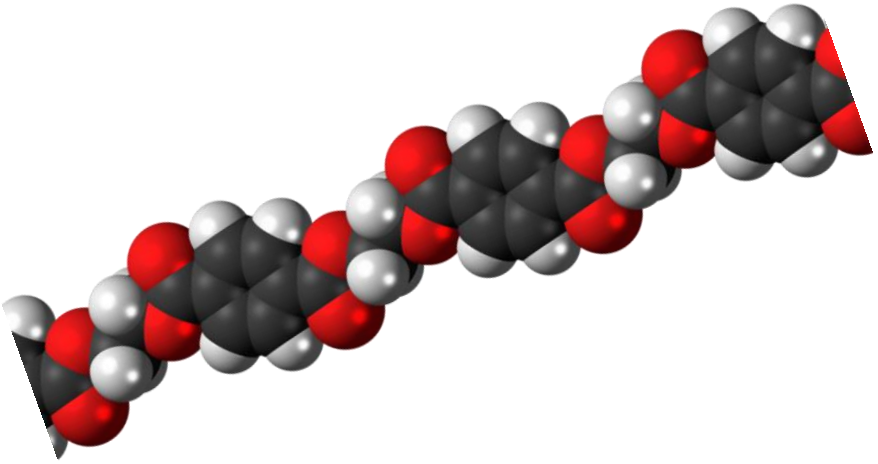
NIJZ Nacionalni inštitut za javno zdravje

# Problematika mikroplastike: okolje-zdravstveni vidik

Agnes Šömen Joksić

13. Posvet Kemijska varnost za vse: *Kemijska varnost mikroplastike,* 7.12.2021, zoom okolje

# Vsebina



Terminologija in definicije

Kratek pregled stanja

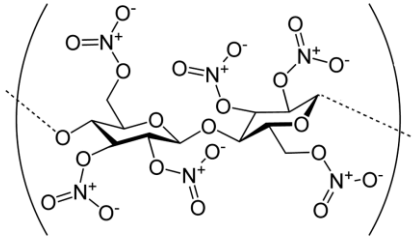
Zakaj je mikroplastika lahko nevarna?

Zakaj lahko predstavlja tveganje (za okolje in zdravje)?

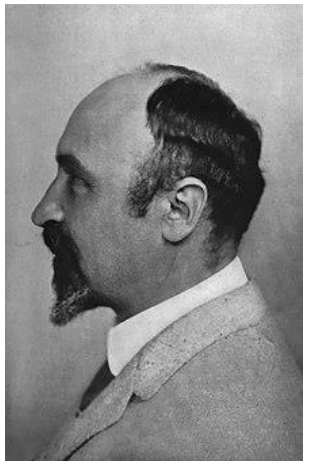
Mikroplastika v kontekstu KV?

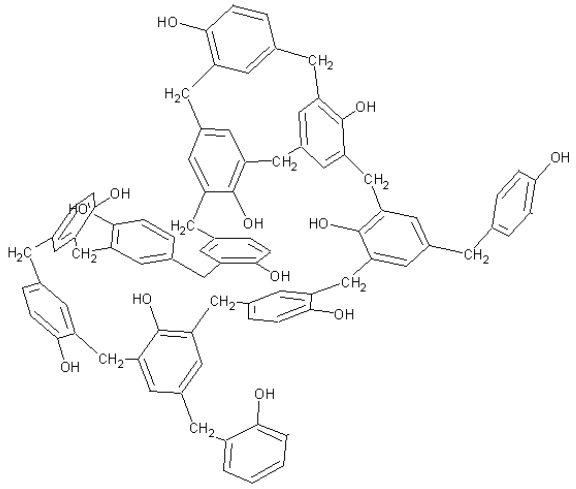
# Zelo kratka zgodovina plastike

John Wesley Hyatt, Jr., 1837-1920



https://en.wikipedia.org/wiki/John_Wesley_Hyatt

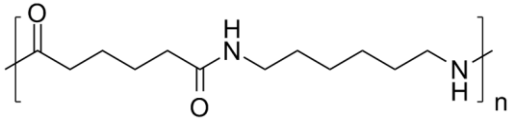




Leo Hendrik Baekeland, 1863-1944


https://collection.sciencemuseumgroup.org.uk/people/cp37108/leo-hendrik-baekeland

Wallace Hume Carothers, 1896-1937



https://en.wikipedia.org/wiki/Wallace_Carothers

# Nekaj definicij:
# ..mikro (in nano) plastika, MP

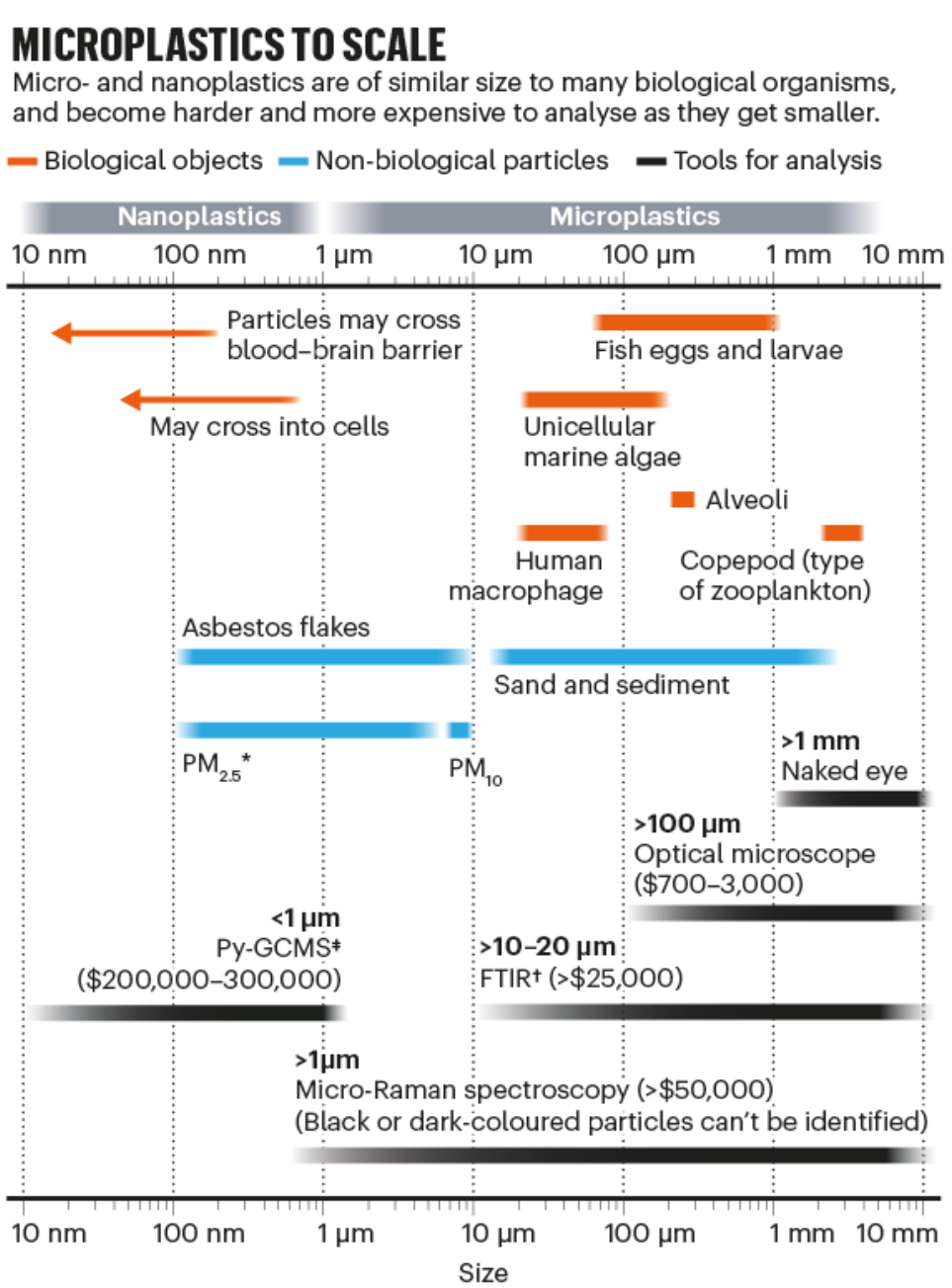
*"Microplastics are any synthetic solid particle or polymeric matrix, with regular or irregular shape and with size ranging from 1 µm to 5 mm, of either primary or secondary manufacturing origin, which are insoluble in water".*

Frias J., Nash R. Microplastics: Finding a consensus on the definition. *Mar. Pollut. Bull.* 2018;**138**:145–147.

Izraz "mikroplastika" predstavil morski biolog Richard Thompson (Univerza Plymouth, 2004).

NATIONAL GEOGRAPHIC

Thompson, R.C., et al., 2004. Lost at sea: where is all the plastic? Science 304 (5672), 838.




S. Primpke *et al. Appl. Spectrosc.* **74**, 1012–1047 (2020), Objavljeno v Nature, 593, 2021

©nature

# …primarna in sekundarna mikro plastika

## Primarna MP

- Namenska proizvodnja, različen namen in uporaba
- Neposredno sproščanje v okolje

## Sekundarna MP

- Posledica razpadanja in fragmentacije večjih delcev oziroma delov polimernega materiala (končna ‚postaja' je večinoma morje)


Prirejeno po:
Rochman, C.M. 2020. The story of plastic pollution: From the distant ocean gyres to the global policy stage. *Oceanography* 33(3):60–70

# Nevarne lastnosti MP

Sestava

- Ostanki topil, monomerja, iniciatorjev, katalizatorjev
- Stranski produkti polimerizacije
- Aditivi
  - UV stabilizatorji
  - pigmenti
  - vodoodbojne spojine
  - zaviralci gorenja
  - mehčala
  - ojačevala

Izvirna toksičnost

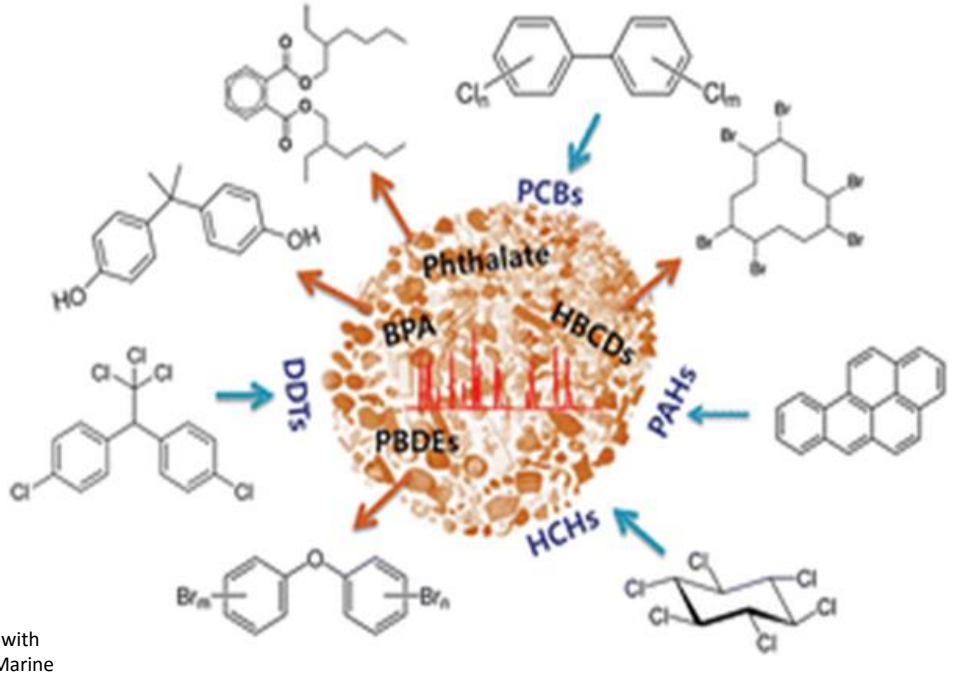
- Se nanaša na monomer
  - Poliuretan (PUR)
  - Poliakrilonitril (PAN)
  - Polivinilklorid (PVC)

‚Naknadna' toksičnost

- Adsorpcija okoljskih kemikalij; MP kot vektor toksičnih kemikalij (in patogenih mikroorganizmov)
  - Tudi ostala MP (v osnovi nenevarna), npr. polipropilen (PP), polivinilacetat (PVAc), polietilen (PE)

Učinki tudi zaradi „velikosti"

- Analogija z ostalimi okoljskimi mikro (in nano) delci
  - Fizikalna aktivnost – iritacija

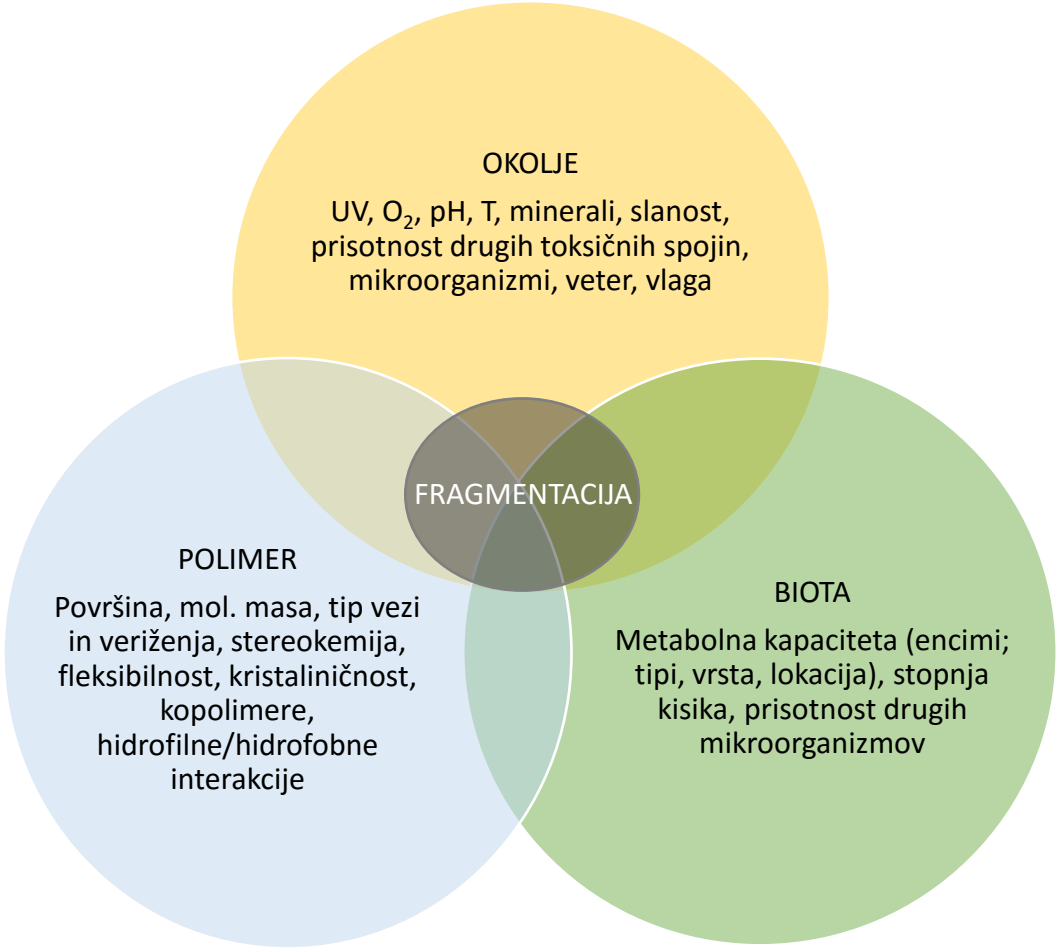



Rochman C.M. (2015) The Complex Mixture, Fate and Toxicity of Chemicals Associated with Plastic Debris in the Marine Environment. In: Bergmann M., Gutow L., Klages M. (eds) Marine Anthropogenic Litter. Springer

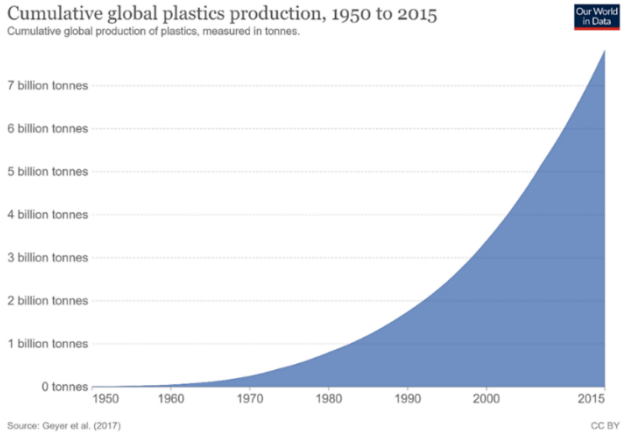
# Usoda plastike v okolju - preperevanje in fragmentacija ter razširjanje

Ključni dejavniki

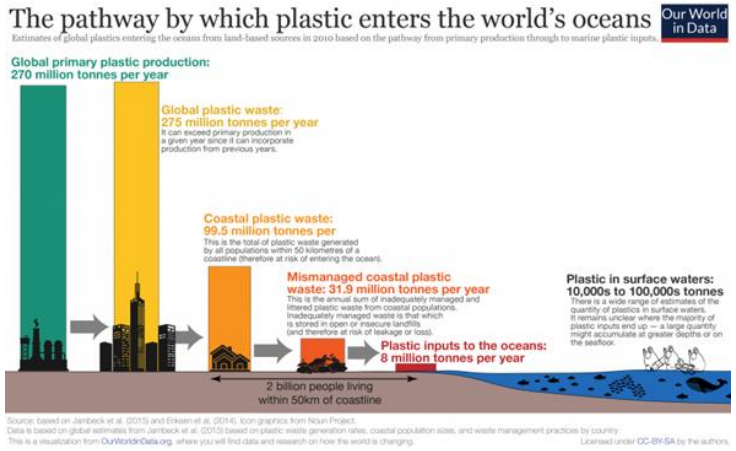
- Lastnosti polimera
- Pogoji v okolju
- Biotski in abiotski procesi
- Razpadanje (preperevanje) / agregiranje
- Sorpcija / desorpcija toksičnih kemikalij
- Prehajanje v organizme
- Razširjanje (na velike razdalje)



# Posledice




Cumulative Plastic Production since 1960. Calculated as the sum of annual global polymer resin, synthetic fiber, and plastic additive production. Most of this plastic still exists.
*Source*: Our World in Data (https://ourworldindata.org/plastic-pollution)




https://www.marineconservation.org.au/ocean-plastic-pollution/



https://www.nwf.org/Home/Magazines/National-Wildlife/2019/June-July/Conservation/Ocean-Plastic

Campanale et al., 2020

**WHAT GOES IN THE OCEAN GOES IN YOU.**

RECENT STUDIES ESTIMATE THAT FISH OFF THE WEST COAST INGEST OVER 12,000 TONS OF PLASTIC A YEAR. FIND OUT HOW YOU CAN HELP TURN THE TIDE ON PLASTIC POLLUTION AT WWW.SURFRIDER.ORG/RAP

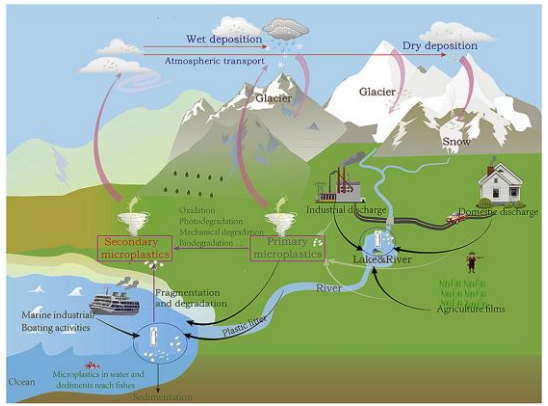
https://www.surfrider.org/

SURFRIDER FOUNDATION

RISE ABOVE PLASTICS

# Plasticen ?

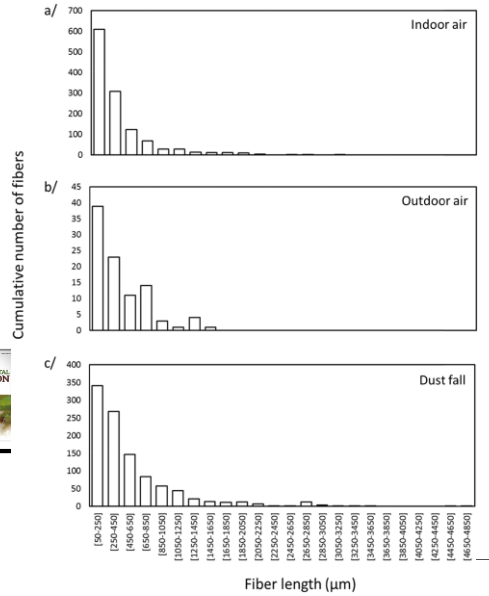
# Poti razširjanja: tudi reke, zemlja (prst), pitna voda zrak (notranji, zunanji)

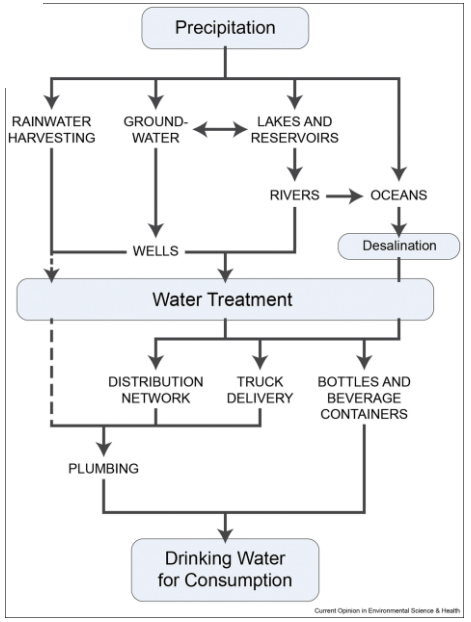



Environmental Pollution 221 (2017) 453–458
Contents lists available at ScienceDirect
Environmental Pollution
journal homepage: www.elsevier.com/locate/envpol

A first overview of textile fibers, including microplastics, in indoor and outdoor environments☆

Rachid Dris [a, *], Johnny Gasperi [a, **], Cécile Mirande [a], Corinne Mandin [b], Mohamed Guerrouache [c], Valérie Langlois [c], Bruno Tassin [a]
[a] Université Paris-Est, LEESU (laboratoire eau environnement et systèmes urbains), 61 avenue du Général de Gaulle, 94010 Créteil Cedex, France
[b] Université Paris-Est, Centre Scientifique et Technique du Bâtiment (CSTB), 77447 Marne-La-Vallée, France
[c] Institut de Chimie et des Matériaux Paris Est, CNRS-UPEC-UMR7182, 2-8, rue Henri Dunant, 94320 Thiais, France




Environmental Pollution 254 (2019) 112953
Contents lists available at ScienceDirect
Environmental Pollution
journal homepage: www.elsevier.com/locate/envpol

Importance of atmospheric transport for microplastics deposited in remote areas☆

Yulan Zhang [a, b, **], Tanguang Gao [c], Shichang Kang [a, b, *], Mika Sillanpää [d]
[a] State Key Laboratory of Cryosphere Sciences, Northwest Institute of Eco-Environment and Resources, Chinese Academy of Sciences, Lanzhou 730000, China
[b] CAS Center for Excellence in Tibetan Plateau Earth Sciences, Chinese Academy of Sciences, Beijing 100101, China
[c] Key Laboratory of Western China's Environmental Systems (Ministry of Education), College of Earth and Environmental Sciences, Lanzhou University, Lanzhou 730000, China
[d] Laboratory of Green Chemistry, Lappeenranta University of Technology, Sammonkatu 12, FIN-50130 Mikkeli, Finland

Available online at www.sciencedirect.com
ScienceDirect
Current Opinion in Environmental Science & Health

**Microplastics in air: Are we breathing it in?**

Johnny Gasperi[1,a], Stephanie L. Wright[2,a], Rachid Dris[1], France Collard[1], Corinne Mandin[3], Mohamed Guerrouache[4], Valérie Langlois[4], Frank J. Kelly[2] and Bruno Tassin[1]

Current Opinion in Environmental Science & Health
Volume 7, February 2019, Pages 69-75

Microplastics in drinking water: A review and assessment

Dafne Eerkes-Medrano [1], Heather A. Leslie [2], Brian Quinn [3]

TECHNICAL ARTICLE 27

Microplastics in the environment: impact on human health and future mitigation strategies

Disha Katyal*, Elaine Kong, and Jacit Villanueva
Environmental Health Program, British Columbia Institute of Technology, Burnaby, BC, Canada

Science of the Total Environment
journal homepage: www.elsevier.com/locate/scitotenv

Exploring the impacts of plastics in soil – The effects of polyester textile fibers on soil invertebrates

Salla Selonen [a,b,*], Andraž Dolar [c], Anita Jemec Kokalj [c], Tina Skalar [d], Lidia Parramon Dolcet [a], Rachel Hurley [e], Cornelis A.M. van Gestel [a]
[a] Vrije Universiteit Amsterdam, Faculty of Science, Department of Ecological Science, De Boelelaan 1085, 1081 HV Amsterdam, The Netherlands
[b] Finnish Environment Institute (SYKE), Mustialankatu 3, 00790 Helsinki, Finland
[c] University of Ljubljana, Biotechnical Faculty, Department of Biology, Jamnikarjeva 101, 1000 Ljubljana, Slovenia
[d] University of Ljubljana, Faculty of Chemistry and Chemical Technology, Chair of Materials and Polymer Science, Večna pot 113, 1000 Ljubljana, Slovenia

International Journal of Environmental Research and Public Health
MDPI
Int J Environ Res Public Health. 2020 Feb; 17(4): 1212.
Published online 2020 Feb 13. doi: 10.3390/ijerph17041212
PMCID: PMC706860
PMID: 3206999

**A Detailed Review Study on Potential Effects of Microplastics and Additives of Concern on Human Health**

Claudia Campanale,* Carmine Massarelli, Ilaria Savino, Vito Locaputo, and Vito Felice Uricchio

jak microplastics and human health

Približno 29.000 rez. (0,15 s)

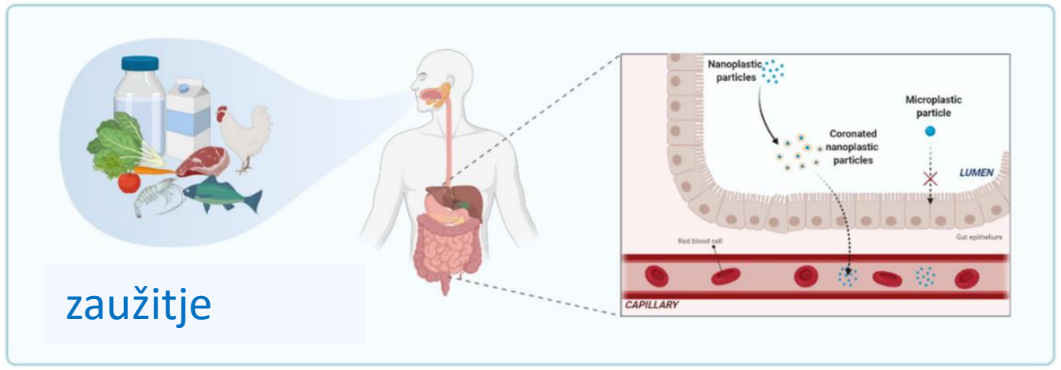
[HTML] **Microplastics** in seafood and the implications for **human health**
M Smith, DC Love, CM Rochman, RA Neff - Current environmental **health** ..., 2018 - Springer
Abstract Purpose of Review We describe evidence regarding **human** exposure to **microplastics** via seafood and discuss potential **health** effects. Recent Findings Shellfish and other animals consumed whole pose particular concern for **human** exposure. If there is ...
☆ Shrani 99 Navedi Navedeno v 540 virih Sorodni članki Vse različice: 11

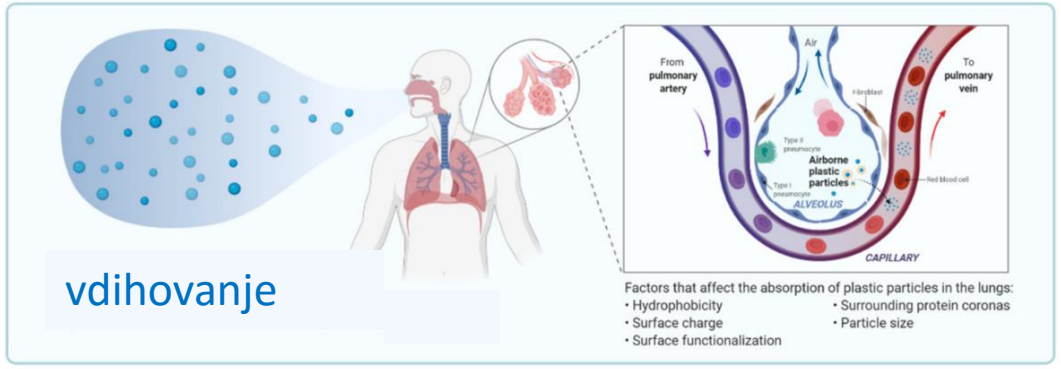
[HTML] Environmental exposure to **microplastics**: An overview on possible **human health** effects
JC Prata, JP da Costa, I Lopes, AC Duarte... - Science of the Total ..., 2020 - Elsevier
**Microplastics** are ubiquitous environmental contaminants leading to inevitable **human** exposure. Even so, little is known about the effects of **microplastics** in **human health**. Thus, in this work we review the evidence for potential negative effects of **microplastics** in the **human** ...
☆ Shrani 99 Navedi Navedeno v 338 virih Sorodni članki Vse različice: 8

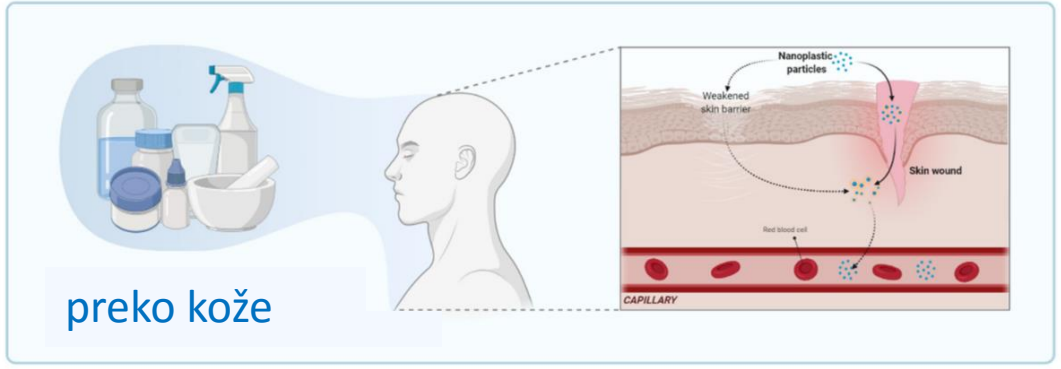
[HTML] Airborne **microplastics**: consequences to **human health**?
JC Prata - Environmental pollution, 2018 - Elsevier
**Microplastics** have recently been detected in atmospheric fallout in Greater Paris. Due to their small size, they can be inhaled and may induce lesions in the respiratory system dependent on individual susceptibility and particle properties. Even though airborne ...
☆ Shrani 99 Navedi Navedeno v 391 virih Sorodni članki Vse različice: 9

**Microplastics** and **human health**
AD Vethaak, J Legler - Science, 2021 - science.sciencemag.org
... The ubiquity of **microplastics** (plastic particles <5 mm, including nanosized plastics <1 µm) in the global biosphere raises increasing concerns about their implications for **human health** (1–3). Recent evidence indicates that humans constantly inhale and ingest **microplastics**; ...
☆ Shrani 99 Navedi Navedeno v 53 virih Sorodni članki Vse različice: 7

# Izpostavljenost človeka in možni učinki




**Nekateri razpoložljivi podatki**

Toksikološke študije

- In-vivo (miške) (Park et al., 2020; Li et al., 2021)
  - vnetje tankega črevesa
  - zmanjšano število spermijev
  - manjši mladiči
- In-vitro (človeške celice/tkiva) (Koelmans et al., 2021)
  - toksičnost (različni učinki na celično aktivnost)
  - ekstrapolacija izsledkov toksikoloških študij

Redke epi oz. HBM študije

- Raziskave placente (Ragusa et al., 2021)
  - v 4 od 6 vzorcev do 12 delcev MP (možna kontaminacija; neponovljiv eksperiment!)

Yee, M.S.-L., . Impact of Microplastics and Nanoplastics on Human Health. Nanomaterials 2021, 11, 496.

# ..... in mnogi manjkajoči...

- Pomanjkljivosti (nezanesljivost) obstoječih?
- Sporadične tox in HBM študije (ni še „zbirke podatkov“)?
- Sinergistični učinek („cocktail“ )?
- Usoda v organizmu (ADME)?
- „Benchmarking“ (kot kriterij za primerjanje toksičnih učinkov; varno-nevarno)?
- Analitski izziv (zahteva oprema ≠ rutinsko določanje)?
- Ekstrapolacija ugotovljene izpostavljenosti (in učinkov) na zdravstvene izide?
- Ostali posredni in neposredni o vplivi zaradi motenj bioloških in vitalnih geoloških procesov?

# Aksiom KV tudi za mikroplastiko




*„Kemijska varnost je stanje takšne uporabe plastike (koktaila kemikalij), da je tveganje za zdravje ljudi in okolje čim manjše ter je s tem omogočen trajnostni razvoj“.*

# Za zaključek:

## Story of a plastic bottle - Greenpeace

https://www.youtube.com/watch?v=CLeccbkBZzs

Viri


Campanale C, et al. *Int. J. Environ. Res. Public Health*. 2020;17(4):1212.

Frias J, Nash R. *Mar. Pollut. Bull.* 2018;138:145-147.

Koelmans AA, et al. *Environ. Sci. Technol*. 2020;54:12307-12315.

Li B, et al. *Chemosphere* 2020;244.

Park EJ, et al. *Toxicol. Lett*. 2020; 324:75-85.

Primpke, S. *et al. Appl. Spectrosc.* 2020; 74:1012–1047. Objavljeno v Nature, 593, 2021.

Ragusa A, et al. Environ. Int. 2021; 146.

Ritchie H, Roser, M. (2018). Plastic Pollution. *OurWorldInData.org;* (https://ourworldindata.org/plastic-pollution)

Rochman CM. *Oceanography* 2020;33(3):60-70

Rochman CM. In: Bergmann M, Gutow L, Klages M. (eds) Marine Anthropogenic Litter, Springer, 2015.

Thompson RC, et al. Lost at sea: where is all the plastic? *Science* 2004;304 (5672), 838.

Yee MS-L. *Nanomaterials* 2021;11, 496.