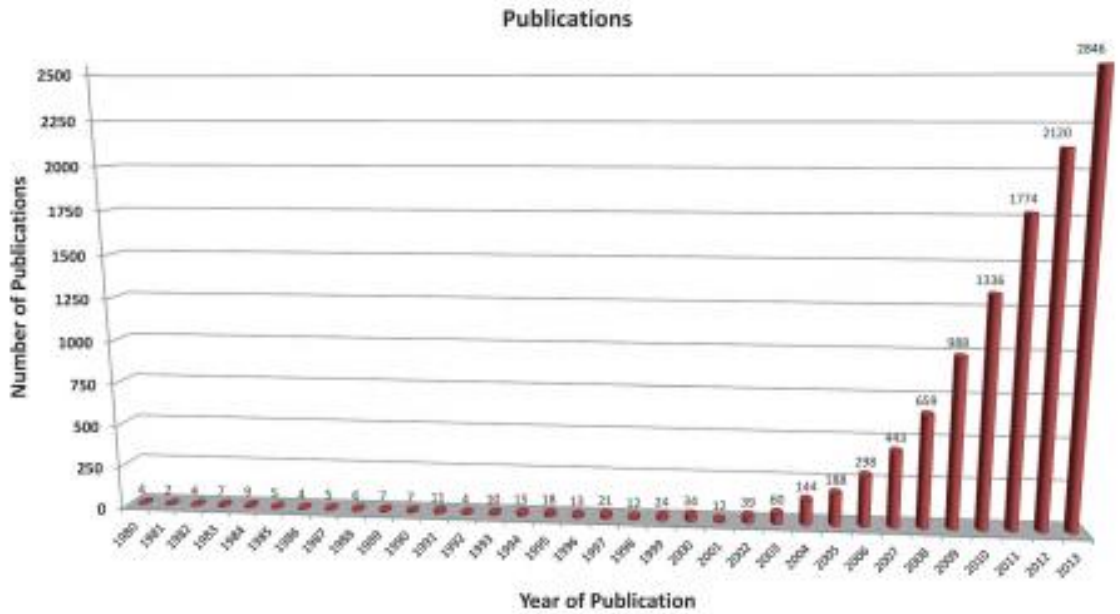
Article

Organ-Specific and Size-Dependent Ag Nanoparticle Toxicity in Gills and Intestines of Adult Zebrafish

Wenli Guo

Olivia J. Osborne, Sijie Lin, Chong Hyun Chang *et al. ACS Nano. 2015*

As the nanotechnology industry continues to expand, so does nanoparticle (NP) production, with over 2000 nanoproducts currently in the marketplace.[1] As a result of their attractive antimicrobial properties, silver nanoparticles (AgNPs) are one of the most abundant commercially available nanomaterials, with over 400 nanoproducts containing nano-Ag.[2,3] AgNPs are found in many consumer products (See Table S1) such as cosmetics, plastics, water purifiers, textiles, medicine, and every day applications.[4] Consequently, this amplifies the likelihood of AgNPs reaching water systems, with the possibility of exposing aquatic organisms that reside there. Research using life cycle modeling predicts that the amount of AgNPs reaching surface waters may amount to >60 tons per year,[5] with the possibility of causing hazardous effects in aquatic life forms such as fish and fish embryos.[6]



Category	Product
Appliances	Hair Straighter Iron Bidet
Cosmetics	Beauty Soap Toothpaste
Food & Beverages	Food box containers Kitchen utensils Health Supplement
Goods for children	Baby carriage Plush Toys
Health & Fitness	Wound Dressing Sports Socks
Home & Garden	Paint Humidifier










人工纳米材料的环境暴露风险和人类的健康风险示意图

Known:

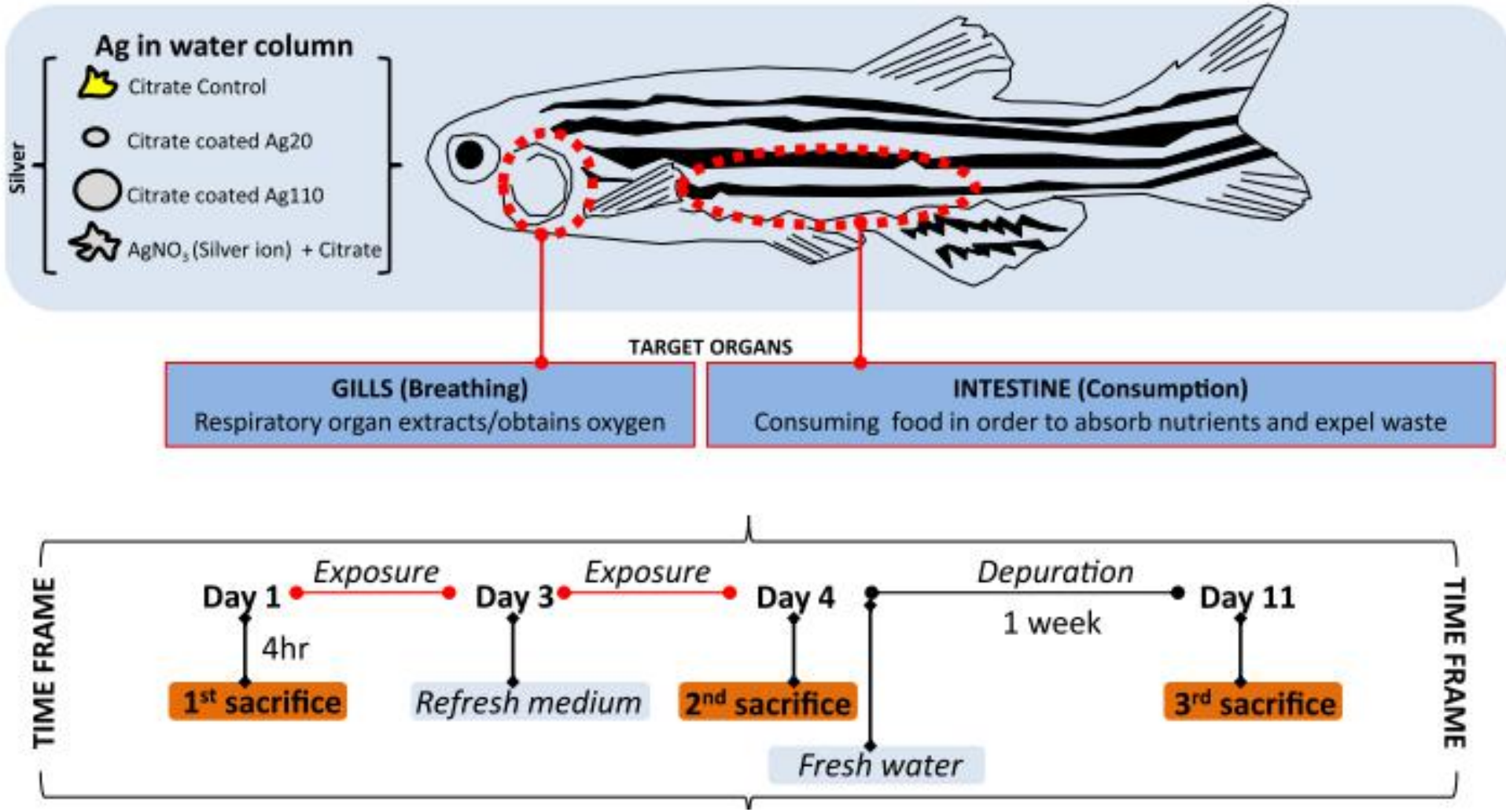
Smaller AgNPs exert more hazardous effects in zebrafish embryos and induce more intense inflammation and oxidative stress in the lungs of rodents than larger particles.

Unknown:

Whether different particle sizes could impact known target organs for hazardous substances in fish, namely, the gills and intestines?

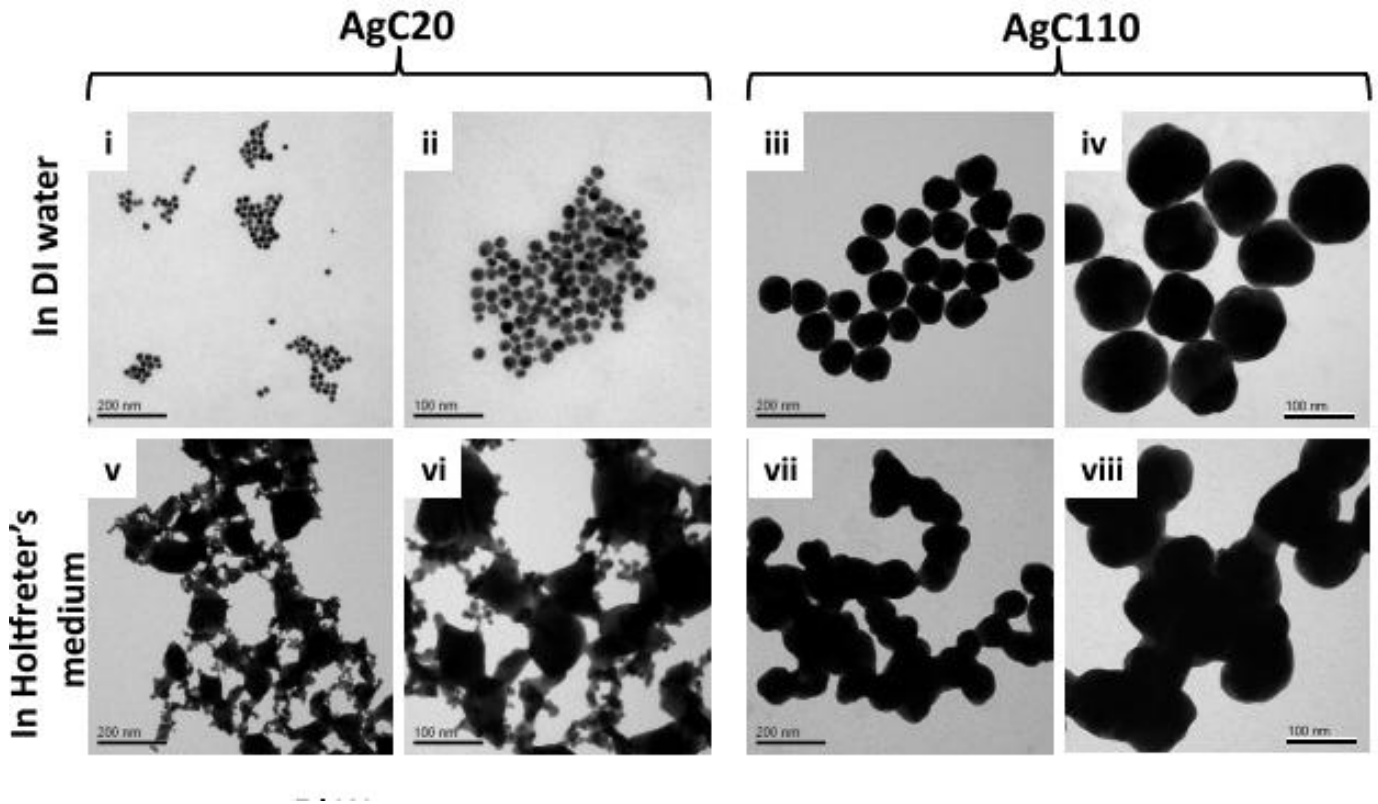
whether size-dependent variances are differently reflected in the target organs?

Scheme 1. Schematic To Show the Experimental Layout[a]



Results

Physicochemical Characterizations of the AgNPs



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Physicochemical Characterizations of the AgNPs

TABLE 1. NP Hydrodynamic Diameter and ζ-Potential in DI Water and Holtfreter's Medium

	DI water			HM		
NPs	d_H (nm)	PDI[a]	ζ-potential (mV)	d_H (nm)	PDI[a]	ζ-potential (mV)
AgC20	25.01 ± 0.1	0.053	−9.3 ± 1.5	522.2 ± 37.3	0.323	−16.6 ± 2.1
AgC110	73.1 ± 0.8	0.278	−25.4 ± 4.8	340.5 ± 9.7	0.257	−23.7 ± 2.6

[a] Polydispersity index.

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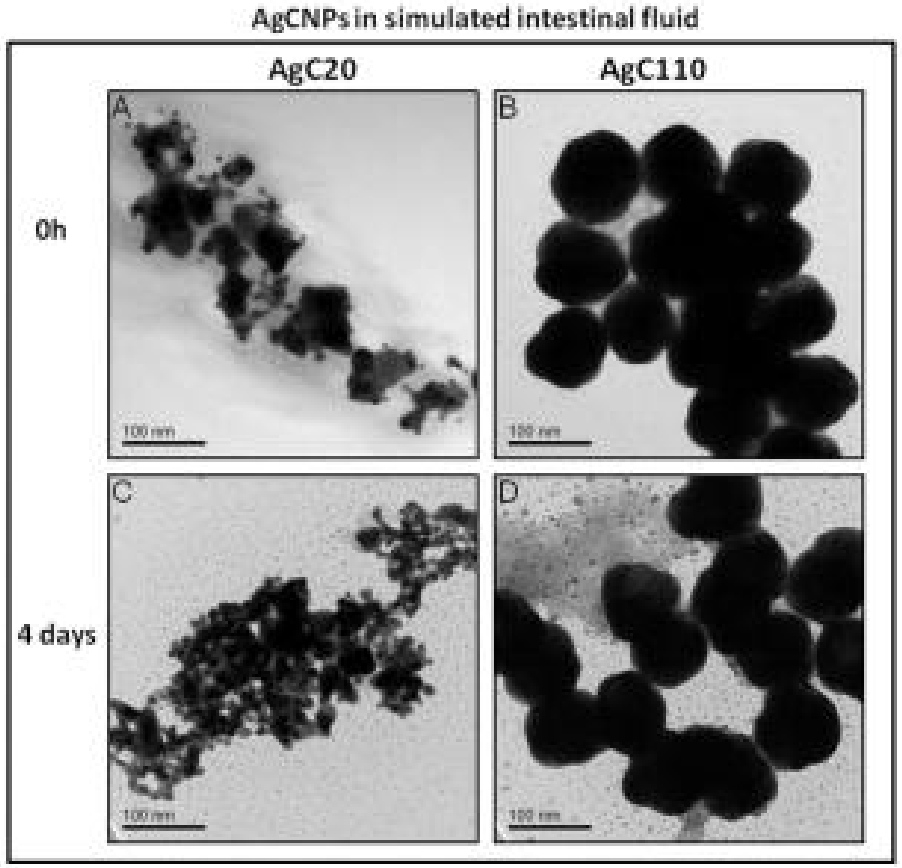


Simulated intestinal fluid	0 hr			4 days		
NPs	d_H (nm)	PdI	ζ-potential (mV)	d_H (nm)	PdI	ζ-potential (mV)
AgC20	1112.5 ±40.5	0.297	-29.65±1.77	759.8±20.4	0.297	-27.72±2.32
AgC110	391.1±17.3	0.292	-40.07±4.94	326.7±10.2	0.328	-38.64±2.80

Results

Quantification of the Ag Content of the Gills and Intestines reveals Size-Dependent Differences.

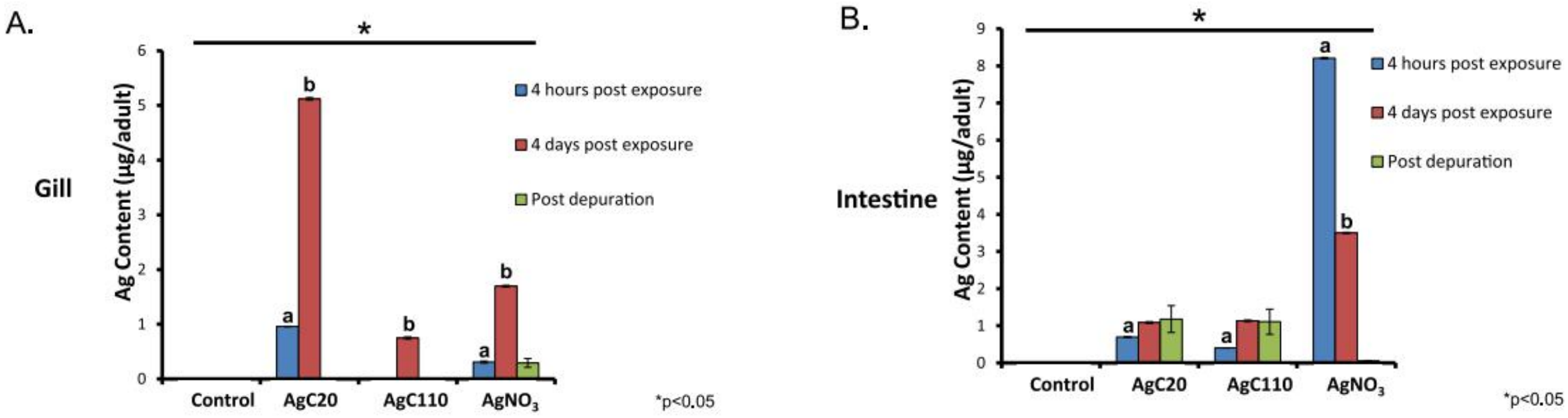
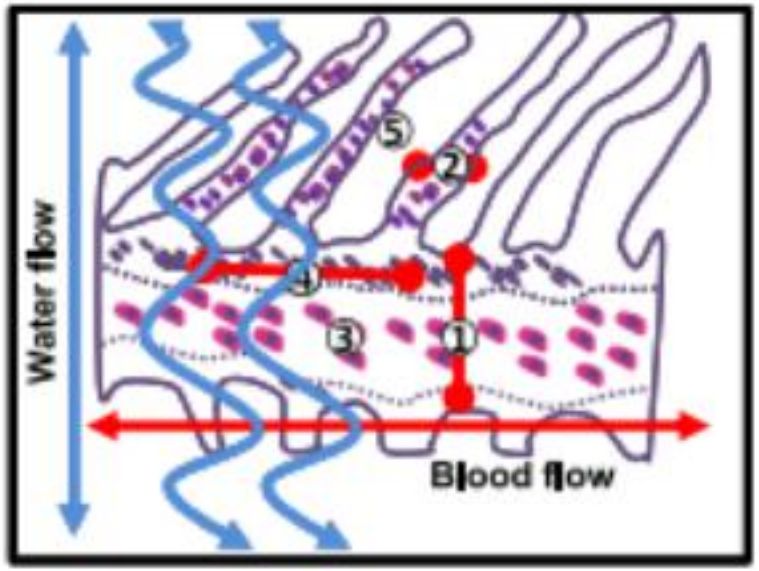


Figure 2. Toxicokinetic profiles of AgC20 and AgC110 in gills and intestines at 4 h postexposure (4hpe) (blue bars), 4 days postexposure (4dpe) (red bars), and 4 days þ 7 days depuration (green bars).

Results

Histopathological Features of Gill and Intestine by Nano-Ag and Ionic-Ag.

Gill



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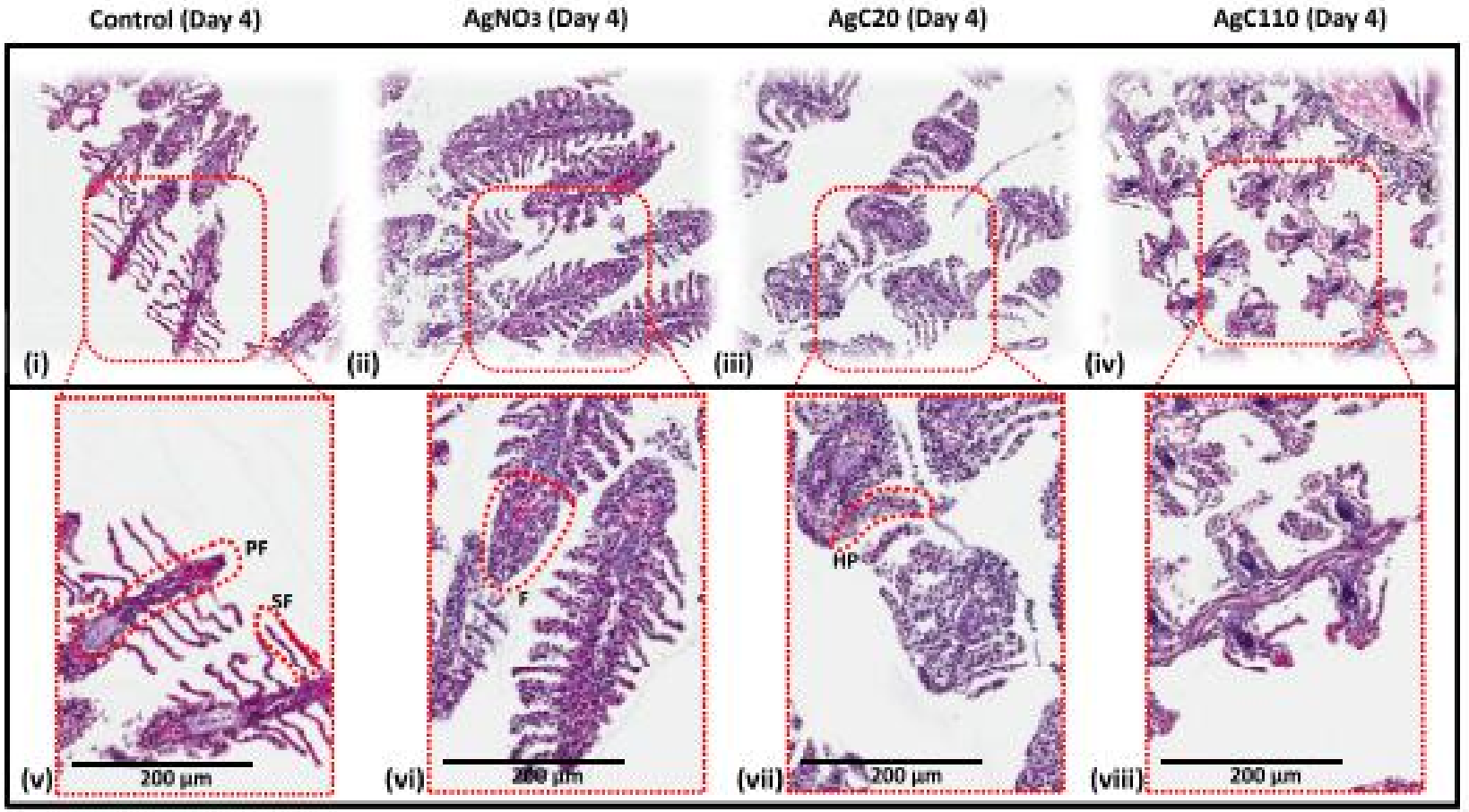

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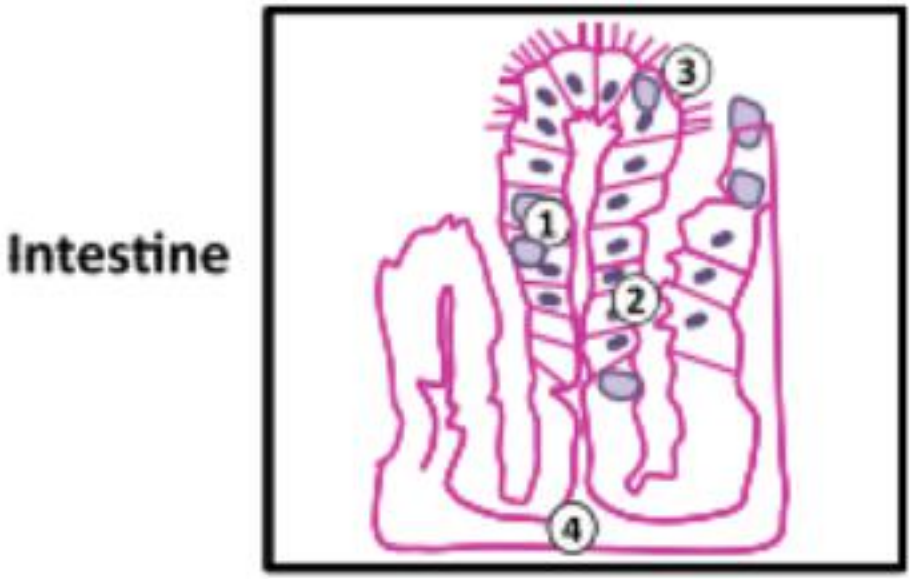

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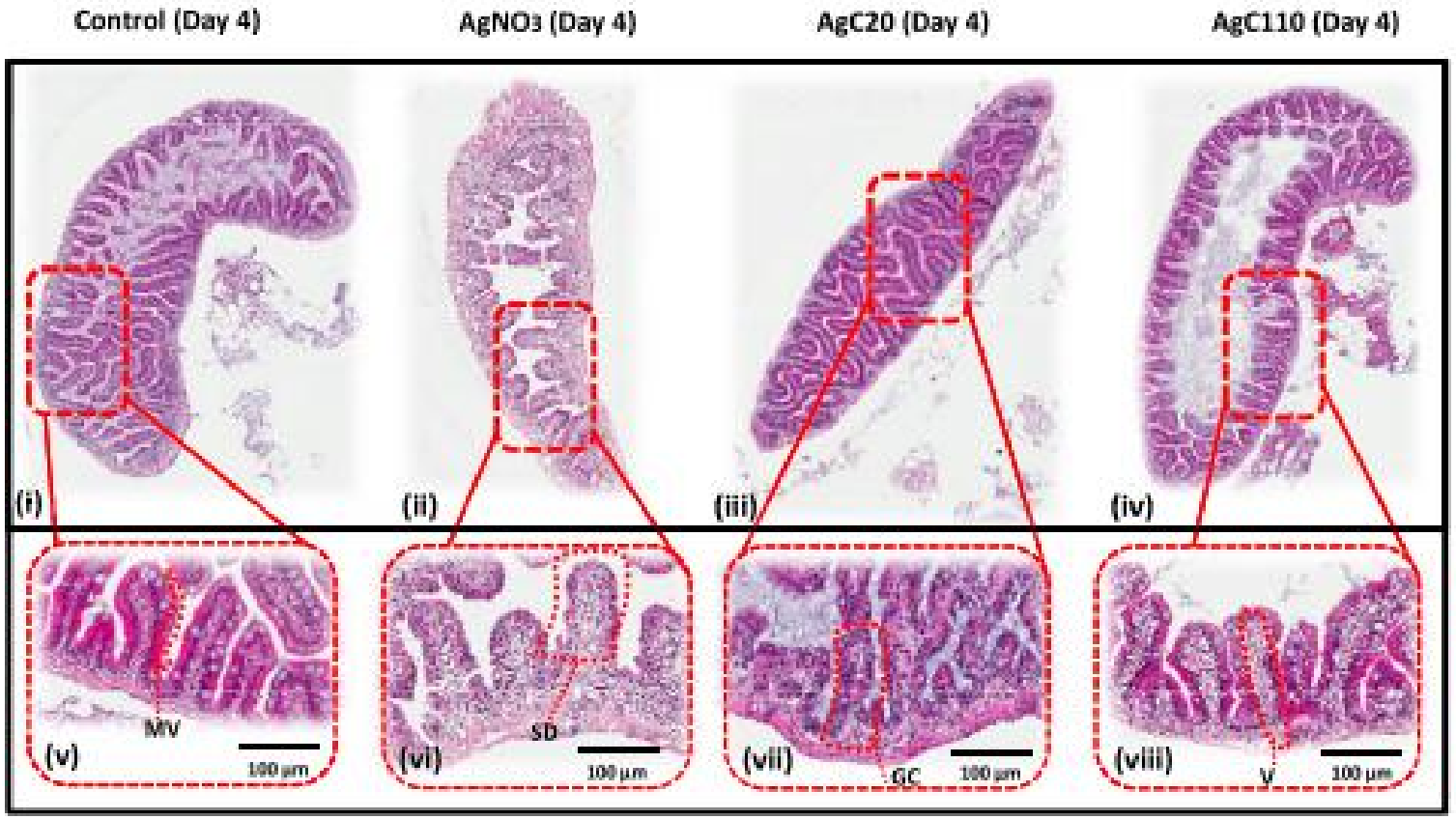

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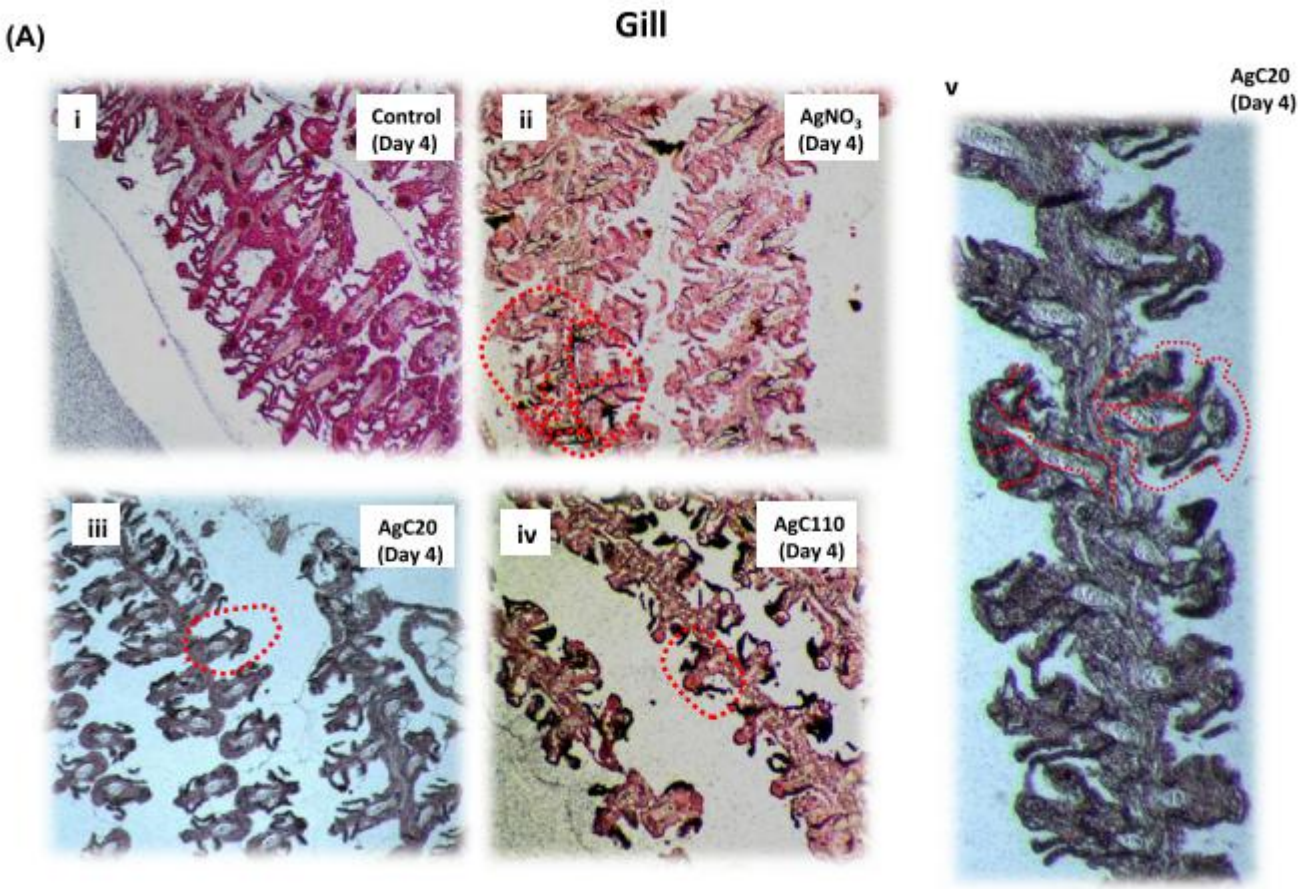
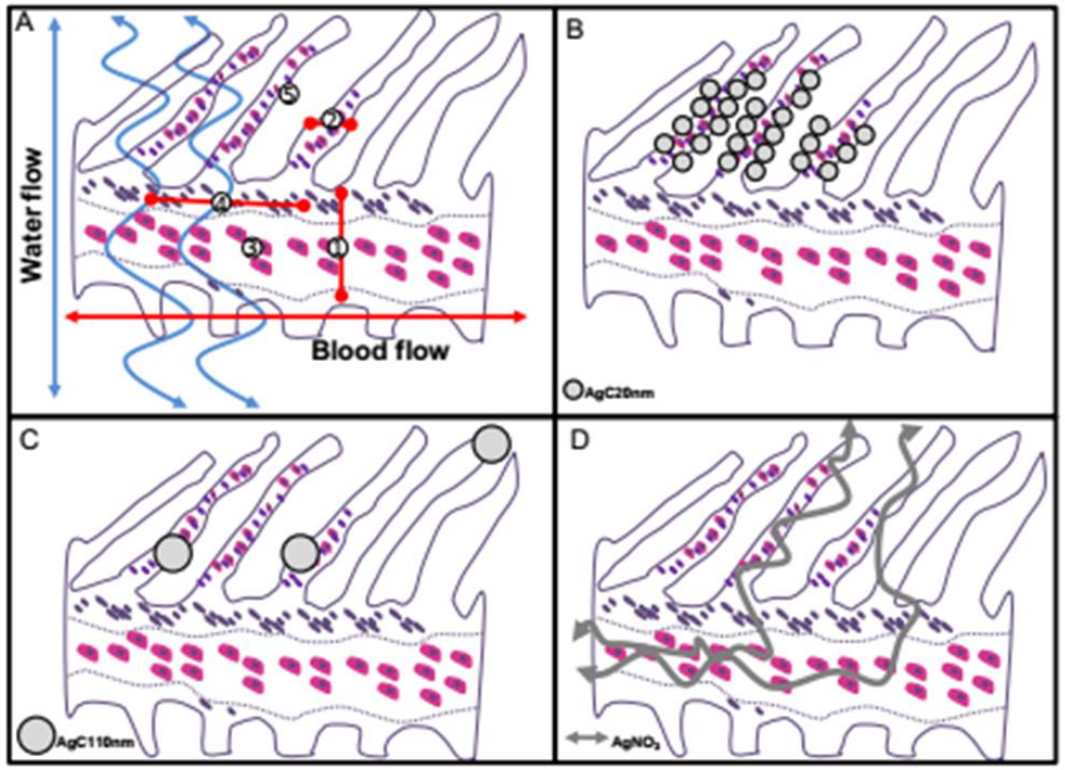
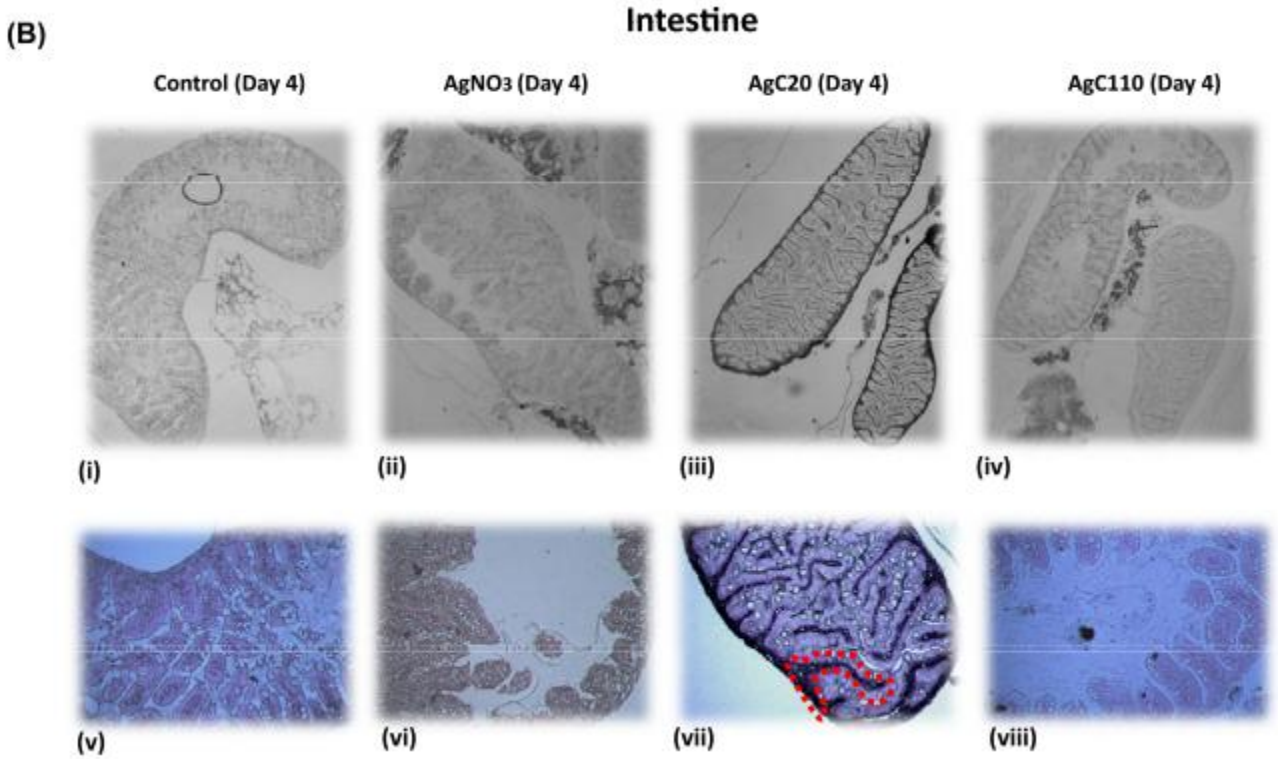
Ag Staining of Gill Tissue Reveals Differences in the Localization of Particulate vs Ionic

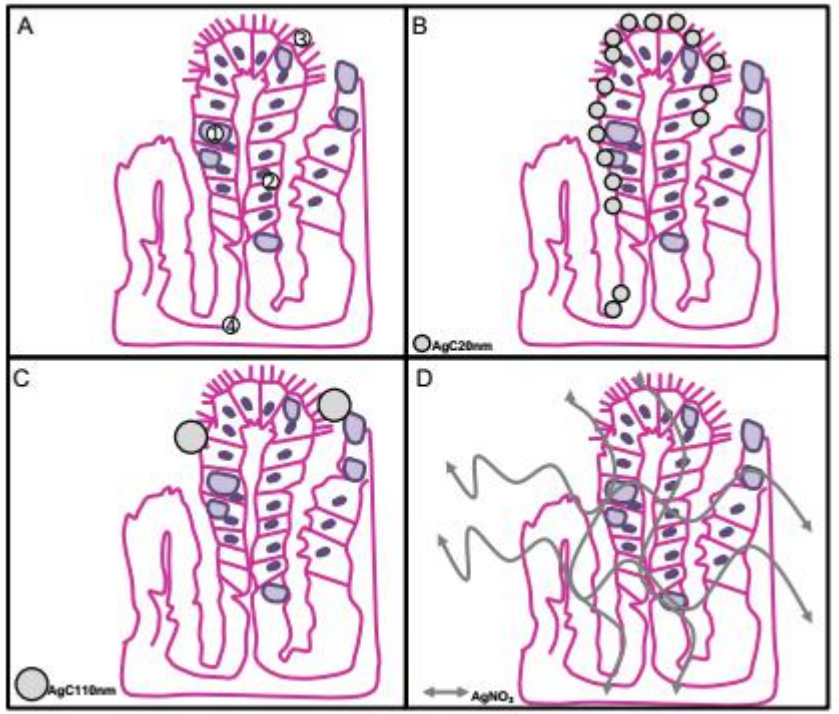




Results

Ag Staining of Intestinal Tissue Reveals Differences in the Localization of Particulate vs Ionic





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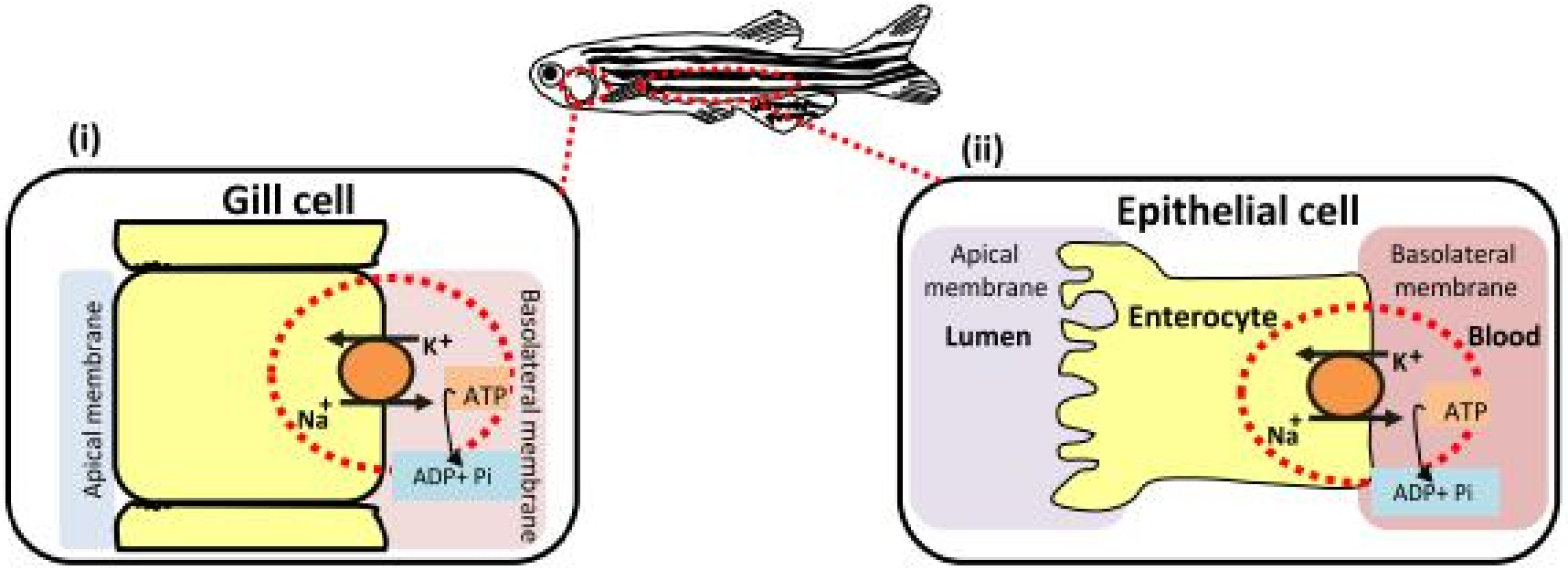
Na^+/K^+ ATPase Immunohistochemistry Staining and Activity Demonstrate Size-Dependent Effects of Nano-Ag



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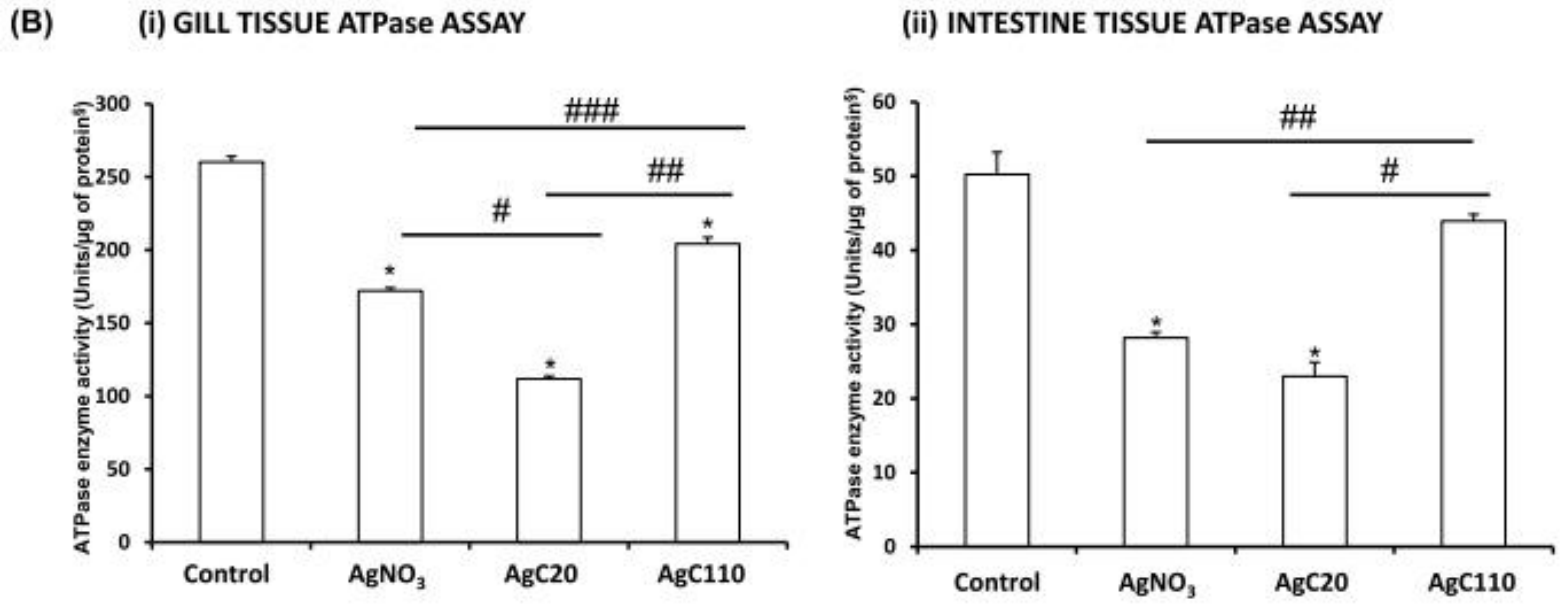

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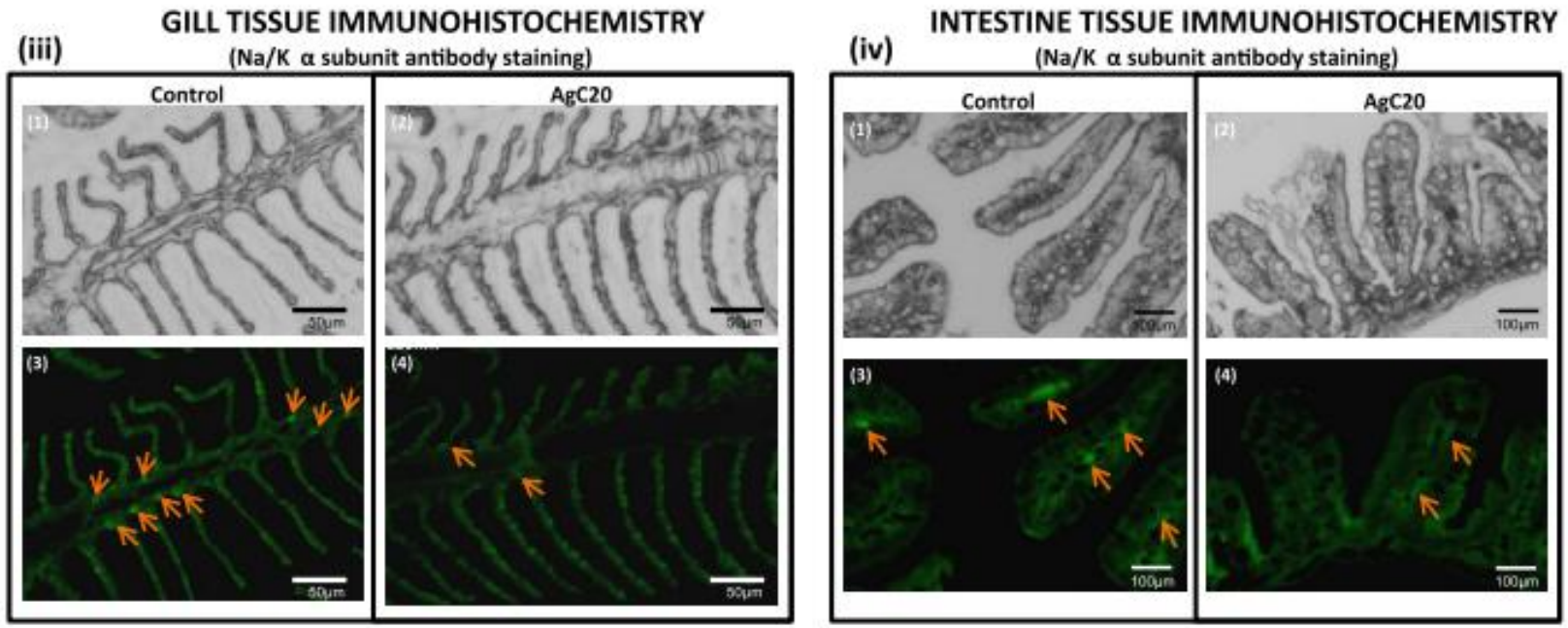

思路

方案

细节

描述

Thank you