. magna when exposed to microplastics across F0, F1, and F2 for control, transgenerational, and multigenerational effects. The multigenerational effect had a big decrease in fitness compared to the Trans and Control, both points being P<0.0001, while Trans versus control was significant by P<0.05.
VOCAB: (w/definition)	Methylation patterns: Patterns of adding methyl groups to DNA --> crucial epegenetic switches. Bisulfite sequencing: Maps DNA methylation by converting unmethylated cytosines to uracils while leaving methylated cytosines alone. Parthenogenetic: Organism develops from unfertilized egg Sheath: cover Cryotome: Refrigerated chamber used to freeze and cut thin sections of tissue for microscopic analysis. Morphology: study of forms Leachates: contaminated liquid Neonates: newborn Sonication: high-frequency sound waves to agitate liquid to remove air bubbles. Fecundity: fertility
Cited references to follow up on	Barrows, A.P.W., Cathey, S.E., Petersen, C.W., 2018. Marine environment microfiber contamination: Global patterns and the diversity of microparticle origins. Environ. Pollut. 237, 275–284. https://doi.org/10.1016/j.envpol.2018.02.062. Caswell, H., 2000. Matrix Population Models, 1. Sinauer Associates: Sunderland, MA, USA. Christoforou, E., Dominoni, D.M., Lindström J., Stilo, G., Spatharis, S., 2020. Effects of long-term exposure to microfibers on ecosystem services provided by coastal mussels. Environ. Pollut. 266, 115184. https://doi.org/10.1016/j. Envpol.2020.115184.

	Cole, M., 2016. A novel method for preparing microplastic fibers. Sci. Rep. 6, 34519. https://doi.org/10.1038/srep34519. Harris, K.D., Bartlett, N.J., Lloyd, V.K., 2012. Daphnia as an emerging epigenetic model organism. Genet. Res. Int. 2012 (1), 147892. https://doi.org/10.1155/2012/147892. Junaid, M., Liu, S., Chen, G., Liao, H., Wang, J., 2023. Transgenerational impacts of micro (nano) plastics in the aquatic and terrestrial environment. J. Hazard. Mater. 443, 130274. https://doi.org/10.1016/j.jhazmat.2022.130274. Lyu, K., Yu, B., Li, D., Gu, L., Yang, Z., 2022. Increased food availability reducing the harmful effects of microplastics strongly depends on the size of microplastics. J. Hazard. Mater. 437, 129375. https://doi.org/10.1016/j.jhazmat.2022.129375. Ma, C., Li, L., Chen, Q., Lee, J.S., Gong, J., Shi, H., 2021. Application of internal persistent fluorescent fibers in tracking microplastics in vivo processes in aquatic organisms. J. Hazard. Mater. 401, 123336. https://doi.org/10.1016/j.jhazmat.2020.123336. Martins, A., Guilhermino, L., 2018. Transgenerational effects and recovery of microplastics exposure in model populations of the freshwater cladoceran Daphnia magna Straus. Sci. Total. Environ. 631, 421–428. https://doi.org/10.1016/j.scitotenv.2018.03.054. Xia, X., Guo, W., Ma, X., Liang, N., Duan, X., Zhang, P., Zhang, Y., Chang, Z., Zhang, X., 2023. Reproductive toxicity and cross-generational effect of polyethylene microplastics in Paramisgurnus dabryanus. Chemosphere 313, 137440. https://doi.org/10.1016/j.chemosphere.2022.137440. Ziajahromi, S., Kumar, A., Neale, P.A., Leusch, F.D., 2017. Impact of microplastic beads and fibers on water flea (Ceriodaphnia dubia) survival, growth, and reproduction: implications of single and mixture exposures. Environ. Sci. Technol. 51, 13397–13406. https://doi.org/10.1021/acs.est.7b03574. Ziajahromi, S., Kumar, A., Neale, P.A., Leusch, F.D., 2018. Environmentally relevant concentrations of polyethylene microplastics negatively impact the survival, growth and emergence of sediment-dwelling invertebrates. Environ. Pollut. 236, 425–431. https://doi.org/10.1016/j.envpol.2018.01.094.
Follow up Questions	- How is heart rate affected cross generationally? - Is there a correlation between the altered genes and heart rate? - If D. magna let go of most of the MPs in their system, is it worthwhile to give the D. magna time to let go of the microplastics to not affect the children generation when put in the wells?

Article #12 Notes: The Effect of Caffeine and Ethanol on the BPM of Daphnia Magna

Source Title	The Effect of Caffeine and Ethanol on the BPM of Daphnia Magna
Source citation (APA Format)	Kurien, B., Perkins, C., Tullos, C., Mittermeier, Q., & Hjalmarson, E. (2018). The Effect of Caffeine and Ethanol on the BPM of Daphnia magna. *Journal of Undergraduate Biology Laboratory Investigations*, *1*(2). https://undergradsciencejournals.okstate.edu/index.php/JUBLI/article/view/8785.
Original URL	https://undergradsciencejournals.okstate.edu/index.php/JUBLI/article/view/8785
Source type	Journal Article
Keywords	N/A
#Tags	#Abstract, #Methods
Summary of key points + notes (include methodology)	- Daphnia have hearts similar to humans. - Hypothesized that caffeine would increase the heart rate, and ethanol would decrease the heart rate. - 5 trials for each solution. - Hypothesis was significantly supported (caffeine p=0.005024, ethanol p=0.028729). - Action potentials connect motor + sensory neurons to the brain. - When graded potential reaches threshold, action potential is fired, which releases neurotransmitters. - Neurotransmitters travel to the next neuron, and bind to channels that allow sodium to go between neurons. - Caffeine and ethanol can affect the neurotransmitters, while can influence bodily functions such as heart rate. - Ethanol can repress heart rate by manipulating baroreflex sensitivity (the more consumed, the more repression). - Ethanol can also hinder production of adrenaline, which can affect the regulation of increasing heart rate. - Caffeine increases activity, which can cause tachycardia. - Daphnia heart rate is myogenic (has a special muscle to regulate heart rate) - Baseline heart rate was recorded pre-exposure and post exposure to the solutions. - 5% ethanol, 1% caffeine, each solution was tested on 5 daphnia. - Daphnia were placed in water and 5 drops of either solution was added to the daphnia slide, with an exposure time of 7 minutes. - Daphnia were exposed on microscope slides. - Heartbeat was recorded for 10 seconds, which was then counted and multiplied by 6 to determine bpm.

	- Paired TTest was used to compare pre and post exposure. - TTest used because same daphnia pre and post exposure. - % change was also calculated using (((post BPM-pre BPM)/pre BPM)*100). - Daphnia moved more slowly with the introduction of ethanol. - Caffeine did not visually have an effect on speed or movement. - Ethanol has inversely proportional relationship with heart rate, caffeine had proportional relationship. - Not very consistent in time of exposure (several daphnia were exposed for around 1 minute extra). - Handling was a bit rough, daphnia could've slowed down when ethanol was added due to less water. - Caffeine can also increase systolic blood pressure and artery stiffness.
Research Question/Problem/ Need	How do different drugs like caffeine and ethanol affect the heart rate of a Daphnia Magna?
Important Figures	 *Figure 1: Demonstrates the percent change (BPM) of ethanol and caffeine. Overall ethanol decreased heart rate (with significant spread in data) while caffeine increased heart rate.* The candlestick plot used to show the percent change of ethanol and caffeine.
VOCAB: (w/definition)	Action potentials: A quick change in resting membrane potential. Graded potential: Change in the conductivity of the sensory receptor cell membrane. Axon: Where electrical pulses travel away to be received by another neuron. Synaptic Cleft: The gap between presynaptic axon terminal and posynaptic dendrite. Synapse: Convert electrical signal (action potential) into chemical signal through

	neurotransmitter release. Ligand gated channels: Proteins that are ion channels that open when ligands binds to them. Baroreflex sensitivity: Sensitivity in the change for the body's demand for blood. Tachycardia: Fast heart rate. (>100bpm) Myogenic: From muscle tissue. Bradycardia: Slow heart rate (60-100 bpm). Systolic blood pressure: The artery pressure when blood pumps throughout the body.
Cited references to follow up on	- Investigating factors affecting the heart rate of Daphnia. (n.d.). http://www.nuffieldfoundation.org/practical-biology/investigating-factors-affecting-heart-rate-daphnia (accessed 10/23/18). - Starr, I., Gamble, C. J., Margolies, A., Donal, J. S., Joseph, N., & Eagle, E. (1937). A clinical study of the action of 10 commonly used drugs on cardiac output, work and size; on respiration, on metabolic rate and on the electrocardiogram. *The Journal of clinical investigation, 16(5):* 799-823. - Abdel-Rahman, A. R., Merrill, R. H., & Wooles, W. R. (1987). Effect of acute ethanol administration on the baroreceptor reflex control of heart rate in normotensive human volunteers. *Clinical science*, *72*(1): 113-122. - Uzbay, I. T. (2007). Serotonergic anti-depressants and ethanol withdrawal syndrome: a review. *Alcohol & Alcoholism*, *43*(1): 15-24.
Follow up Questions	- How do different levels of caffeine and ethanol affect the heart rate of a Daphnia Magna? - How are the filial generations of Daphnia Magna affected by caffeine and ethanol exposure? - How do other drugs affect the heart rate?

Article #13 Notes: “Do’s and don’ts of microplastic research: a comprehensive guide”

Source Title	Do’s and don’ts of microplastic research: a comprehensive guide
Source citation (APA Format)	Prata, J. C.; Padrão J.; Khan, M. T.; Walker, T. R. Do's and don'ts of microplastic research: a comprehensive guide. *Water Emerg. Contam. Nanoplastics 2024*, *3*, 8. http://dx.doi.org/10.20517/wecn.2023.61
Original URL	https://www.oaepublish.com/articles/wecn.2023.61
Source type	Research Article
Keywords	Plastic pollution, environmental monitoring, environmental impact, toxicity assays
#Tags	#Contamination, #Health, #Abstract

Summary of key points + notes (include methodology)	- Guide for microplastics research that addresses all challenges (severity based on survey) and bringing up best practices.
	- Lack of analytical equipment as well as working with lower concentrations for toxicity are difficult.
	- Will focus on definitions, sampling, and negative effects.
	- Most research focused on marine life
	- 16,083 publications in Web of Science (January 2024), 4056 (25.2%) published in 2023 for MPs.
	- Greatest challenges (MP sample and analysis) are:
	  ○ Lack of standardized methods
	  ○ Contamination control
	  ○ Lack of specialized equipment
	  ○ Difficulty in identifying MPs and MPFs
	- Greatest challenges in ecotoxicity are:
	  ○ Access to good MPs for testing
	  ○ Quantification of MPs for solutions or confirm nominal concentrations
	  ○ Environmentally accurate concentrations
	- 44% of plastic used in packaging, 79% end up in landfills or the environment
	- Each MP is unique in polymer type, additives, adsorbed contaminants,

	degradation state, color, size, shape, and biofouling. - Size classification of MPs from National Oceanic and Atmospheric Administration --> size that can be easily consumed by organisms - 1 micrometer is the lowest limit from limits of common equipment. - Nanoplastics have been defined as <1 micrometer. - Microplastics should be insoluble in water and made of a synthetic polymeric matrix. - Modified natural polymers, hybrid polymers, copolymers, composites, surface coatings also containing polymers, and tire wear particles are all also MPs. - Primary MPs can be produced for cosmetics or abrasives. - Solar ultraviolet radiation creates a reaction that degrades plastic. - Complete degradation expected to take hundreds of years (450 for polyethylene) - MPFs are also MPs and may be able to penetrate deeply into tissue, causing issues. - The paper goes into the collection sampling of microplastics and statistical tests for that. It mainly touches upon sampling of water, soil, air, and biological matter. - Biological matter is hardest to work with due to multiple factors to take into consideration, so more research on MP effects on land ecosystems is needed. - Screening of MPs under microscope or stereoscope is one of the simplest and cheapest methods (can be subjective) - Hot needle test can separate melting plastics as thermoplastics. - Soldering iron and classification criteria (particle melts, bends, curls) results in >= 82% classification. - Staining also helps identify MPs - Article also provides insight on chemical characterization of microplastics and the technices that could be used such as Fourier transform infrared spectroscopy - Contamination is easy, the main two ways being airborne MPs and cross contamination from solutions and materials - Can be reduced by: o Regular laboratory cleaning o Proper ventilation/reduced movement o Capping samples o Fume hood (ideally laminar flow hood) o Cotton lab coats o Filtering solutions used in cleaning or added to solution o Washing materials between samples (ideally in acid-->running distilled water) o Only glass and metal materials o Decontaminating inorganic filters o There should be blanks during sample collection and processing (procedural blanks, field blanks, etc) o MPs in blanks can be subtracted from results

	- Error is most found in human error, however error in size, shape, color, or matrix properties of MPs are other sources of error.
	- Sample preparation reduces errors in identifying microplastics (removes confounding particles)
	- Higher error in smaller MP size
	- Most common variation was underestimation from sample contamination.
	- Relevant sources of MPs are pellets, microbeads (cosmetics), paint, textiles, wastewater effluents, synthetic pavement, artificial turf, tire wear, fishing gear, and littering.
	- MPs reaching the sea through rivers, reaching remote locations through the atmosphere.
	- MPs can also be mixed with sediment and put into geological formations.
	- MPs found in GI tract of of invertebrates and vertebrates.
	  o Limited to large MPs in GI lumen or tissue
	- MPs in gut could cause internal issues and go through food chain.
	- Bivalves (filter feeders) suggested as bioindicator.
	  o Insight into spatial distribution of MPs and interaction with organisms
	- Not a lot of testing done for abiotic effects (though marine plastic pollution is already considered dangerous and bad)
	- Plastisphere: there is microorganism communities living on MPs through biofilm formation, which degrade the plastic but also can cause issues to the surrounding environment due to the microorganisms differing between plastic and environment.
	- Human exposure to MPs is estimated at 2.93x10^10 MPs/year.
	  o Accurate estimation is needed due to some sources of error
	- Skin exposure is not relevant
	- Once ingested/inhaled, <1% o smaller MPs translocate, however some may find way into blood and be distributed.
	- No evidence to support impacts on health
	- More realistic/not pristine microplastics may change the results

Research Question/Problem/ Need	How can a lot of the issues with the lack of standardization in MP testing be addressed in a way for new researchers to understand?

Important Figures

Figure 1. Primary microplastic (transparent bead), secondary microplastic (blue fragment), and mesoplastic (white fragment) found on Matosinhos beach, Portugal, in September 2023.

Image of a mesoplastic (white), primary microplastic (translucent), and secondary microplastic (blue).

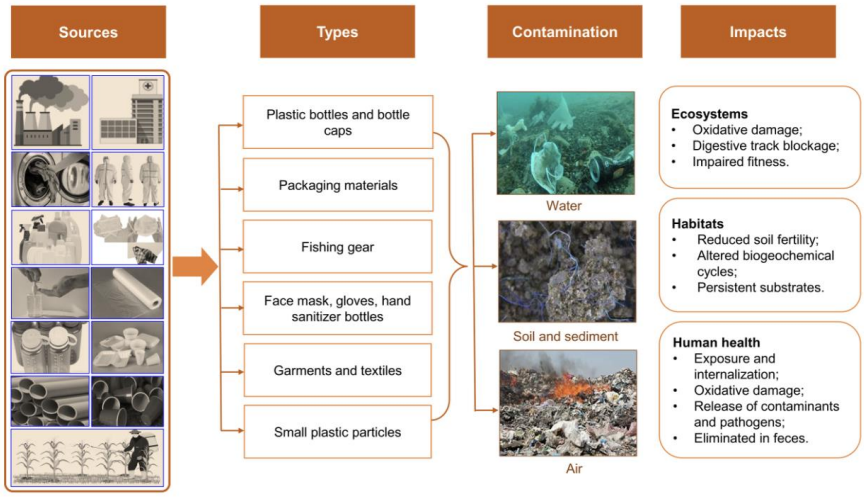


Figure 7. Examples of sources, types, contamination, and impacts of microplastics in the environment.

A diagram featuring sources of MPs --> types of MPs, the types of contamination, and the impacts

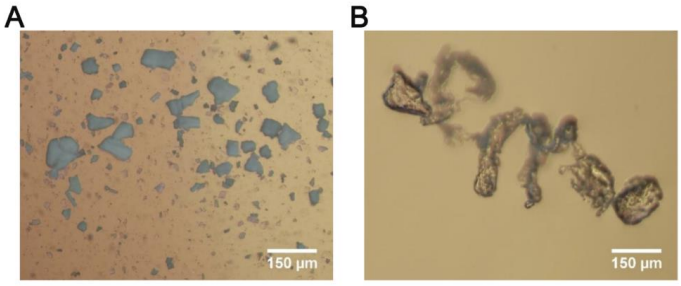


Figure 8. (A) Commercially available polystyrene microplastics; and (B) polypropylene microplastics produced in a coffee grinder in the laboratory.

Commerical microplastics versus manually produced microplastics under a

	microscope.  **Table 1. Main conclusions arising from interlaboratory tests conducted on the methods for quantification and characterization of microplastics** **Test name** | **Published date** | ***n*** | **Samples** | **Main conclusions** | **Ref.** Isobe *et al.*, 2019 | 2019 | 12 | Two bottles with different concentrations of PP, LDPE, HDPE, and NOM in seawater (400-5,700 μm) | High uncertainty (> 50%) likely results from human error (i.e., misidentification or measuring errors) Sample preparation (i.e., chemical treatment, density separation) reduced uncertainty from 40% to 20% Underestimation of 20% for microplastics < 1 mm (spectroscopy recommended) | [87] Müller *et al.*, 2020 | 2020 | 17 | Sugar water spiked with PE, PVC, PET, PMMA, and PS (8-140 μm) | Better identification of polymer type by micro-Raman spectroscopy and Σ-GC/MS than by micro-FTIR Quantification using microscopy and micro-FTIR worked best | [90] Becker *et al.*, 2020 | 2020 | 9 | Sediment sample spiked with PP, PS, PE, PET, and suspended particulate matter (2,000-3,000 μm) | Py-GC-MS, TED-GC-MS, TGA-FTIR correctly identified all polymers and produced reasonable results The mean absolute deviation from the median was 14% for PE and PS and > 40% for PP and PET High variability in the analysis of PET likely results in the use of adsorber materials and stationary phase adapted for non-polar compounds Additives in PE could influence the formation of decomposition products and interfere with readings TGA-MS not recommended since it did not confirm the presence of the four polymer types | [93] Cadiou *et al.*, 2020 | 2020 | 5 | Clean water or sediment spiked with PET, PVC, PC, HDPE, and PP (300-5,000 μm) | Error was < 25% of the absolute value for microplastic counts (60% underestimation and 40% overestimation) Errors in quantification were higher in sediment compared to water samples (18% vs. 14% root mean square errors) Laboratories varied greatly in the error of detection of microplastics (2%-3% vs. 23%-30%) Regarding shape, films are generally overestimated while others are correctly counted or underestimated Color also influences the correct estimation of microplastics Underestimation might be explained by lack of detection, loss of laboratory material, or loss by being blown out during handling. | [85] JRC's interlaboratory test | 2021 | 98 | One sample of PET in salt water (30-200 μm) | Methods had a high variability depending on research groups Many groups efficiently detected the correct number of plastics in the samples using multiple techniques, including microscopy, micro-FTIR, and micro-Raman spectroscopy Some contamination control measures (i.e., the use of cleaning paper and gloves) seem to be related to the underestimation of microplastics | [86] WEPAL-QUASIMEME/NORMANs | 2021 | 30 | 11 samples comprised each of the most common polymer types (PC, PS, PP, PET, LDPE, EPS, PVC) and one blank (2,270-4,310 μm) | Correct chemical identification > 80% (except for low-density polyethylene) Consistent performance of micro-Raman spectroscopy Quantification was often flawed in terms of absolute number and the high dispersion of data (i.e., relative standard deviation of 57%-91%) | [91] The Plastic Busters MPAs | 2021 | 4 | Fish gastrointestinal tract and mussel tissues spiked with PE, PP, and PET (> 200 μm) | The coefficient of variation after digestion and counting under the microscope was < 11% for most samples Recovery rates were 96.7% for 5 mL/g of 10% KOH and 88.8% for 20 mL/g of 15% H_2O_2 | [89] Prata *et al. Water Emerg Contam Nanoplastics* 2024;3:8	https://dx.doi.org/10.20517/wecn.2023.61 Changes due to sample preparation were observed as fragmentation (7.1%), discoloration (2.1%), deformation (9.2%), and degradation (17.1%) Microplastics correctly identified by FTIR varied between 47.8% and 69.5% De Frond *et al.*, 2022 | 2022 | 22 | Three samples of PE, PS, PVC, PET, and NOM in drinking water and one blank (1-5,000 μm) | Microscopy allowed for a mean recovery rate of 92% for microplastics > 20 μm and 32% for < 20 μm The mean blank sample count was 91 particles Micro-FTIR accurately identified 95% of microplastics and misidentified 8% of NOM as microplastics Micro-FTIR accuracy was 33% for microplastics < 20 μm Micro-Raman spectroscopy accurately identified 91% of microplastics and misidentified 68% of NOM as microplastics Micro-Raman spectroscopy performed poorly on dyed cellulose fibers due to the interfering fluorescence. | [92] PP: Polypropylene; LDPE: low-density polyethylene; LDPE: low-density polyethylene; NOM: natural organic matter; PE: polyethylene; PVC: polyvinyl chloride; PET: polyethylene terephthalate; PMMA: polymethyl methacrylate; Σ-GC/MS: thermo-extraction-and-desorption- or pyrolysis- combined with gas chromatography coupled to mass spectrometry; micro-FTIR: micro-Fourier transform infrared spectroscopy; Py-GC-MS: pyrolysis gas chromatography–mass spectrometry; TED-GC-MS: thermal extraction desorption followed by gas chromatography coupled to mass spectrometry; TGA-FTIR: thermogravimetry-infrared spectroscopy; TGA-MS: thermogravimetry coupled to mass spectrometry; PS: polystyrene; EPS: expanded polystyrene. A table featuring 8 experiments and their MP sample type with their main conclusions in relation to error.
VOCAB: (w/definition)	Ubiquity: Common Nominal: in mane Adsorbed: Hold liquid on the outside as a thin film Biofouling: unwanted small organisms accumulating on surfaces Mesoplastic: Plastic between 5mm and 1cm Trophic transfer: Movement of energy, nutrients, and contaminants between food chain. Effluent: sewage put into a river or sea Lumen: inner space in tubes like vessels in the body
Cited references to follow up on	Allen S, Allen D, Karbalaei S, Maselli V, Walker TR. Micro(nano)plastics sources, fate, and effects: what we know after ten years of research. J Hazard Mater Adv 2022;6:100057. DOI Geyer R, Jambeck JR, Law KL. Production, use, and fate of all plastics ever made. Sci Adv 2017;3:e1700782. DOI PubMed PMC Carpenter EJ, Anderson SJ, Harvey GR, Miklas HP, Peck BB. Polystyrene spherules in coastal waters. Science 1972;178:749-50.

	DOI Cole M, Lindeque P, Halsband C, Galloway TS. Microplastics as contaminants in the marine environment: a review. Mar Pollut Bull 2011;62:2588-97. DOI PubMed Emissions of primary particles and secondary particulate matter precursors. European Environment Agency. 2017. Available from: https://www.eea.europa.eu/data-and-maps/indicators/emissions-of-primary-particles-and-1. [Last accessed on 26 Feb 2024]. Jahnke A. A discussion of single-use plastics in medical settings. Reinf Plast 2020;64:190-2. DOI Cole M. A novel method for preparing microplastic fibers. Sci Rep 2016;6:34519. DOI PubMed PMC Uddin S, Fowler SW, Habibi N, Behbehani M. Micro-nano plastic in the aquatic environment: methodological problems and challenges. Animals 2022;12:297. DOI PubMed PMC Panel on Contaminants in the Food Chain (CONTAM). Presence of microplastics and nanoplastics in food, with particular focus on seafood. EFS2 2016;14:e04501. DOI Bellon D, Zamudio WH, Tiria LC, Durán SM, Useche IE, Peña J. Effect of expanded polystyrene waste in the creation of waterproofing paint. J Phys Conf Ser 2019;1386:012075. DOI Campbell SH, Williamson PR, Hall BD, Schindler D. Microplastics in the gastrointestinal tracts of fish and the water from an urban prairie creek. FACETS 2017;2:395-409. DOI Silva CJM, Silva ALP, Gravato C, Pestana JLT. Ingestion of small-sized and irregularly shaped polyethylene microplastics affect Chironomus riparius life-history traits. Sci Total Environ 2019;672:862-8. DOI PubMed Turroni S, Wright S, Rampelli S, Brigidi P, Zinzani PL, Candela M. Microplastics shape the ecology of the human gastrointestinal intestinal tract. Curr Opin Toxicol 2021;28:32-7. DOI
Follow up Questions	- Are microplastics harmful to people or not? - Is there a way to speed up the degradation of MPs? - Can MPs also whether in our bodies? If so does that mean that MPs can get to the point in our bodies where they are small enough to cause cellular damage?

Article #14 Notes: "Investigation of potential behavioral and physiological effects of caffeine on *D. magna*"

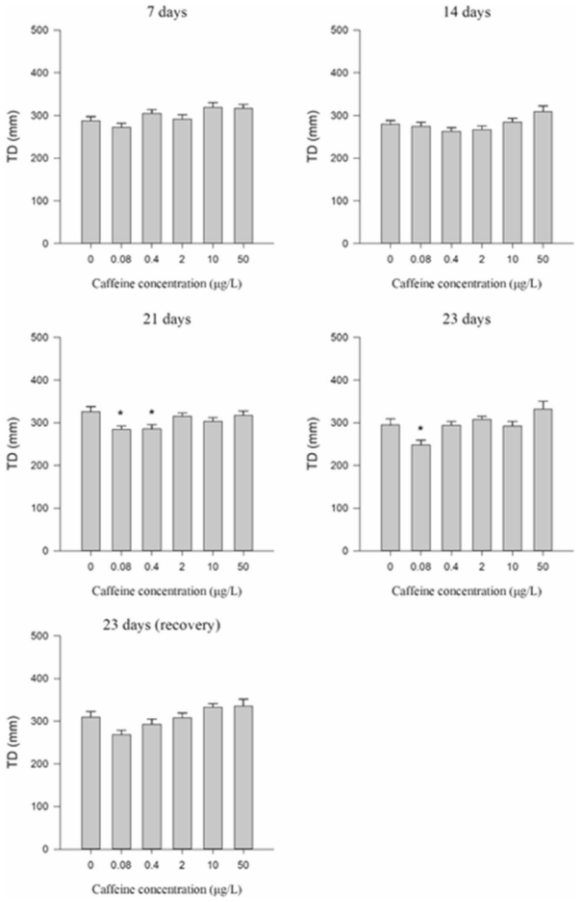
Source Title	Investigation of potential behavioral and physiological effects of caffeine on *D.*

	magna
Source citation (APA Format)	Nunes, B., Santos, J., Dionísio, R., & Dias de Alkimin, G. (2022). Investigation of potential behavioral and physiological effects of caffeine on D. magna. *Environmental Science and Pollution Research International*, *29*(28), 43237–43250. https://doi.org/10.1007/s11356-022-18695-0
Original URL	https://link.springer.com/article/10.1007/s11356-022-18695-0
Source type	Research Article
Keywords	Pharmaceutical compounds, caffeine, *Daphnia magna*, behavior, respirometry, glycogen
#Tags	#Abstract, #Discussion, #Methodology
Summary of key points + notes (include methodology)	- Consumption of pharmaceutical compounds is increasing, presence in environment undeniable. - Most compounds get released into the wild after use. - Consequences could be permanent, crucial to study long term exposure as well as if the chemicals cause addiction in organisms. - Caffeine is natural alkaloid in a lot of plants, but is also one of the most common pharmaceuticals found in the environment. - Caffeine is also addictive - Study aims to study environmentally relevant concentrations of caffeine on behavior and physiology *D. magna* of certain ages (<24hrs), and with/without recovery period. - Caffeine in low concentrations reduced movement, while high concentrations did not affect anything. - Subtle withdrawal effects were identified after they were exposed to caffeine for 21 days and then not exposed to it for 2 days. - Caffeine did not have significant effects on oxygen uptake and glycogen storage. - Caffeine was measured into concentrations 0.08, 0.4, 2, 10, and 50 micrograms/Liter. - *D. magna* are planktonic microcrustaceans belonging to Branchiopoda - Primary consumers in freshwater ecosystems - Good organisms to be used in toxicity assays for freshwater environments - Easy to handle in lab settings, a lot of them exist in environments - The Straus clone K6 daphnia were kept in a laboratory, being kept at temperatures of 20 degrees Celsius with a light dark cycle of 16 hours, 8 hours. - They were cultured in 1L glass bottles with 800mL culture medium (ASTM hard water) and 20 adult organisms. - Fed suspension with unicellular algae - Also had seaweed organic extract

	- Medium changed 3 times a week - Babies from 3rd-5th broad <24 hrs of age were used. - Daphnia divided into groups and exposed to the different concentrations with 20 organisms per concentration. - Solutions renewed every 2 days - Exposed for 21 days with an extra 2 days of being transferred to a recovery medium without caffeine. - Used a movement tracking system under 10-minute period using the light-dark cycle (5 minute light, 5 minute dark) - *D. magna* responsive to light changes. - ANOVA was used and differences between groups were found using the Dunnett test. P<0.05 - At light stimulus, organisms tended to swim long distances as caffeine increased, but not significant. - Without light did not have a pattern - Recovering organisms moved more when in light than non-recovering. Not stat. Significant. - D. magna swim in a circular movement (sensitive) - Travel time, travel speed, frequency of spiral, vertical/horizontal distribution. - **Caffeine cannot be directly correlated to increase in motor activity**
Research Question/Problem/ Need	What are the long term consequences of exposure to toxicants on non-target organism and can they cause addiction?

Important Figures	

Fig. 1 Effects of caffeine on *D. magna* behavior by analyzing the distance moved (mm) with the presence of a light stimulus. The graphs correspond to each analysis during the exposure time (7, 14, 21, and 23 days), with media and standard error values represented. TD refers to total distance travelled by the organisms. The asterisks (*) represent statistically significant differences ($p < 0.05$) between the nominal coffee concentration and the control group (group exposed to 0 µg/L)



The 5 different graphs for each increment in days with light stimulus which looks at the total distance traveled by the daphnia with each concentration. Asterisks represent significance from control.

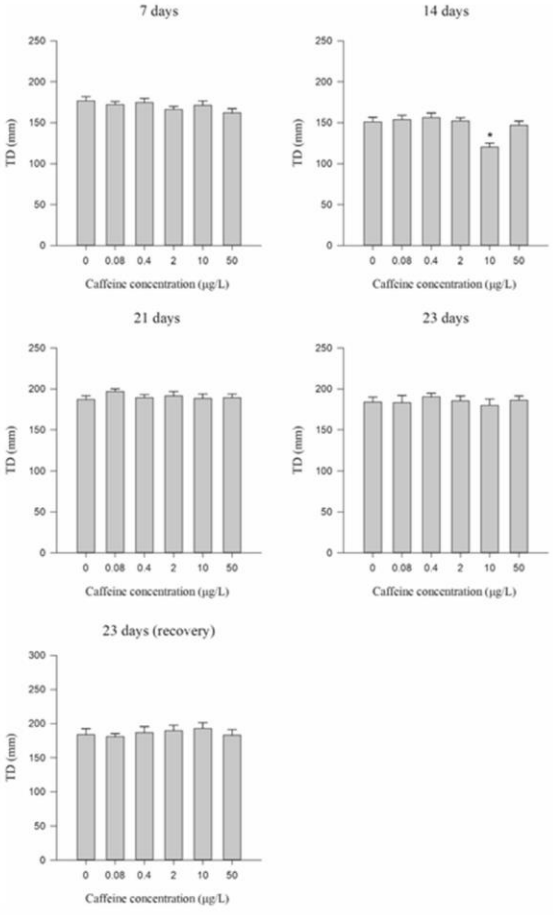


Fig. 2 Effects of caffeine on *D. magna* behavior by analyzing the distance moved (mm) without the presence of a light stimulus. The graphs correspond to each analysis during the exposure time (7, 14, 21, and 23 days), with media and standard error values represented. TD refers to total distance travelled by the organisms. The asterisks (*) represent statistically significant differences ($p < 0.05$) between the nominal caffeine concentration and the control group (group exposed to 0 µg/L)

Same idea as Figure 1 except this is without the light stimulus.

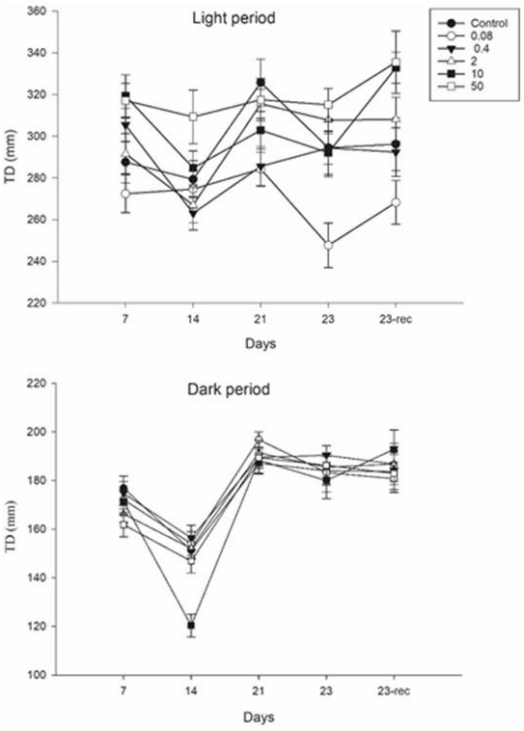
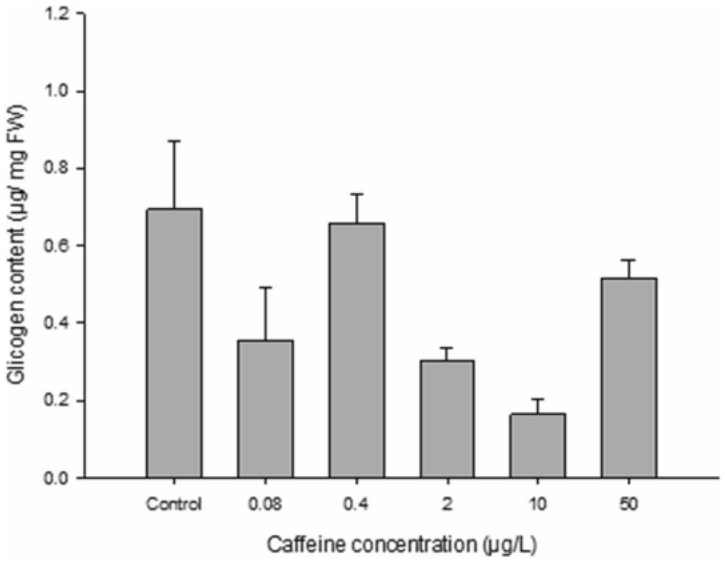
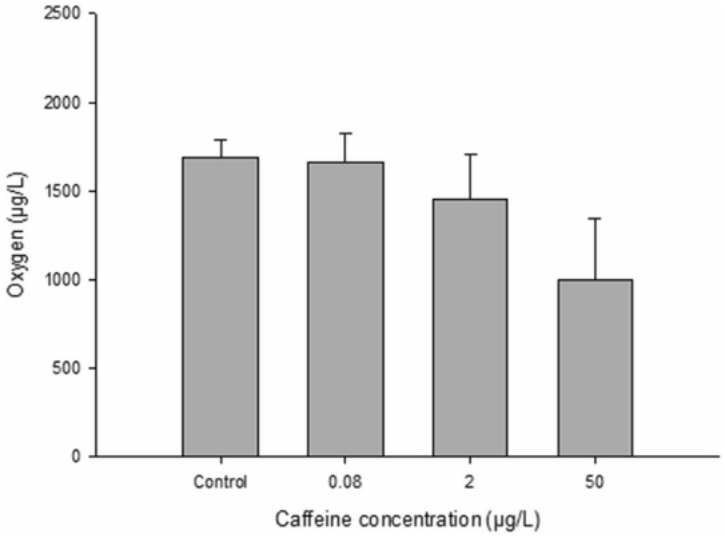


Fig. 3 Effects of caffeine in *D. magna* behavior over the exposure period according to the concentrations established. TD refers to total distance travelled by the organisms. The top graph represents the effects on light-stimulating organisms (with light), and the bottom graph represents the same effects without the light stimulus (no light/ dark)

Representations of the two bar graphs above but in a way that shows progressive movement of the Daphnia.

	 **Fig. 4** Effects of caffeine on glycogen content (µg/mg FW) in *D. magna* after 21 days exposure. For the biochemical parameter in question, mean and standard error are shown Glycogen content after 21 days. Means are the bars and standard deviation is represented by the lines above the bars.  **Fig. 5** Effects of caffeine on oxygen consumption (µg/L) in *D. magna* after acute exposure of 96 h. For the physiological parameter in question, mean and standard error are shown Oxygen consumption after 96 hours. Means are the bars and standard deviation is represented by the lines above the bars.
VOCAB: (w/definition)	Xenobiotics: foreign substance not naturally produced that body must make water soluable to remove.

	Alkaloid: Nitrogen containing organic compounds found in plants Brood: group of offspring from same parents Glycogen: Main way to store sugar from carbs xanthine oxidation: xanthine oxidase converts purine products, hypoxanthine, and xanthine into uric acid. ROS: Reactive oxygen species, unstable oxygen containing molecules Idiopathic apnea: a type of sleep apnea when brain fails to send signals, causing breathing to stop Bronchodilator: medication that opens airways
Cited references to follow up on	Alkimin GD, Paisio C, Agostini E, Nunes B (2020b) Phytoremediation processes of domestic and textile effluents: evaluation of the efficacy and toxicological effects in Lemna minor and Daphnia magna. Environ Sci Pollut Res 27:4423-4441. https://doi.org/10.1007/s11356-019-07098-3 Baillieul J (1997). Response of the waterflea Daphnia magna straus to environmental stress: scope for growth, reproduction and swimming activity. Ph.D. thesis. University of Antwerp, Belgium Baird DJ, Soares AMVM, Girling A, Barber I, Bradley MC, Calow P (1989). The long-term maintenance of Daphnia magna for use in ecotoxicity tests: problems and prospects. In: Lokke H, Tyle H, Bro-Rasmussen (Eds). Procedings of the First European Conference on Ecotoxicology, 17- 19 October 1988, Lyngby, Denmark, p. 144–148 Bownik A (2017) Daphnia swimming behaviour as a biomarker in toxicity assessment: a review. Sci Total Environ 601–602:194–205 Daniel D, Dionísio R, Alkimin GD, Nunes B (2019) Acute and chronic effects of paracetamol exposure on Daphnia magna: how oxidative effects may modulate responses at distinct levels of organization in a model species. Environ Sci Pollut Res 26(4):3320–3329. https:// doi. org/ 10. 1007/ s11356- 018- 3788-y Edmondson W (1987). Daphnia in experimental ecology: notes on historical perspectives. In 'Daphnia' Memorie dell'Istituto Italiano di Idrobiologia Dr Marco De Marchi (Peters RH, de Bernardi R), Vol. 45, Consiglio Nazionale Delle Ricerche Instituto Italiano Di Idrobiologia, Verbania Pallanza
Follow up Questions	- Why can't heart rate be compared to locomotive movement? - Can MPs induce effects in oxygen consumption and glycogen production? - Do MPs affect locomotion in daphnia?

Article #15 Notes: "The elusive copepods: their production and suitability in marine aquaculture"

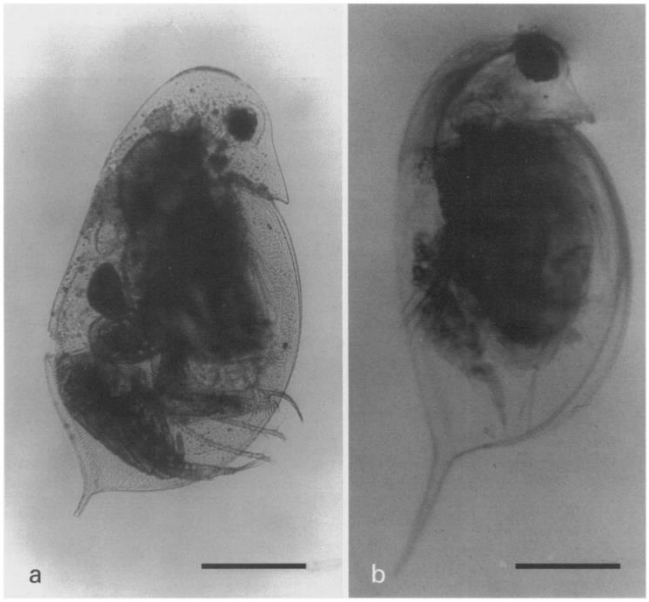
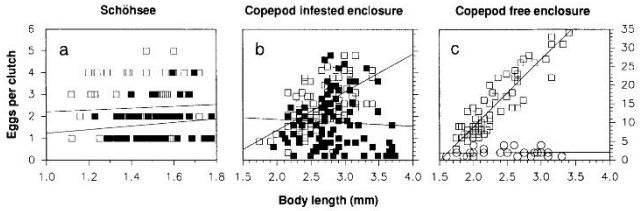
Source Title	The elusive copeods: their production and suitability in marine aquaculture
Source citation (APA Format)	Støttrup, J.G. (2000), The elusive copepods: their production and suitability in marine aquaculture. *Aquaculture Research*, *31*: 703-711. https://doi-org.ezpv7-web-p-u01.wpi.edu/10.1046/j.1365-2109.2000.318488.x
Original URL	https://onlinelibrary.wiley.com/doi/epdf/10.1046/j.1365-2109.2000.318488.x?saml_referrer
Source type	Journal Article
Keywords	N/A
#Tags	#Abstract, #Tables
Summary of key points + notes (include methodology)	- Copepods pray on marine fish larvae - Easy to produce - Common food for fish - Copepods are fed to the fish larvae; one system describes the copepods being taken and concentrated to a certain size before being fed to fish larvae. - Double filter is needed for specific size range. - Copepods are between 80-200 micrometers. - Some copepods are known for being intermediate hosts for parasites. - Cestodes can also be found in copepods. - A. tonsa (145 micrometers) and T. holothuriae (100 micrometers) are raised in 16-18 degrees celsius with a life of 20 days and 12 days respectively. - Canalus finmarchius (200 micrometers) raised in 15 degrees Celsius with a slower growth rate (~4 weeks). - Calanoids and harpacticoid copepods are main targeted copepods for production - Benthic copepods (higher densities) do not need to eat planktonic microalgae. - Copepods are nutritious for fish larvae - Have good lipid/protein content for fish larvae - T. holothuriae improved growth rate of juvenile - Improved stress resistance - Can serve as tank cleaners - This study compiled information from other studies
Research	What are the advances in copepod production systems and their nutritional value

Question/Problem/ Need	to fish?
Important Figures	**Table 1** Different methods for the larger scale mass culture of calanoid or harpacticoid copepods, which were harvested at regular intervals and/or used as live prey for marine fish larvae | Culture species	Culture size	Densities	Productivity	Food/conditions	Reference | |---|---|---|---|---|---| | *Acartia tsuensis*	24 m^3	20% ER = 150 µg DW L^{-1}	20% ER = 30 µg DW L^{-1} day^{-1}	Natural phytoplankton, extensive (1990)	Ohno, Takahashi & Taki | | *Acartia tsuensis*	25 L	30% ER = 100 µg DW L^{-1}	Max 30% exploitation rate	*Nannochloropsis oculata*, intensive	Ohno *et al.* (1990) | | *Acartia tonsa*	1890 L	232 L^{-1}	2–75 nauplii/adult	Natural phytoplankton, extensive	Ogle (1979) | | *Acartia tonsa*	200–450 L	50–100 L^{-1}	200–220 eggs L^{-1} culture	*Rhodomonas baltica*, *Isochrysis galbana*, intensive	Støttrup *et al.* (1986) | | *Eurytemora affinis*	30 m^3	300–500 L^{-1} copepodites and adults > 1000nauplii L^{-1}	7–10%	Algae and detritus, extensive	Nellen, Quantz, Witt, Kuhlmann & Koske (1981) | | Calanoid species	*c.* 2800 m^3			Natural phytoplankton; extensive	B. Urup (pers. commun.) | | *Tisbe* spp.	1.5-L floating baskets in 200-L fish tanks	92–115 mL^{-1}	Not estimated	*Mytilus* powder lettuce pieces	Kahan, Uhlig, Schwenzer & Horowitz (1982) | | *Schizopera elatensis*		29/mL			| | *Tigriopus japonicus*	210 m^3	10–22 mL^{-1}	4–5 kg at regular intervals	*Chlorella minutissima*, ω-yeast, baker's yeast co-culture with rotifers; outdoor tanks, semi-extensive	Fukusho (1980) | | *Tisbe* spp.	32 L	1 mL^{-1} adults 31 mL < 200 µm	1.4 nauplii/ind day^{-1}	Microfeast L-10 larval diet or *Isochrysis galbana*	Nanton & Castell (1997) | | *Tisbe holothuriae*	5-L trays	8 mL^{-1}	300 000 (20 mg) nauplii/tray day^{-1}	*Rhodomonas baltica*, batch intensive	Støttrup & Norsker (1997) | | *Tisbe holothuriae*	150-L closed tank	Not registered	500 000 ind day^{-1} mixed nauplii and copepodites in food-limited cultures	*Rhodomonas baltica*, continuous intensive	Støttrup & Norsker (1997) | ER, exploitation rate; DW, dry weight. Different copepods with culture size, densities, productivity and conditions listed.
VOCAB: (w/definition)	Zooplankton: plankton consisting of small animals and immature stages of larger animals. Calanoid copepods: tiny crustaceans (<3mm) that are a teardrop shape. Harpacticoid copepods: small benthic copepods that looks like a scorpion or bee Phytoplankton: microscopic photosynthetic organisms Cestodes: parasitic worm (tapeworms) Nauplii: larval stage of crustaceans Estuarine: area where freshwater meets saltwater Docosahexanoic acid: omega-3 fatty acid crucial in nervous system development and function
Cited references to follow up on	Chandler G.T. (1986) High-density culture of meiobenthic harpacticoid copepods within a muddy sediment substrate. Canadian Journal of Fisheries and Aquatic Sciences 43, 53±59 Fukusho K. (1980) Mass production of a copepod, Tigriopus japonicus in combination culture with a rotifer Brachionus plicatilis fed w±yeast as a food source. Bulletin of the Japanese Society of Fisheries Science 46, 625±629 Ikeda T. (1973) On the criteria to select copepod species for mass culture. Bulletin of the Plankton Society of Japan 20, 41±48. Ogle J. (1979) Adaptation of a brown water culture technique to the mass culture of the copepod Acartia tonsa. Gulf Research Reports 6, 291±292. Stùttrup J.G., Shields R., Gillespie M., Gara M.B., Sargent J.R., Bell J.G., Henderson R.J., Tocher D.R., Sutherland R., Nñss T., Mangor Jensen A., Naas K., van der Meeren T., Harboe T., Sanchez F.J., Sorgeloos P., Dhert P. & Fitzgerald R. (1998) The production and use of copepods in larval rearing of halibut, turbot and cod. Bulletin of the Aquaculture Association of Canada 4, 41±46.

Follow up Questions	- Why were they present in my D. magna culture? - How sensitive are they? - Can they survive being washed with soap and water? - Do they reproduce more with 24 hour light? - How dangerous are they to D. magna?

Article #16 Notes: "Egg Predation by Copepods in *Daphnia* Brood Cavities"

Source Title	Egg Predation by Copepods in Daphnia Brood Cavities
Source citation (APA Format)	Gliwicz, Z. M., & Stibor, H. (1993). Egg Predation by Copepods in Daphnia Brood Cavities. *Oecologia, 95*(2), 295–298. https://doi.org/10.1007/BF00323503
Original URL	https://www-jstor-org.ezpv7-web-p-u01.wpi.edu/stable/4220440?sid=primo&seq=1
Source type	Journal Article
Keywords	Cladocera, Clutch size, Copepods, *Daphnia,* Food limitation
#Tags	#Abstract, #Figure, #Results
Summary of key points + notes (include methodology)	- Juvenile copepods enter D. magna brood cavities and eat their eggs. - Both cyclopoid and calanoid copepods can do this. - Acanthocyclops robustus were found to eat daphnia eggs in enclosures with a lot of algae. - Eudiaptomus gracilus were also found in brood cavities. - The infestations caused declines in clutch sizes, and the predation could be confused with food limitation. - It is thought that copepods "accidentally enter brood pouch", so reports of them there are not taken seriously. - This caused their effects on reproduction to be overlooked - Density, fecundity, and food availability of Daphnia populations were moitored - Multiple daphnia species were monitored - Data was followed for 100 days with each of the organism cultures being suspended in a lake. - 3 enclosures were kept rich in algal food however they also contained a cyclopoid copepod - Copepods did not develop in other enclosures due to poor food. - Another study was conducted for 200 days had copepod density, daphnia density, body length, and clutch size estimated from samples taken weekly or every 4th day - Some samples pre-fixed with liquid nitrogen to prevent copepods from escaping. - Each study observed a decline in Daphnia clutch size - Smallest clutch size observed on day 50, 60, and 70 of each enclosure. - Many D. magna found to have copepods in brood cavities

	- 1-2 eggs were eaten by copepods per visit, but more were punctured. - 9 visits is less than 2 minutes.
Research Question/Problem/ Need	Do copepods entering daphnia brood cavities cause a decline in population?
Important Figures	 **Fig. 2a, b.** Two examples of juvenile copepods in *Daphnia* brood cavities. The copepodite of a calanoid copepod *Eudiaptomus gracilis* (G.O. Sars) in the cavity of *D. hyalina* from the lake (**a**); and first copepodite of *Acanthocyclops robustus* (G.O. Sars) in the cavity of *D. pulex* (**b**). Each *scale bar* denotes 0.5 mm  Images of copepods in daphnia brood cavities (2a). The body length in infested versus free enclosure compared to clutch size (2b).
VOCAB: (w/definition)	Cyclopoid copepod: copepods that use thoracic legs to move around and are found in freshwater. They are known for rapid movement and being predators. Clutch size: number of eggs produced by female organism. Conical: shape of a cone Clonal inoculation: introducing single-origin biological entity to a controlled study. Ceriodaphnia reticulata: Daphnia that differ than daphnia magna in that they are much shorter and wider, with internal organs not completely clear. Heart is not obvious. Cladoceran reproduction: asexual reproduction by cloning females. but able to switch to sexual reproduction when stressed. Cladocreans: water fleas
Cited references to follow up on	Gliwicz ZM (1985) Food and predation in limiting clutch size in cladocerans. Verh Int Verein Limnol 21 : 1562-1566

	Gliwicz ZM, Lampert W (1993) Body size related survival of cladocerans in a trophic gradient: an enclosure study. Arch Hydrobiol 127 (in press) Lampert W (1988) The relative importance of food limitation and predation in the seasonal cycle of two *Daphnia* species. Verh Internat Verein Limnol 23:713-718 Santer B (1993) Do cyclopoid copepods control *Daphnia* populations in early spring, thereby protecting their juvenile instar stages from food limitation? Verh International Verein Limnol 25 (in press) Threlkeld ST (1979) Estimating cladoceran birth rates: the importance of egg mortality and egg age distribution. Limnol Oceanography 24: 601-612
Follow up Questions	- Can eggs be compressed/dried before being rehydrated? - Are copepods dangerous to humans? - Do filtered spring water catch copepods? - How can you get copepods out of the daphnia cultures without harming the daphnia?

Article #17 Notes: "Clutch-size variability in *Daphnia*: Body-size related effects of egg predation by cyclopoid copepods"

Source Title	Clutch-size variability in *Daphnia*: Body-size related effects of egg predation by cyclopoid copepods
Source citation (APA Format)	Gliwicz, Z. M., & Lampert, W. (1994). Clutch-Size Variability in Daphnia: Body-Size Related Effects of Egg Predation by Cyclopoid Copepods. *Limnology and Oceanography, 39*(3), 479–485. https://doi.org/10.4319/lo.1994.39.3.0479
Original URL	https://aslopubs-onlinelibrary-wiley-com.ezpv7-web-p-u01.wpi.edu/doi/epdf/10.4319/lo.1994.39.3.0479
Source type	Journal Article
Keywords	N/A
#Tags	#Abstract, #Discussion

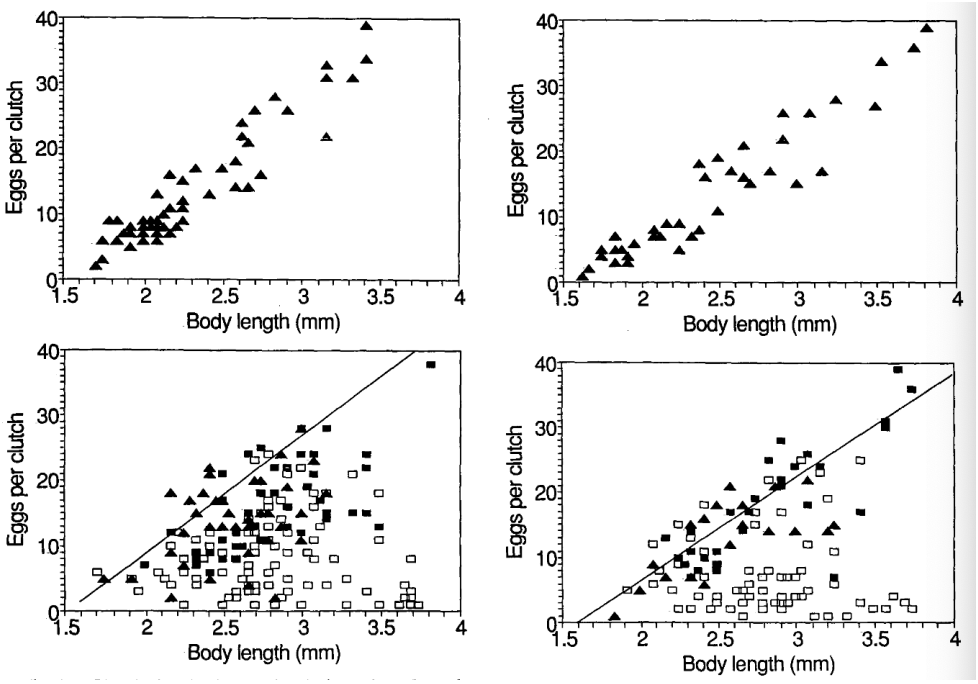
Summary of key points + notes (include methodology)	- Food limitation resulted in lower egg # for all
	- Egg predation resulted in variability because of random probability of an organism being affected.
	- Only small copepods can enter brood cavity, so only large daphniids are affected.
	- <2.25mm Daphniids were fine
	- Could explain variability in clutch sizes
	- Daphniids are food limited when not carrying max # of eggs
	- Egg #s corresponds with food availability
	- Underestimate possible factors:
	  ○ Underdeveloped eggs (aborted eggs)
	  ○ Eggs lost from brood pouches
	  ○ Egg predation
	- 8 enclosures in a mesotrophic lake and made different conditions
	- Each enclosure had 6 species of daphnia
	- D. magna are the largest of the water fleas.
	- Experiment lasted 100 days
	- Water temp went from 18 degrees Celsius to 5 degrees Celsius
	- Got clutch size and body size for daphniids
	- Linear relationship between body length and clutch size
	- Daphnia eggs are rich in polyunsaturated fatty acids, which may be a good fatty acid source for copepods.

	- Acanthocyclops prayed a lot on neonate daphniids, but did not affect fecundities.
Research Question/Problem/ Need	Does the size of daphnia give it certain immunities against copepod predation?
Important Figures	Table 1. Effect of food conditions on body length (L)–clutch size (CS) relationships of three *Daphnia* species in copepod-free enclosures. Linear regression: $CS = a + b \times L$. Food conditions: low—oligotrophic and mesotrophic enclosures (0.1–0.8 mg POC liter^{-1}); high—eutrophic enclosure (0.2–3.0 mg POC liter^{-1}). ANCOVA testing for differences between high and low concentrations of food.

Treatment	N	a	b	r^2	P
D. pulex					
High	81	−12.46	10.21	0.333	<0.0001
Low	23	−5.47	5.18	0.612	<0.0001
D. pulicaria					
High	48	−22.65	14.30	0.623	<0.0001
Low	27	−7.88	6.58	0.657	<0.0001
D. galeata					
High	64	−8.51	9.56	0.447	<0.0001
Low	50	−6.53	7.54	0.663	<0.0001

ANCOVA		df	F	P
Difference between slopes	*D. pulex*	1,100	5.10	0.026
	D. pulicaria	1,71	15.00	<0.001
	D. galeata	1,110	1.22	0.271
Difference between adjusted means	*D. pulex*	1,101	25.18	<0.001
	D. pulicaria	1,72	24.63	<0.001
	D. galeata	1,111	6.68	0.011

Food conditions versus body length. Most values were statistically significant. The data shows correlation between body length and food amount.



Bodt length versus eggs per clutch in Daphnia pulex (left) and Daphnia pulicaria (right). The black triangles are triangles, the white squares were small copepods feasting on eggs, and the black squares were large copepods feasting on eggs. Top graph was without predators, bottom was with predators.

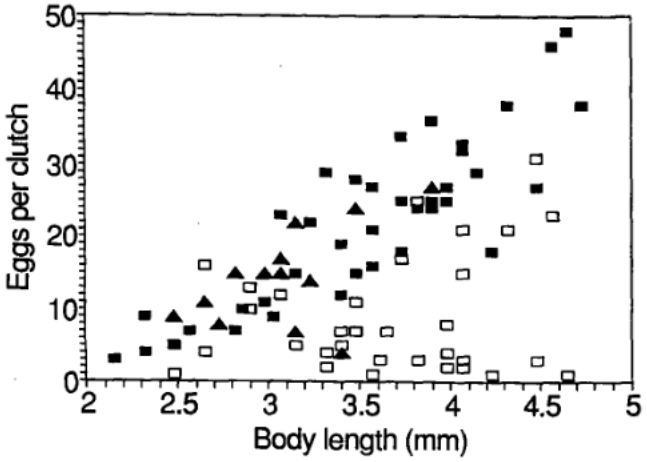


Fig. 4. As Fig. 1 (lower panel), but for *Daphnia magna*. No data for the predator-free environment are available for this species.

Charts above but for D. magna. There is no trend line because as of the time of publication for the paper there was no predator-free data for the D. magna.

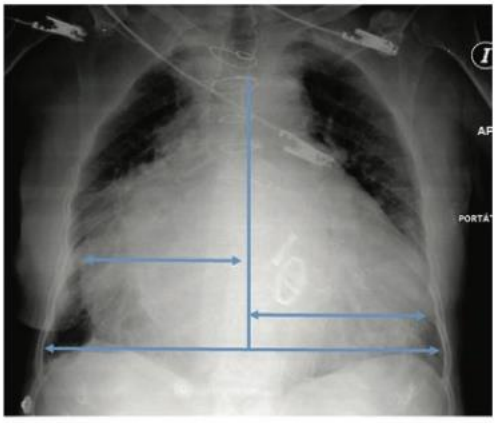
VOCAB: (w/definition)

Mesotrophic: mediocre nutrient conditions for soil or lakes.
Algal inoculation: Introducing microalgae to a system for good outcomes.
Hypertrophic: overgrown
Cladoceran carapace: Two part shell that covers most of a water flea.
Cyprinids: minnows and carps

	Cyanobacteria: autotrophic bacteria that can get energy through oxygenic photosynthesis. Eutrophic: rich in nutrients body of water Ovigerous: having eggs
Cited references to follow up on	Edmondson, W. T., and A. H. Litt. 1982. Daphnia in Lake Washington. Limnol. Oceanogr. 27: 272-293. -, and W. Lampert. 1990. Food thresholds in *Daphnia* species in the absence and presence of blue-green filaments. Ecology 71: 691-702 -, AND H. STIBOR. 1993. Egg predation by copepods in Daphnia brood cavities. Oecologia 95: 295-298. Lampert, W. 1978. A field study on the dependence of the fecundity of *Daphnia* spcc. on food concentration. Occologia 36: 363-369. Hawkins, P., and W. Lampert. 1989. The effect of *Daphnia* body size on filtering rate inhibition in the presence of a filamentous cyanobacterium. Limnol. Oceanogr. 34: 1084-1089. Haney, J. F., and D. J. Hall. 1973. Sugar coated *Daphnia*: A preservation technique for Cladocera. Limnol. Oceanogr. 18: 33 l-333
Follow up Questions	- What are the normal clutch size-body length correlations for *D. magna*? - Do different copepods have different predation rates? - Can *D. magna* cultures completely die out from copepod predation? If so how long would that take?

Article #18 Notes: “Massive cardiomegaly”

Source Title	Massive cardiomegaly
Source citation (APA Format)	Charco-Roca, L. M., Garví-López, M., & Moreno-De la Rosa, L. (2023). Massive cardiomegaly. *Gaceta médica de México, 154*(6). https://doi.org/10.24875/GMM.M19000217
Original URL	https://www.gacetamedicademexico.com/files/es/gmm_6_18_uk_624.pdf
Source type	Journal Article
Keywords	Cardiomegaly, biatrial enlargement, chest radiograph
#Tags	N/A
Summary of key points + notes (include methodology)	- An 80 year old lady with a history of heart conditions and is on oxygen support for 17 hrs a day. She came in after a stroke. - On radiography, cardiomegaly and tracheal bifurcation

	horizontalization was shown. - Cardiac cavities dilatation - Severe growth in atria and right ventricular. - Decreased right ventricular ejection fraction - Preserved left ventricular ejection fraction - Increase of both cavities --> massive cardiomegaly - Restrictive cardiomyopathy, rheumatic heart disease, isolated mitral incompetence, and constrictive pericarditis can all be causes. - Consequences are congestive heart failure and other organ compression (dyspnea) - Chest X-ray enough for detect cardiomegaly - Cardiothoracic index can be found by taking longest cardiac diameter/longest lung horizontal diameter. - This then helps detect silhouette growth and is normal when is <=0.5.
Research Question/Problem/ Need	An 80 year old woman came into the hospital after a stroke of cardioembolic etiology.
Important Figures	 Cardiothoracic index $\frac{a+b}{c}$ **Figure 1.** *Portable anteroposterior chest X-ray. Cardiothoracic index of 0.8.* A chest x-ray where the index was calculated. The heart is not normal as it is above 0.5
VOCAB: (w/definition)	Cardioembolic etiology: Strokes caused by blood clots that travel to the brain Rheumatic valvular heart disease: Permanent damage caused by rheumatic fever (autoimmune for untreated strep throat or scarlet fever), leading to scarring and thickening that can restrict blood flow. Mitral valve: Valve between left atrium and right ventricle, two tapered cusps. Tracheal bifurcation horizontalization: anatomical variation where trachea splits into main bronchi at higher, more horizontal level than normal. Pericardial effusion: Buildup of excess fluid in pericardium. Biatrial enlargement: Both right and left atrium are enlarged.

	Dyspnea: shortness of breath Electrocardiogram: Quick, painless test that records heart's electric activity.
Cited references to follow up on	Sethi T, Singh AP, Singla V, Singh Y. Biatrial enlargement: an unusual cause of massive cardiomegaly. *BMJ Case Reports*. 2013;2013. Rogers WR, Wittels B. extreme bilateral atriomegaly; review of the literature and report of a case. *Circulation*. *1957;15*:434-441.
Follow up Questions	- How did the heart get to the way both ventricles were dilated? - Can long term microplastic exposure result in effects similar to this? - If there was a heart transplant, how would the old heart look when dissected?

Article #19 Notes: "Post-mortem cardiomegaly descriptor: Call for consistent criteria"

Source Title	Post-mortem cardiomegaly descriptor: Call for consistent criteria
Source citation (APA Format)	Kroll, M. W., Wolf, D. A., Witte, K., Calkins, H., Kunz, S. N., & Williams, H. E. (2025). Post-mortem cardiomegaly descriptor: Call for consistent criteria. *Journal of Forensic Sciences, 70*(6), 2352–2359. https://doi.org/10.1111/1556-4029.70135
Original URL	https://onlinelibrary-wiley-com.ezpv7-web-p-u01.wpi.edu/doi/epdf/10.1111/1556-4029.70135
Source type	Journal Article
Keywords	Autopsy, cardiomegaly, diagnosis, forensic pathology, heart disease, sudden cardiac death
#Tags	#Abstract, #Methodology, #Discussion
Summary of key points + notes (include	- No complete definition for cardiomegaly. - Study used 1071 autopsy reports from the US where heart weight and

methodology)	cardiomegaly were recorded - Medical examiners rely on the cutoffs (350,400,450,500g) - Age, weight, ethnicity, and toxicology did not really influence cardiomegaly. - Cardiomegaly diagnosis increasing 3.6% annually. - Left ventricular hypertrophy is risk for sudden death. - Increased heart weight usually listed as cause of death for unexplained death. - Cardiomegaly just means large heart - Cardiothoracic ratio >0.5 listed as cardiomegaly (1 SD above normal heart weights) - Not used by cardiologists as it does not give whether there is hypertrophy (heavier heart) or dilation (larger dimensions). - Cardiomegaly is used to describe heavier heart and not dimensionally larger heart. - Autopsy report includes synpotice page and organ description - Analyzed after death cardiomegaly descriptor with published models for normal heart weight. - 4 models were applied to estimate expected heart rate of individual and then used to determine if actual weight was an underestimate. - 400, 450, and 500g were popular for cardiomegaly descriptors (popular hard step cutoffs). - Medical Examiners do not incorperate body weight or height into cardiomegaly diagnosis. - Heart weight prediction models are not common - Cardiomegaly can be linked to cardiomyopathy possibly - Radiology diagnosis is when chest radiograph exceeds 0.5. - Databases used were arrest-related sudden death reports (there could have been other instances of sudden death) - Did not account for different ways heart weight can be taken - Could be variation in forensic pathologist personal procedures
Research Question/Problem/ Need	How does cardiomegaly relate to heart weight? Can different factors influence cardiomegaly such as sex or race?

Important Figures

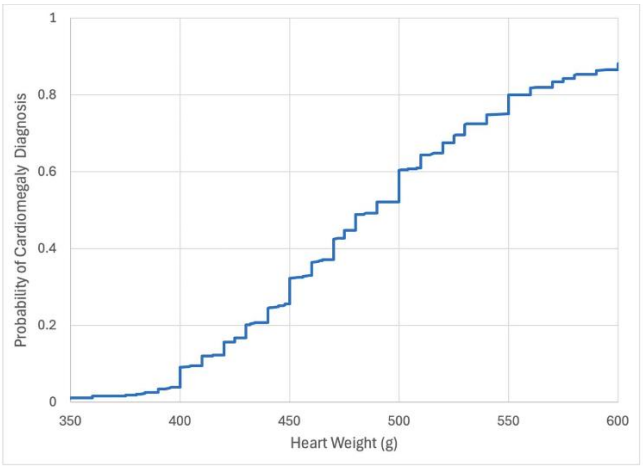


FIGURE 4 Cardiomegaly labeling as a function of heart weight.

Cardiomegaly diagnosis as a function of heart weight

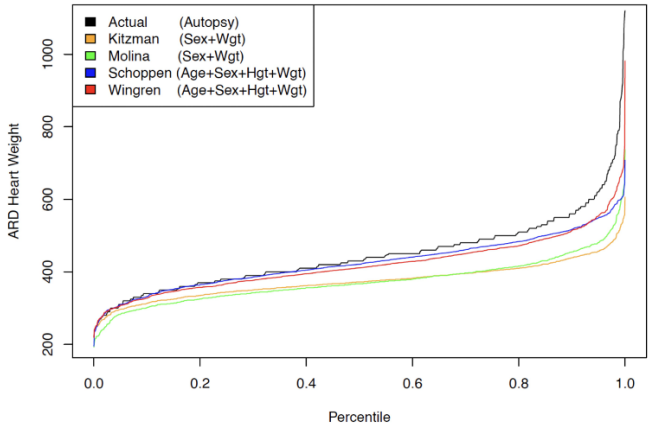


FIGURE 3 Comparison of Kitzman, Molina, Schoppen, and Wingren models.

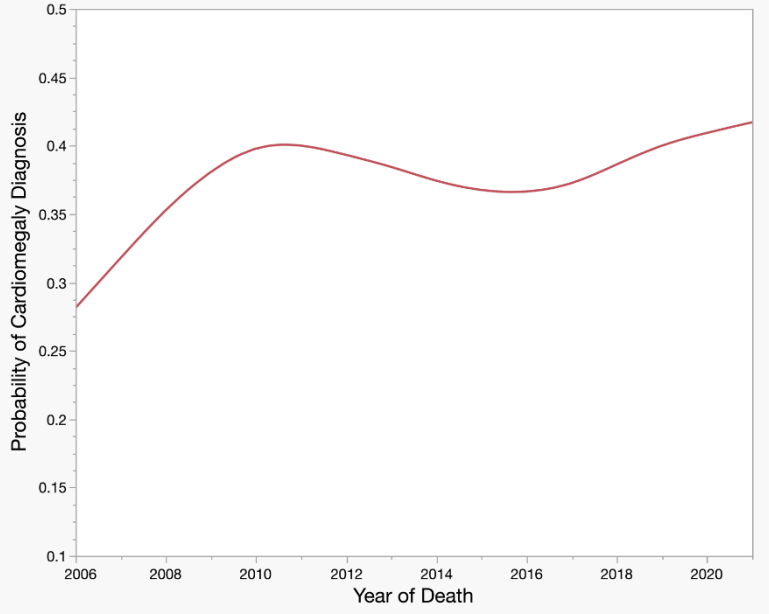
Comparison between models used

TABLE 1 Summary data of subject age, body habitus, and heart weight.

	Mean	Min	Median	Max	Cardiomegaly (373)	Controls (698)
Age (years)	38.2±10.8	15	37	87	41.2±10.6	36.6±10.5
Male					512±100	418±91
Female					430±78	338±76
Body height (m)	1.77±0.08	1.40	1.78	2.01	1.79±0.08	1.76±0.08
Body weight (kg)	94.7±24.4	40.8	91.1	239.0	105±25.8	89.1±21.7
BMI (kg/m^2)	30.1±7.0	15.2	29.3	63.6	32.6±7.6	28.7±6.2
Heart weight (g)	445.8±105.9	220	430	1120	509±100.6	412±92.4

Note: All cardiomegaly vs. control differences are significant at $p < 0.0001$ by pooled *T*-test.

Data for age, gender, body proportions, and heart weight with cardiomegaly diagnosis.

	 FIGURE 5 Cardiomegaly diagnosis as a function of year of death. Diagnosis as a function of death year
VOCAB: (w/definition)	Ventricular hypertrophy: Thichening of the lower chambers in the heart from increased workload Cardiothoratic: Medical field dealing with organs in the chest Cardiomyopathy: Chronic heart muscle disease Radionuclide ventriculography: Non-invasive test using a radioactive tracer attached to red blood cells to create a video of heart chambers Echocardiography: Using sound waves to create moving heart pictures Aortic arch: Curved upper part of aorta Bivariate analysis: relationship between two variables Left Ventricular ejection: measure of percentage of blood pumped out of left ventricle (should be 55-70%)
Cited references to follow up on	Kragel AH, Roberts WC. Sudden death and cardiomegaly unassociated with coronary, valvular, congenital or specific myocardial disease. Am J Cardiol. 1988;61(8):659–60. https://doi.org/10.1016/0002- 9149(88)90789-8 Simkus P, Gutierrez Gimeno M, Banisauskaite A, Noreikaite J, McCreavy D, Penha D, et al. Limitations of cardiothoracic ratio derived from chest radiographs to predict real heart size: comparison with magnetic resonance imaging. Insights Imaging. 2021;12(1):158. https:// doi.org/10.1186/s1324 4-021-01097- 0 Hurwitz D, Irving F. Cardiomegaly in the infant of a diabetic mother. Am J Med Sci. 1937;194:85. Simkus P, Gutierrez Gimeno M, Banisauskaite A, Noreikaite J, McCreavy D,

	Penha D, et al. Limitations of cardiothoracic ratio derived from chest radiographs to predict real heart size: comparison with magnetic resonance imaging. Insights Imaging. 2021;12(1):158. https:// doi.org/10.1186/s1324 4-021-01097- 0 Clark AL, Coats AJ. Unreliability of cardiothoracic ratio as a marker of left ventricular impairment: comparison with radionuclide ventriculography and echocardiography. Postgrad Med J. 2000;76(895):289–91. https:// doi.org/10.1136/pmj.76. 895. 289
Follow up Questions	- Can the thickening of the left ventricle capture MPs? If so, can the MPs cause damages? - How does a heart dilation compare to cardiomegaly? - What negative effects can heart dilatations have on the body? - What are heart dilations caused by?

Article #20 Notes: “Microplastics and nanoplastics in cardiovascular disease – a narrative review with worrying links”

Source Title	Microplastics and nanoplastics in cardiovascular disease – a narrative review with worrying links
Source citation (APA Format)	Zheng, H., Vidili, G., Casu, G., Navarese, E. P., Sechi, L. A., & Chen, Y. (2024). Microplastics and nanoplastics in cardiovascular disease—a narrative review with worrying links. *Frontiers in Toxicology, 6*, 1479292. https://doi.org/10.3389/ftox.2024.1479292
Original URL	https://pmc.ncbi.nlm.nih.gov/articles/PMC11499192/pdf/ftox-06-1479292.pdf
Source type	Journal Article
Keywords	Microplastics, nanoplastics, cardiovascular disease, correlation, cardiotoxicity, environmental health
#Tags	#Abstract, #3, #2

Summary of key points + notes (include methodology)	- MNPs may have negative impacts on human health.
	- May be a link between MNPs exposure and cardiovascular disease.
	- Animals exposed to MNPs exhibit abnormalities in cardiovascular system
	  o Increased blood pressure
	  o Vascular inflammation
	  o Myocardial damage
	- People exposed to MNPs more likely to suffer from:
	  o Hypertension
	  o Myocardial infarction
	- Specific impact mechanism not fully understood
	- MNPs can spread by ocean currents, winds, and ground phenomena.
	- There could be a link between MPs and cardiovascular disease through toxicity and microvascular areas.
	- Cardiovascular disease (very dangerous):
	  o Hypertension
	  o Coronary heart disease
	  o Heart failure
	- Submicroplastics are 1 micrometer – 100 nanometers
	- Nanoplastics are <100 nanometers
	- Roughness and charge of MNPs can influence interactions between them and biological systems.
	- Weathering can make MNPs hydrophobic or hydrophilic
	- MNPs once entered in the bloodstream can form a protein corona
	- Hydrophilic protein corona may allow MNPs more time in the blood stream, worsening toxicity.
	- Type of polymer can influence effect on cells
	- Polystyrene found to cause oxidative stress and neurotoxicity effects
	- Cited Marfella et al. source as an example of MNPs worsening CVD.
	- MPs detected in:

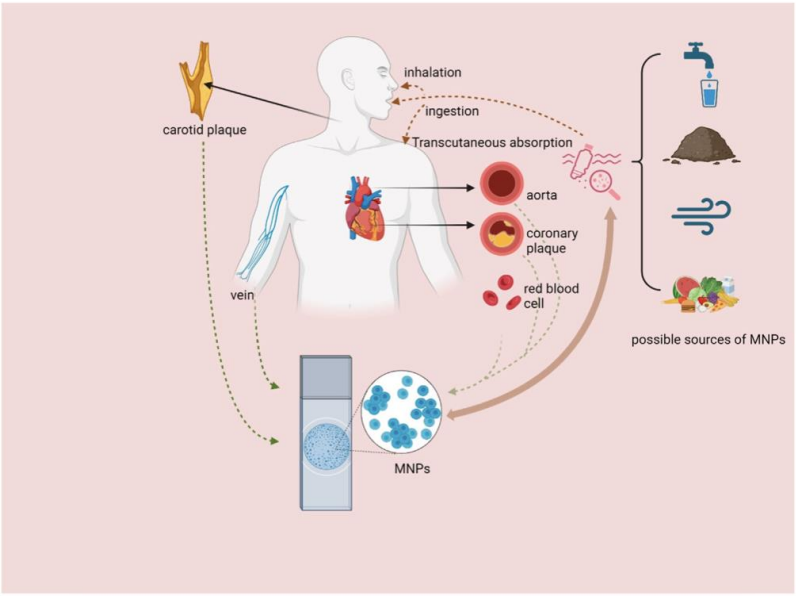
	○ Carotid plaques ○ Coronary arteries (atherosclerotic plaques) ○ Aortas without plaques - Atherosclerosis plaque had greater MP content than non-plaque -->contributed to development of Atherosclerosis - MPs found in sealed off organ tissues - MPs detected in membranes, myocardium, and venous blood - MNPs can start up alterations in cardiac structure, can damage larger organs - In a hypertension mouse model, ingesting polystyrene MNPs led to increased cardiac hypertrophy, reduced output, and increased renal fibrosis expression ○ Also associated with increased weight gain - Microplastics can lead to a slowed heart rate (bradycardia), abnormal rhythm (for fish) - Concentration of detectible plastic in blood is 1.6 micrograms/mL. - Though this is low, it will increase soon. - Autophagy disruption due to a cardiotoxic response, inflammatory responses, and clotting can all be correlations between MNPs and CVD. - Positive correlation between # of particles in thrombus and clotting count
Research Question/Problem/ Need	What are the gaps in literature between relationships of MNPs and CVD/where are we at right now?
Important Figures	 FIGURE 1 Sources of MNPs, pathways into the human body and distribution in cardiovascular-related organs and tissues. MNPs = microplastics and nanoplastics (created with BioRender.com). A graphic of sources of MPs, how they can enter the body, and where they can be found.

TABLE 1 MNPs discovered in human organ tissue.

Literature sources, Yrs	Organ tissue	Detection method	Types of MNPs	Size/Quantity/ Shape	Potential impact
Detection of microplastics in human lung tissue using muFTIR spectroscopy,2022	lung	μFTIR spectroscopy	PP, PET, resin	223.10 × 22.21 μm/ 1.42/g fibrous, fragmentary filmy	direct future cytotoxicity research to investigate any health implications associated with MNPs inhalation
Microplastics detected in cirrhotic liver tissue,2022	cirrhotic liver	Nile red staining, fluorescence microscopy, Raman spectroscopy	PVC, PET, PMMA, POM, PP	4–30 μm fragmentary microbeads	evaluate whether hepatic MNPs accumulation represents a potential cause in the pathogenesis of fibrosis or a consequence of cirrhosis and portal hypertension
First Evidence of Microplastics in Human Urine, a Preliminary Study of Intake in the Human Body,2022	urine	Raman spectroscopy	PVA, PVC, PP, PE	4–15 μm irregular	better characterize the level of risk and understand the possible transportation routes in biological fluids and tissues
Discovery and quantification of plastic particle pollution in human blood,2022	blood	Pyrolyzer-gas chromatography/mass spectrometry	PET, PP PS, PMMA	≥700 nm 1.6 μg/mL	evaluate whether blood exposure may affect immune regulation or have an immune basis susceptibility to disease
First evidence of microplastics in human placenta,2021	placenta	Raman spectroscopy	PP	5–10 μm spheres or irregular fragments	assess if the presence of MNPs in the human placenta may trigger immune responses or may lead to the release of toxic contaminants, resulting in harmful pregnancy
Raman Microspectroscopy Detection and Characterization of Microplastics in Human Breastmilk, 2022	breastmilk	Raman spectroscopy	PE, PVC, PP	1–12 μm spheres and irregular fragments	deepen the knowledge of the potential health impairment caused by MNPs internalization and accumulation, especially in infants, and to assess innovative, useful ways to reduce exposure to these contaminants during pregnancy and lactation

MNPs: microplastics and nanoplastics Yrs: publication years μFTIR: the micro Fourier transform interferometer.
PP: polypropylene PET: polyethylene terephthalate.
PVA: polyethylene vinyl acetate PVC: polyvinyl chloride PE: polyethylene.
PMMA: polymethyl methacrylate POM: polyoxymethylene PS: polymers of styrene.

A table of studies focusing on different tissues with different detection methods and the types of microplastics they found, as well as the possible impact these MPs can have.

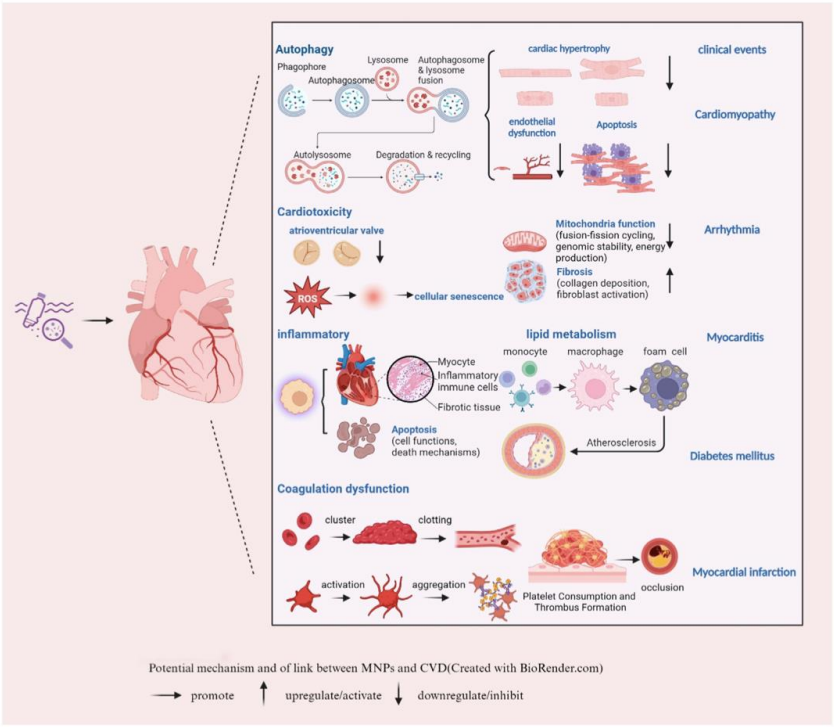


FIGURE 2
Potential mechanism of the link between MNPs and CVD (created with BioRender.com). → promote ↑ upregulate/activate ↓ downregulate/inhibit.

A graphic for the different ways MNP exposure could lead to heart problems and

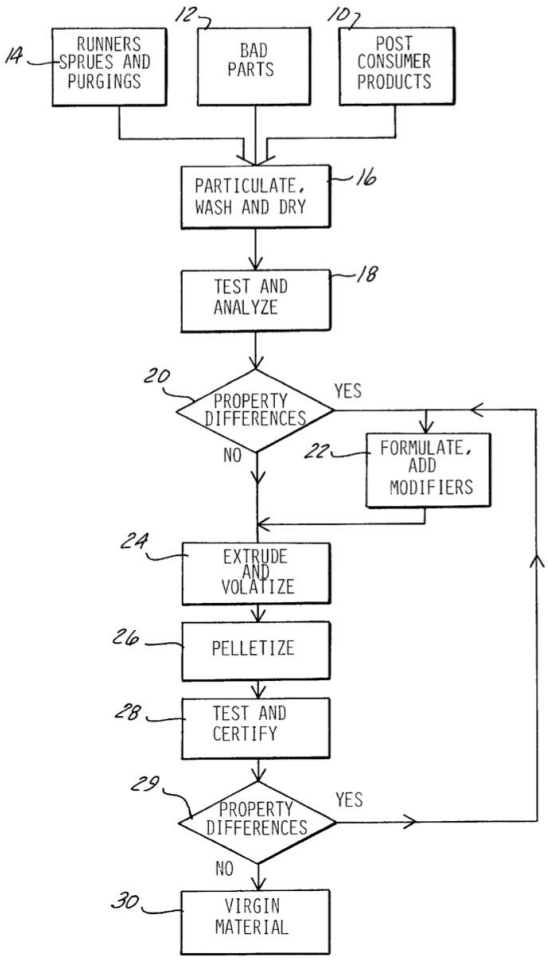
	CVD.
VOCAB: (w/definition)	Myocardial: Muscle tissue of heart Coronary heart disease: When plaque builds up in coronary arteries, causing restricted blood, oxygen, and nutrient supply. Protein corona: a layer of proteins that forms around nanoparticles atherosclerotic plaques: buildup of fat, cholesterol, and other substances on artery walls. Atherosclerosis: An artery disease where fatty material builds up on the inner walls. Pericardial tissue: tissue of the pericardium, double layered fluid filled sac surrounding heart. ***Hypertrophy: Growth and enlargement of tissues or organs*** Renal fibrosis: Scarring of kidney tissue
Cited references to follow up on	Ali, N., Katsouli, J., Marczylo, E. L., Gant, T. W., Wright, S., and Bernardino de la Serna, J. (2024). The potential impacts of micro-and-nano plastics on various organ systems in humans. EBioMedicine 99, 104901. doi:10.1016/j.ebiom.2023.104901 Bojic, S., Falco, M. M., Stojkovic, P., Ljujic, B., Gazdic Jankovic, M., Armstrong, L., et al. (2020). Platform to study intracellular polystyrene nanoplastic pollution and clinical outcomes. Stem Cells 38 (10), 1321–1325. doi:10.1002/stem.3244 Chowdhury, S. R., Dey, A., Mondal, S., and Gautam, M. K. (2023). Environmental microplastics and nanoplastics: effects on cardiovascular system. Toxicol. Anal. Clinique 36, 145–157. doi:10.1016/j.toxac.2023.11.006 Cverenkarova, K., Valachovicova, M., Mackulak, T., Zemlicka, L., and Birosova, L. (2021). Microplastics in the food chain. Life (Basel) 11 (12), 1349. doi:10.3390/life11121349 Lu, Y. Y., Li, H., Ren, H., Zhang, X., Huang, F., Zhang, D., et al. (2022). Size-dependent effects of polystyrene nanoplastics on autophagy response in human umbilical vein endothelial cells. J. Hazard Mater 421, 126770. doi:10.1016/j.jhazmat.2021.126770
Follow up Questions	- Can MP exposure cause cardiomegaly? - Can MP exposure increase the size of the heart? - Why does heart rate decrease when exposed to MPs?

Article #21 Notes: “Painted Plastic Material Recycling Process”

Source Title	Painted Plastic Material Recycling Process
Source citation (APA Format)	Lieberman, M. (2001, April 17). *Painted Plastic Material Recycling Process.*
Original URL	https://patentimages.storage.googleapis.com/b0/f6/52/427491769bdf82/US6217804.pdf
Source type	Patent
Keywords	N/A
#Tags	N/A
Summary of key points + notes (include methodology)	- Plastic coated with paint film is melted in extruder. - Paint film is volatilized and removed by a vacuum from granulate steam. - Additives are mixed in and water is introduced to melted plastic steam in order to stop toxic material. - Plastic disposal use is a problem, as there are so many items that need to be

	disposed.
	- Currently plastic is incinerated, buried in landfill, given biodegradable properties or recycled, though recycled is a small amount.
	  o Incineration causes environmental problems
	  o Landfills are running out of space
	  o Biodegradable materials are costly
	- One recycling process uses high bulk density polystyrene and low bult density polystyrene to create a new polystyrene sheet.
	- Another uses raw polyethylene to a low bulk density polyethylene film.
	- Dealing with waste that has non-compatible materials is more difficult.
	- Compatibilizing agents and using materials with low property requirements are ways to solve this.
	- Only good for commodity plastics, not engineering plastics.
	- Invention is the process to recycle thermoplastic material which includes:
	  o Testing particulates to determine properties
	  o Comparing tested properties to raw counterparts
	  o Putting particulates into a twin screw extruder
	  o Mixing additives
	  o Withdrawing dangerous constituents
	  o Preparing extruded material for re-use
	- The process is simple and allows for a lot of different plastics, as well as the ability to recycle painted plastics and engineering plastics.

Research Question/Problem / Need	Create a way to recycle plastics while also being able to account for possible paint jobs on the plastic.

Important Figures	 FIG - 1 A flow chart representing the steps of the process.

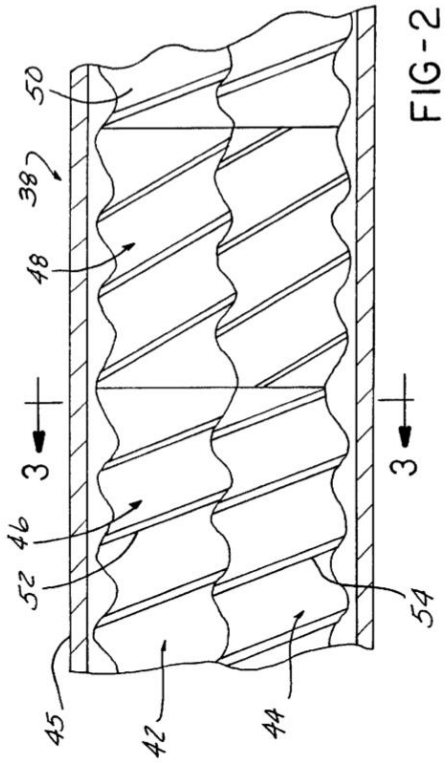


FIG-2

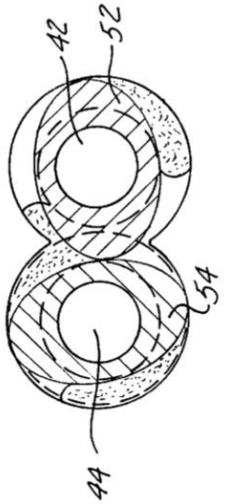
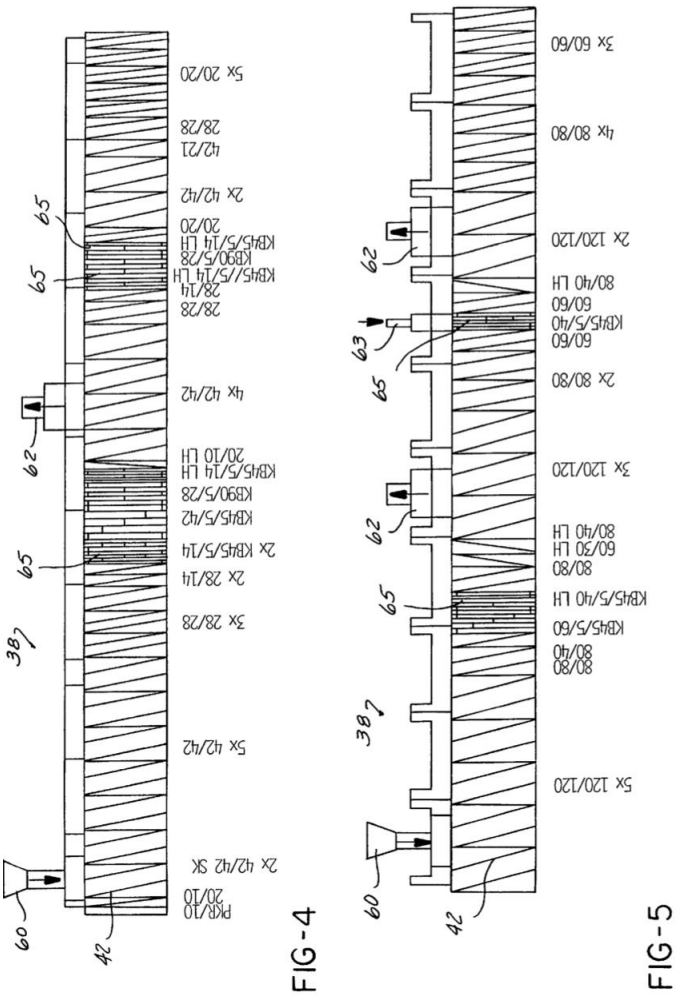


FIG-3

A cross-section view of the twin screw extruder.

	 FIG-4 FIG-5 Schematics showing extruder screw sections.
VOCAB: (w/definition)	Volatized: Substance turned into vapor Thermoplastic: Plastic that softens when heated Constituents: a component Dielectric: electric insulator that supports electric fields by becoming polarized Terpolymer: Polymer for bonding 3 different monomer units. Homopolymer: Long chain that is just a repeated 1 monomer Spures: hydraulic structures Purgings: removing unwanted substances from closed system
Cited references to follow up on	N/A
Follow up Questions	- How strong are the newly created recycled polymers? - How many different plastics can be added? - Does the system release microplastics unintentionally?

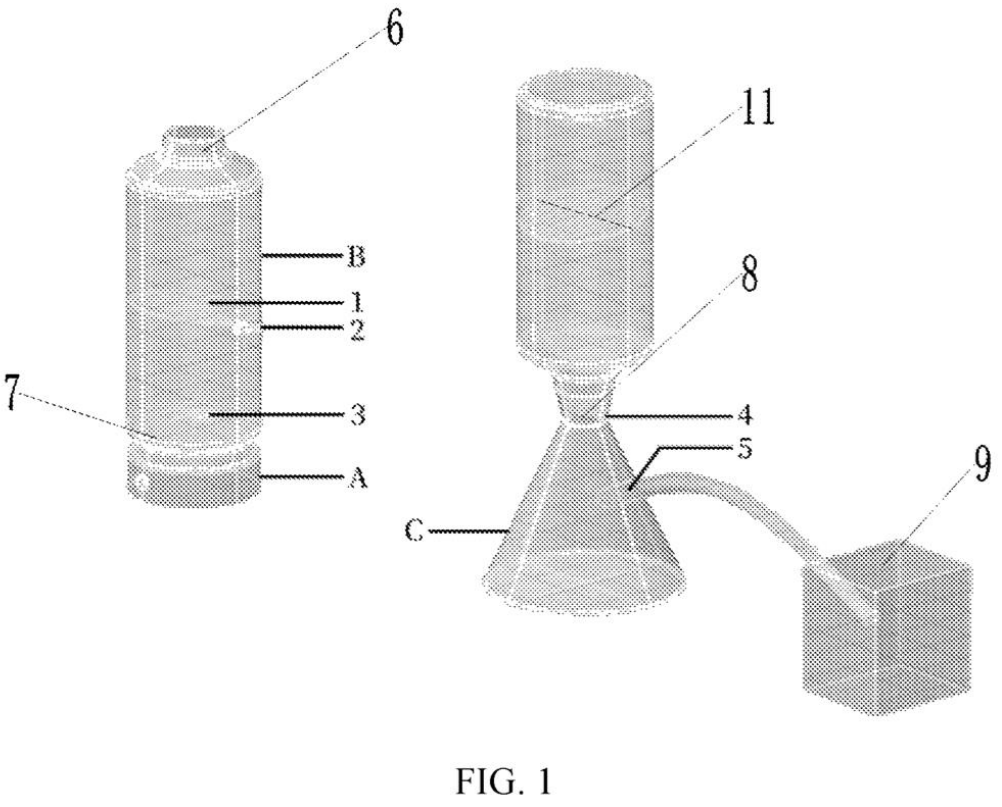
Article #22 Notes: “Integrated Separation Unit for Microplastics in the Costal Sediments and Collection Method of Microplastics”

Source Title	Integrated Separation Unit for Microplastics in the Costal Sediments and Collection Method of Microplastics
Source citation (APA Format)	Weng, W., Ye, M., Xu, X., Lu, Y., Zhang, D., & Ma, Q. (2022). *Integrated separation unit for microplastics in the coastal sediments and collection method of microplastics*.
Original URL	https://patentimages.storage.googleapis.com/cb/fe/ec/3778c54ee25bce/US11420140.pdf
Source type	Patent
Keywords	N/A
#Tags	N/A

Summary of key points + notes (include methodology)	- Integrated separation unit for MPs in costal sediments.
	  - Collection method
	- Includes:
	  - A holder
	  - A separation cylinder
	  - A collection bottle
	  - A central baffle plate
	  - A baffle plate control knob
	  - A stirring propeller
	  - A motor
	  - A cylinder switch
	  - A filtration screen
	  - A welding nozzle
	  - A filter membrane
	  - A vacuum pump
	- Easy to operate, cheap, environmentally friendly, efficient, and durable.
	- 129 costal countries pour 4.8-12.7 million tons of plastic waste into the ocean.
	- China pours the most plastic into the sea (2.4 million tons, 30% global total)
	- Microplastics found in seawater, seafloor, and submarine sediments
	- Additives used in production of plastics are toxic.
	- Density separation method used to get MPs from sediments
	- MPs separated from sediments by flotation or elutriation

	- Separation of MPs in sediment mainly goes to removing organic matter, removing non-MPs, and then getting MPs.
	- Sodium chloride solution is most common solution used.
	- Contraption:
	  o Integrated separation unit for MPs in costal sediments
	  ▪ Holder
	  ▪ Separation cylinder
	  ▪ Collection bottle
	  ▪ Central baffle plate
	  ▪ Baffle plate control knob
	  ▪ Stirring propeller
	  ▪ Motor
	  ▪ Cylinder switch
	  ▪ Filtration screen
	  ▪ Welding nozzle
	  o A filter membrane and vacuum pump
	- Filter can filter from 0.15, 0.22, 0.45, 0.80, and 1.20 micrometers
	- Samples are filtered and dried before being taken to analyze.
	- The contraption is easy to operate while also being cost-effective, durable, environment safe, and efficient.

Research Question/Problem / Need	Create a device that can separate MPs from sediment quickly and efficiently.

Important Figures	 FIG. 1 A design for the contraption

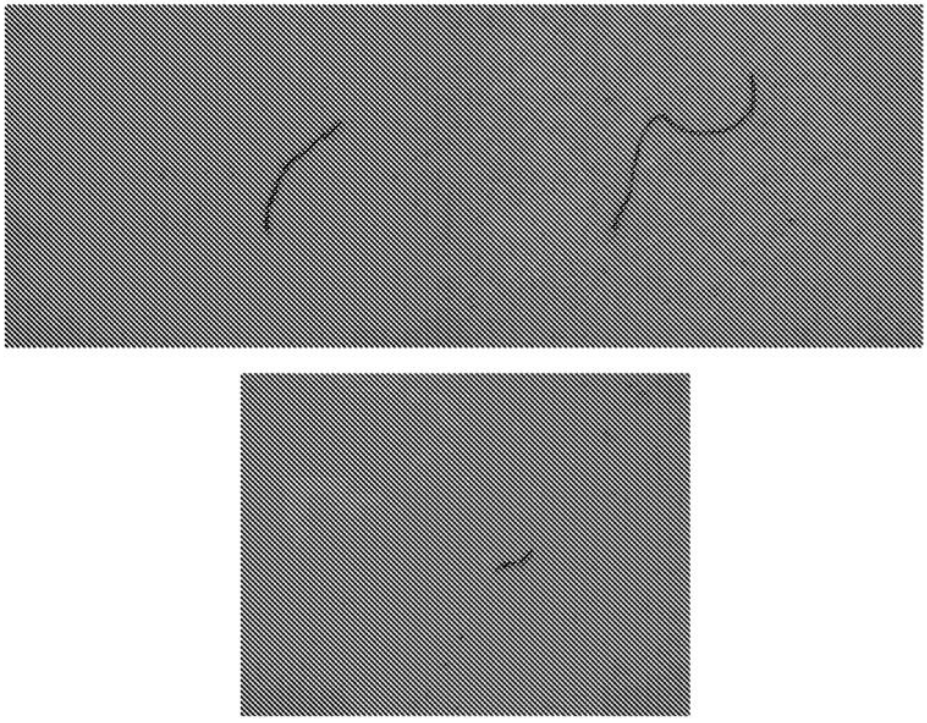
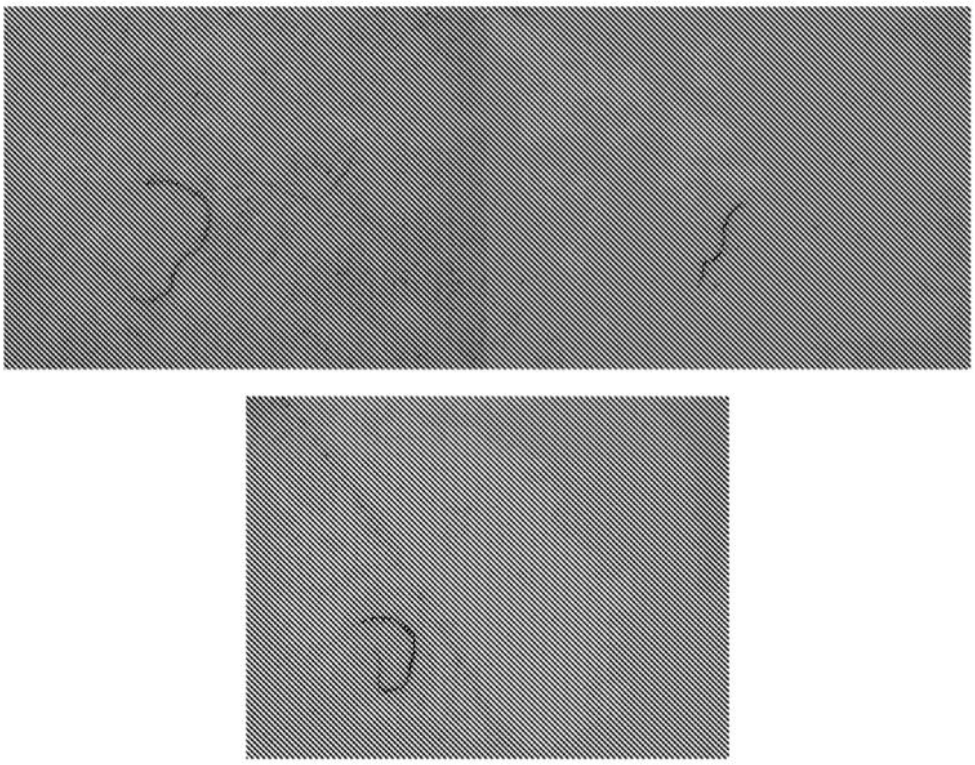
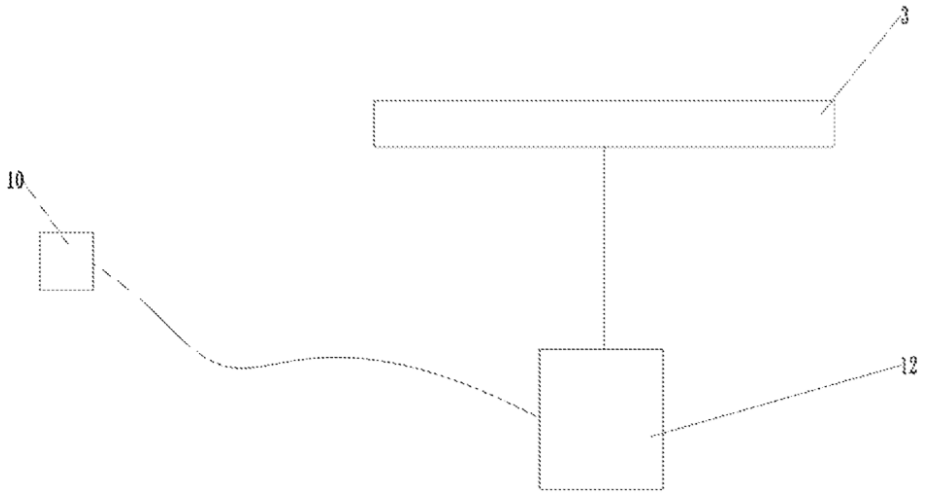


FIG. 2

Microscopic image according to Embodiment 1

	 FIG. 3 Microscopic image but according to Embodiment 2  FIG. 4 Schematics for stirring blade, cylinder switch, and motor
VOCAB: (w/definition)	Elutriation: separation process that sorts particles by size, shape, and density Centrifugation: Uses centrifugal force from rapid spinning to separate a mixture

	Supernatant: The liquid lying above a solid residue after crystallization, precipitation, centrifugation, or other process. Stratification: Arrangement of something into 2 groups Pathogenic: Capable of causing disease Photodegradation: break down of materials from light energy (UV from sun) Aperture: adjustable opening in a camera lens Baffle plate: A metal or ceramic barrier in devices like wood stoves that slows flow of heat, smoke, or gas
Cited references to follow up on	N/A
Follow up Questions	- Can this be implemented at larger scales? - Can it be modified to extract microplastics from water? - Does it work on all terrains? For example soil versus sand?