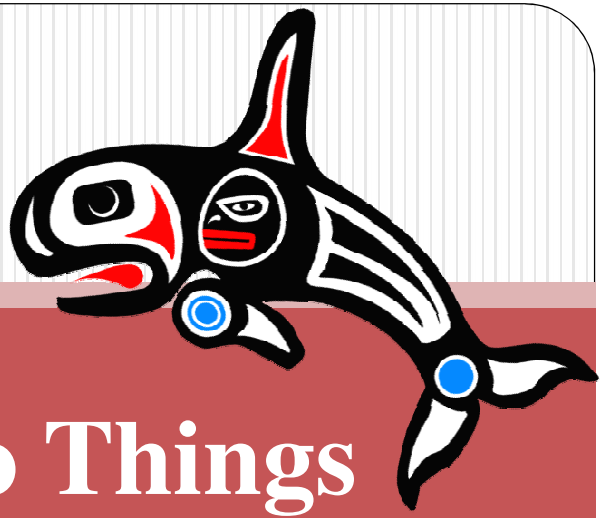
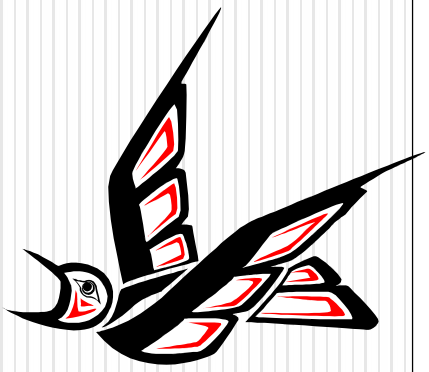
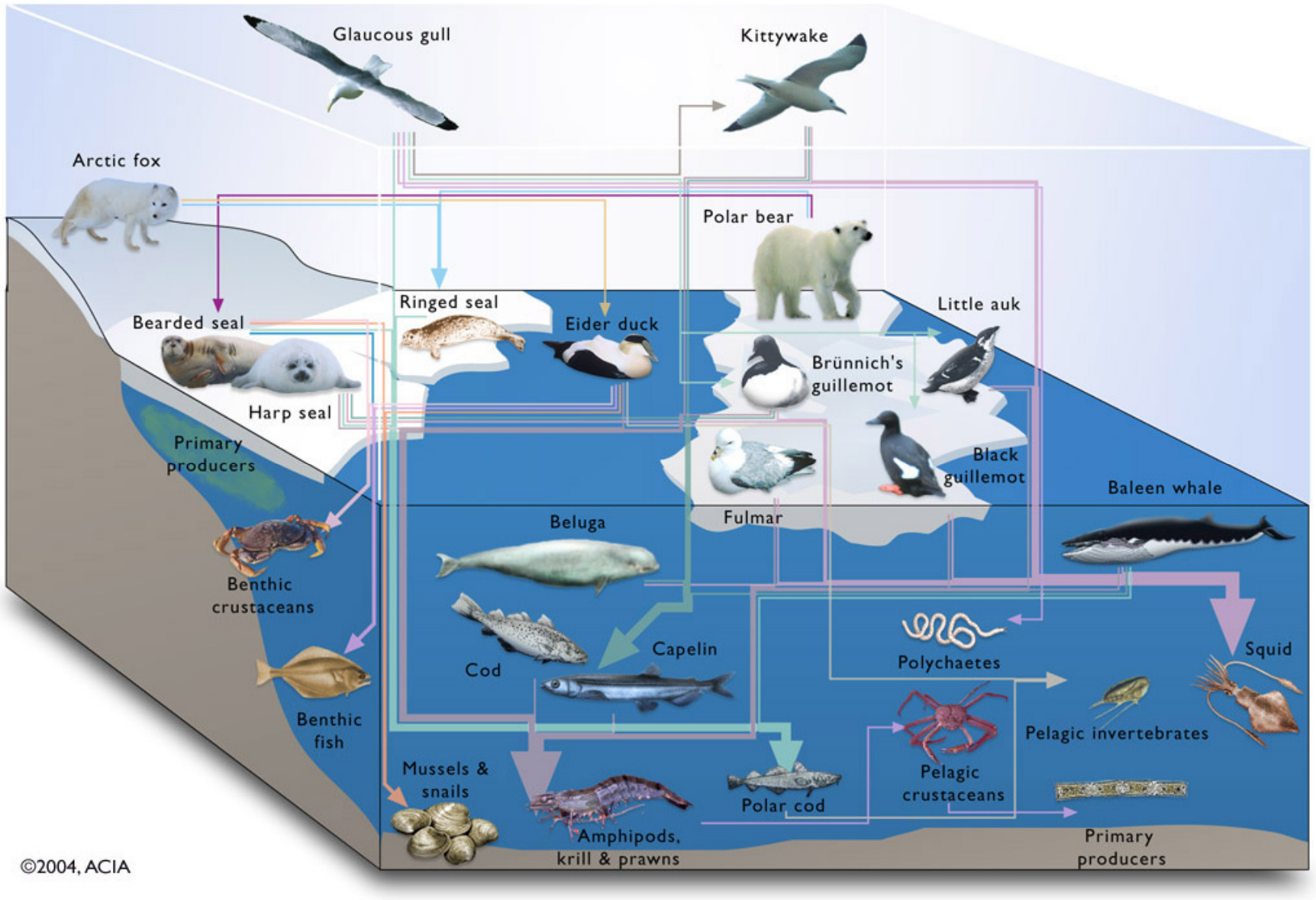


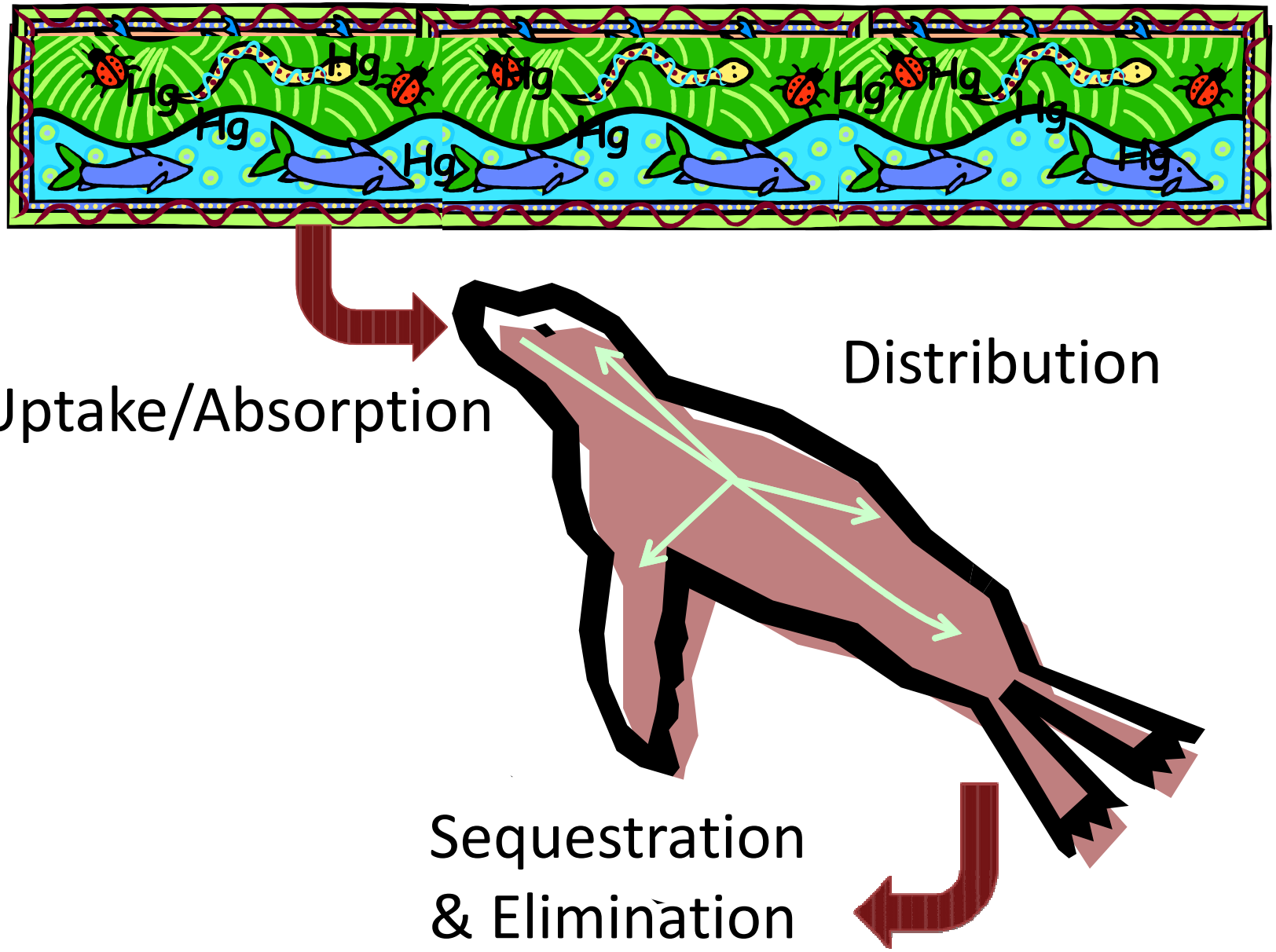
How Mercury Gets into Things

The Feathers, Fins and Fur Edition

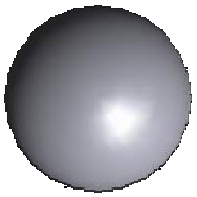


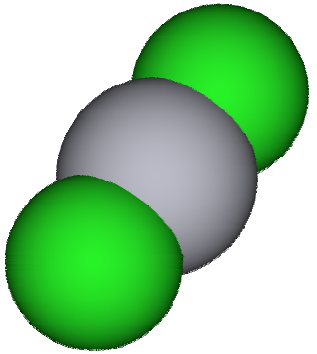


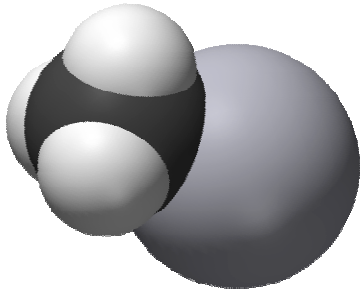
from Arctic Climate Impact Assessment (ACIA): Impacts of a warming arctic


Hg
Hg
Hg
Hg
Hg
Hg
Hg
Hg
Hg
Hg
Uptake/Absorption
Distribution
Sequestration
& Elimination

Absorption



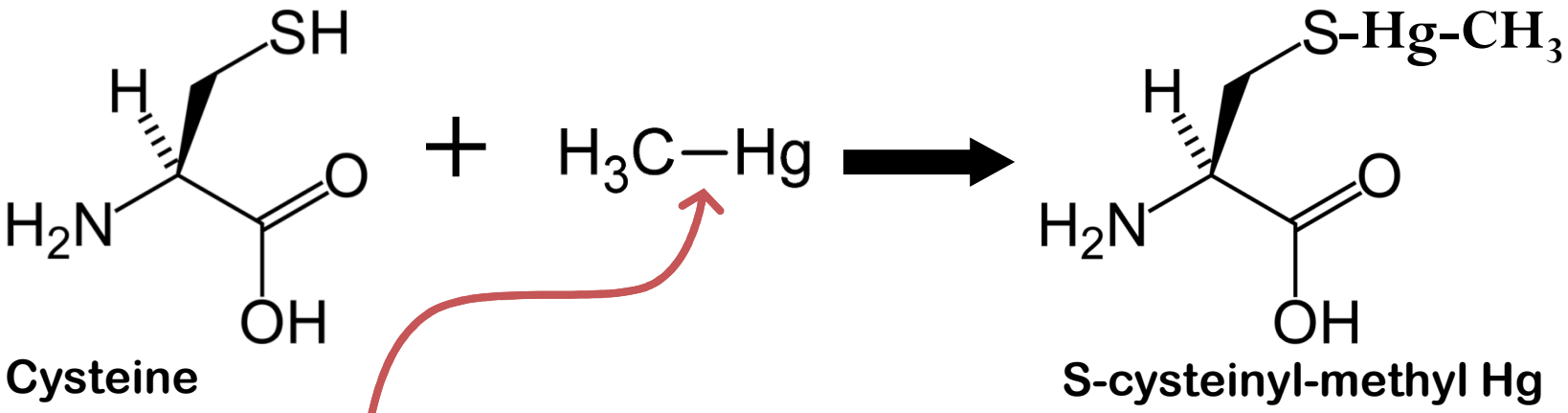




- **Form of Mercury**
  - Elemental (Hg^0)
  - Divalent Inorganic (Hg^{2+})
  - Organic (methylmercury, CH_3Hg)
- **Route**
  - Inhalation
  - Ocular
  - Dermal

  } Minor
  - Ingestion – Primary route of exposure

Methylmercury Uptake

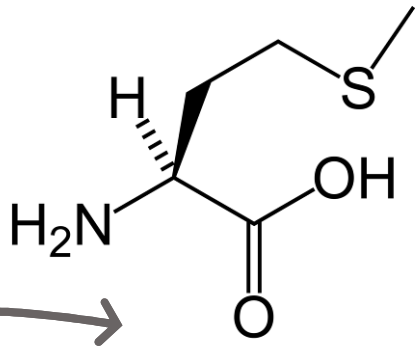


Cysteine

S-cysteinyl-methyl Hg

High affinity for sulfhydryl (-SH) groups

Structurally similar

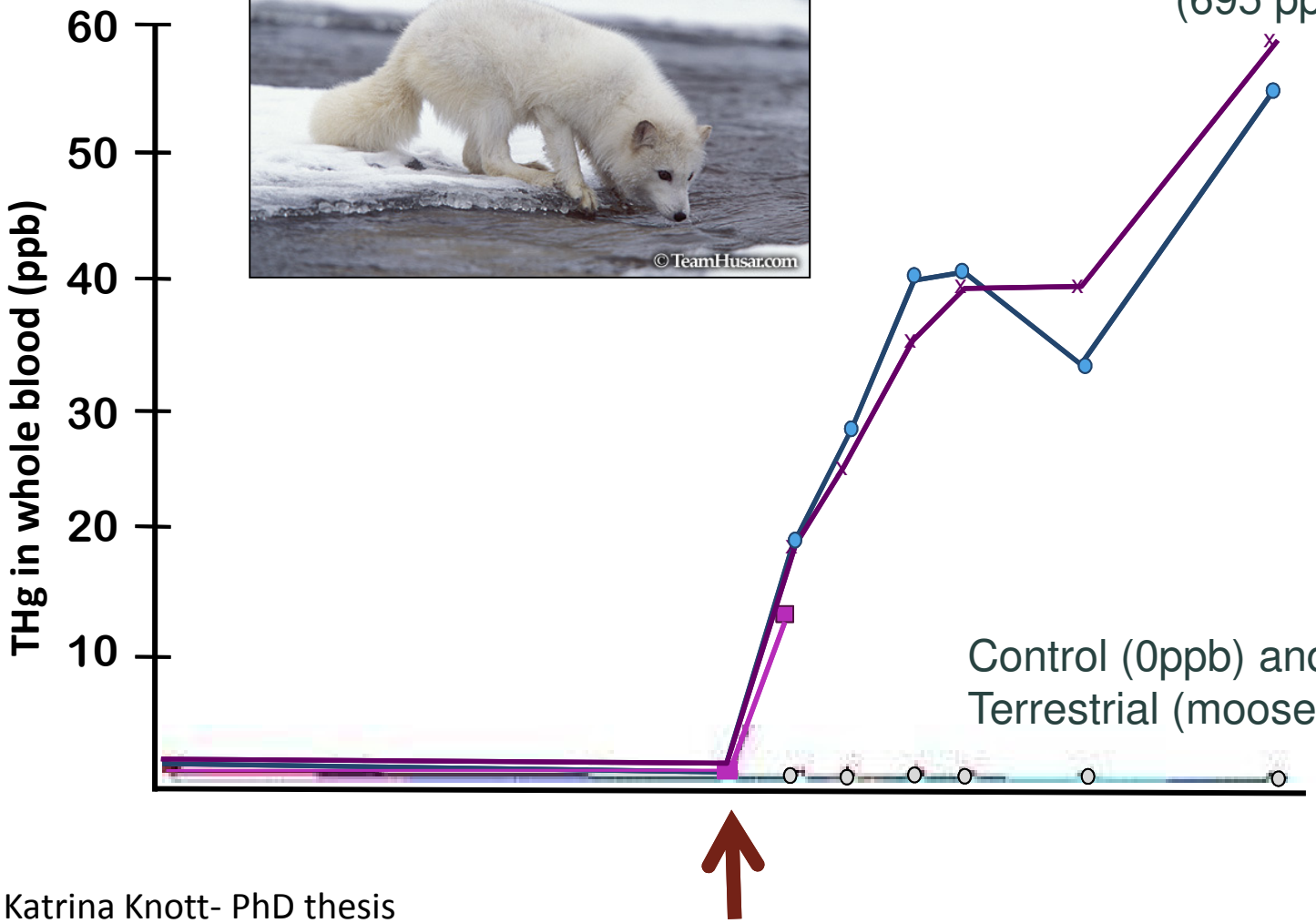


Transported across GIT and BBB by AA transporters

Methionine
(amino acid)

Absorption from GI tract

Foxes fed spotted seal
(695 ppb Hg)

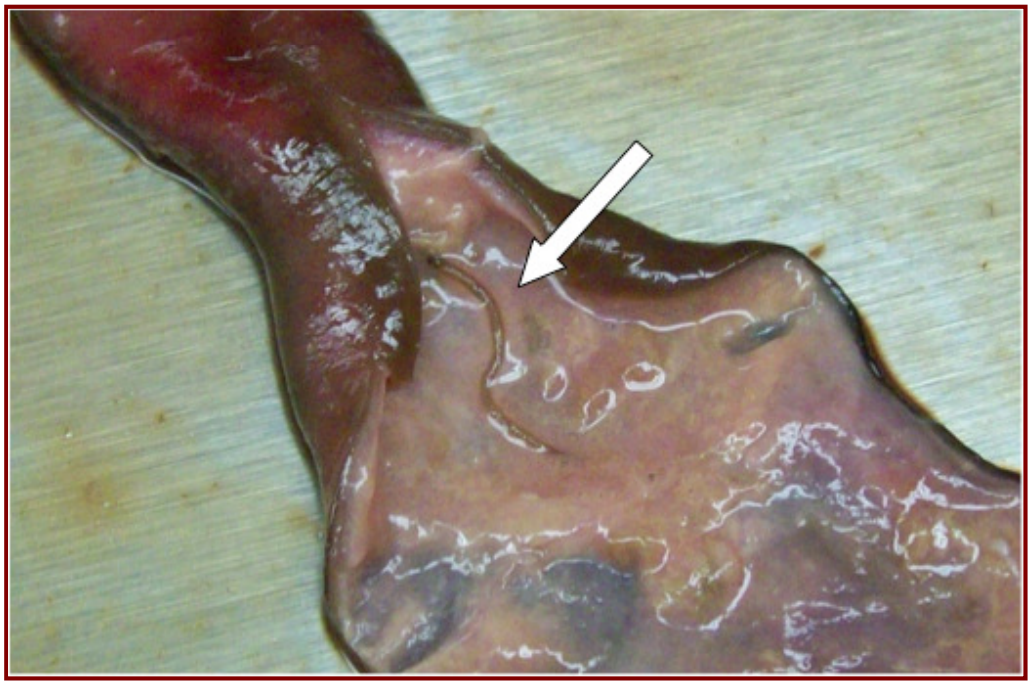


Control (0ppb) and
Terrestrial (moose) diet (5ppb)

Katrina Knott- PhD thesis

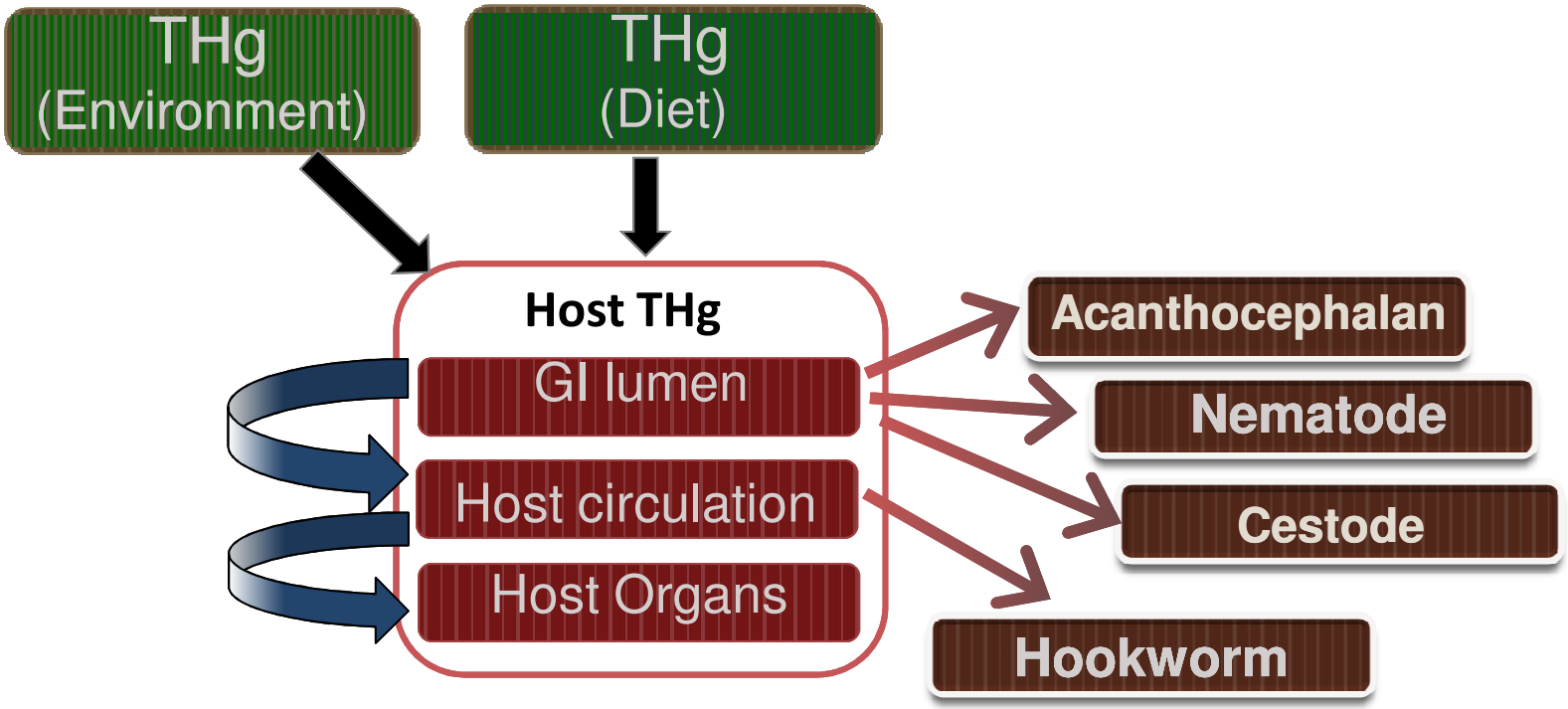
Gastrointestinal Parasites

- Cestodes and acanthocephalans
  - Accumulate heavy metals
  - Derive nutrients directly from their definitive host



Ashley McGrew

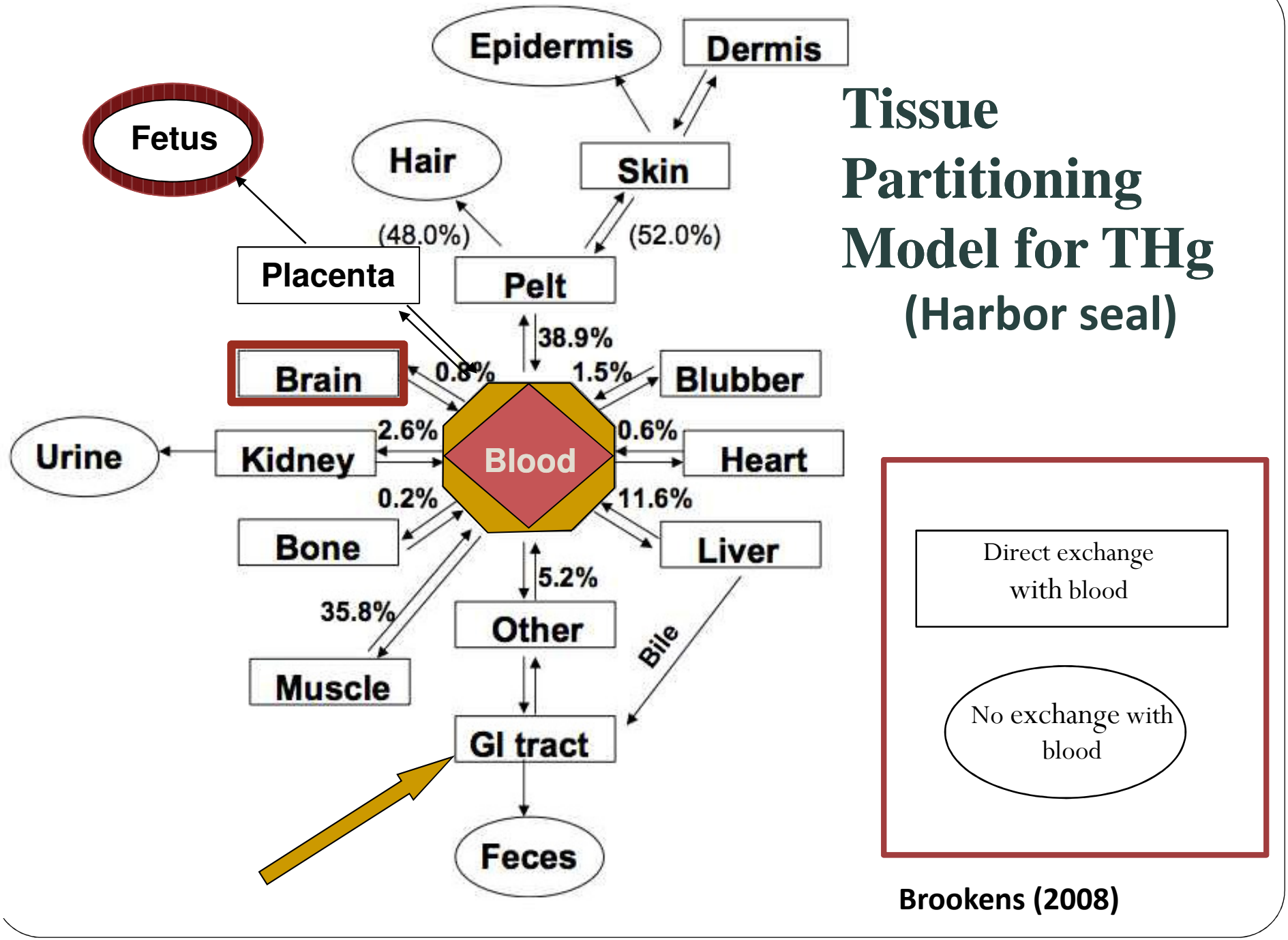
Proposed Role of Parasites



Adapted from Ashley McGrew

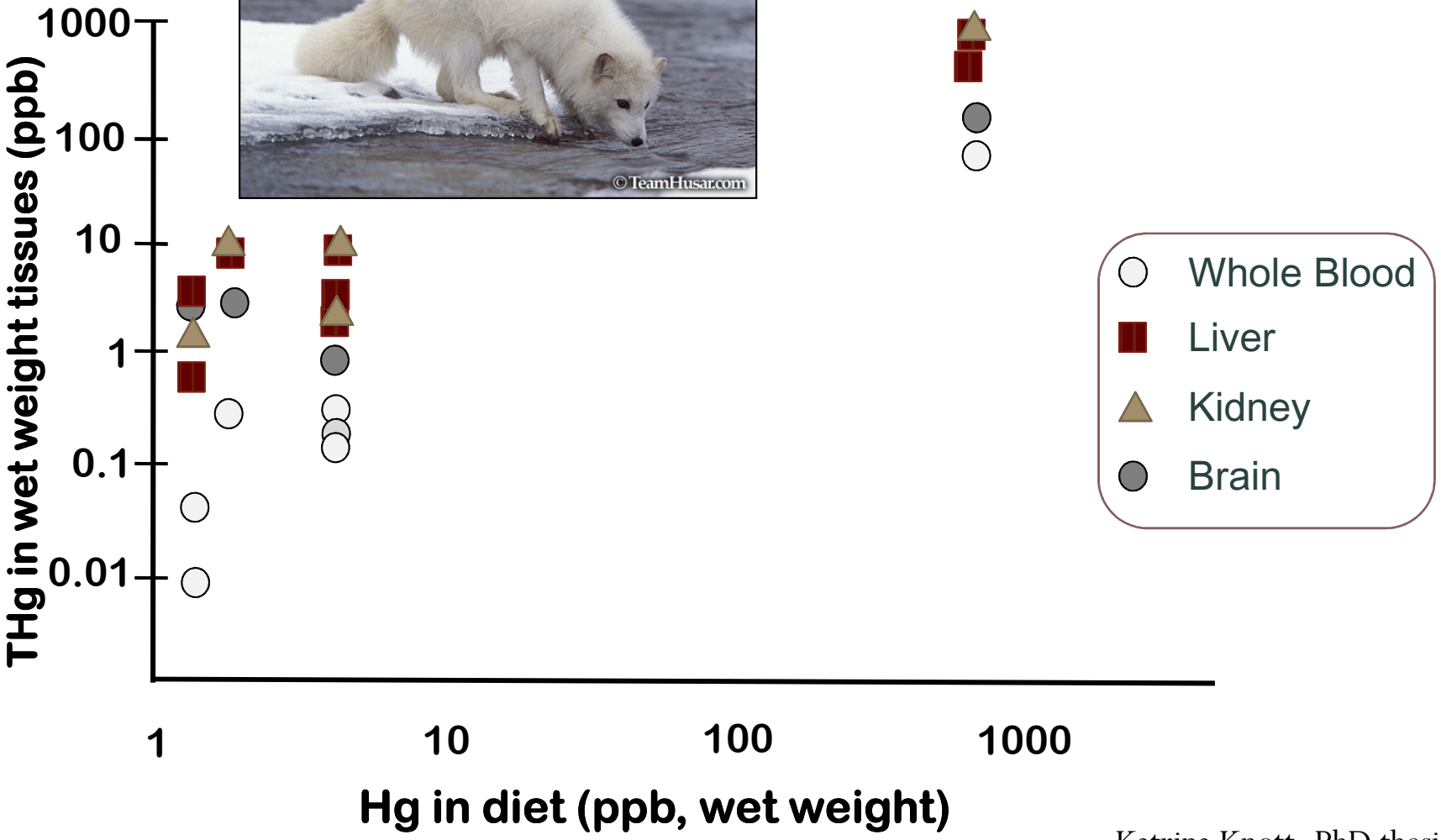
Distribution

Tissue Partitioning Model for THg (Harbor seal)



Brookens (2008)

Tissue Distribution

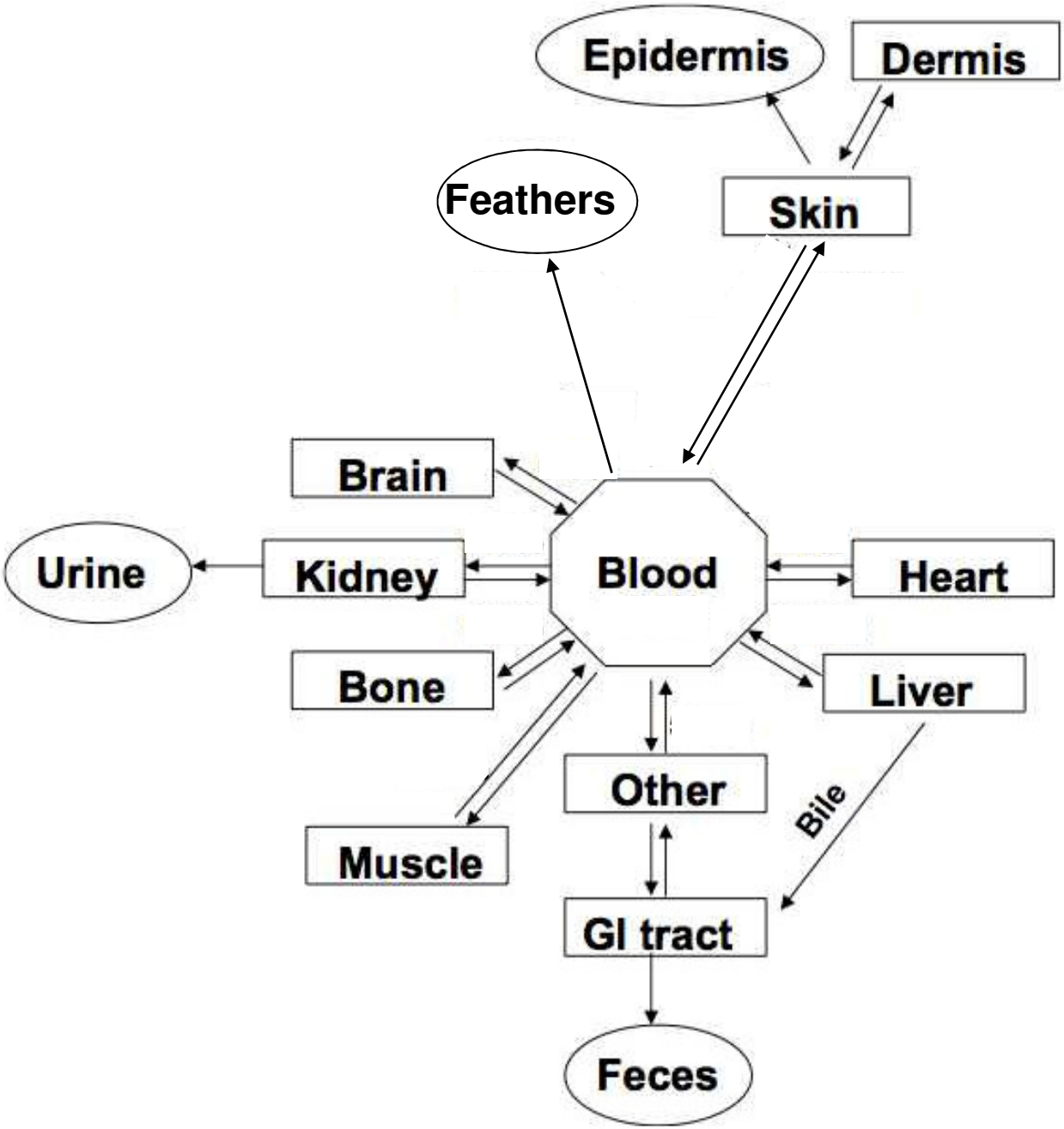


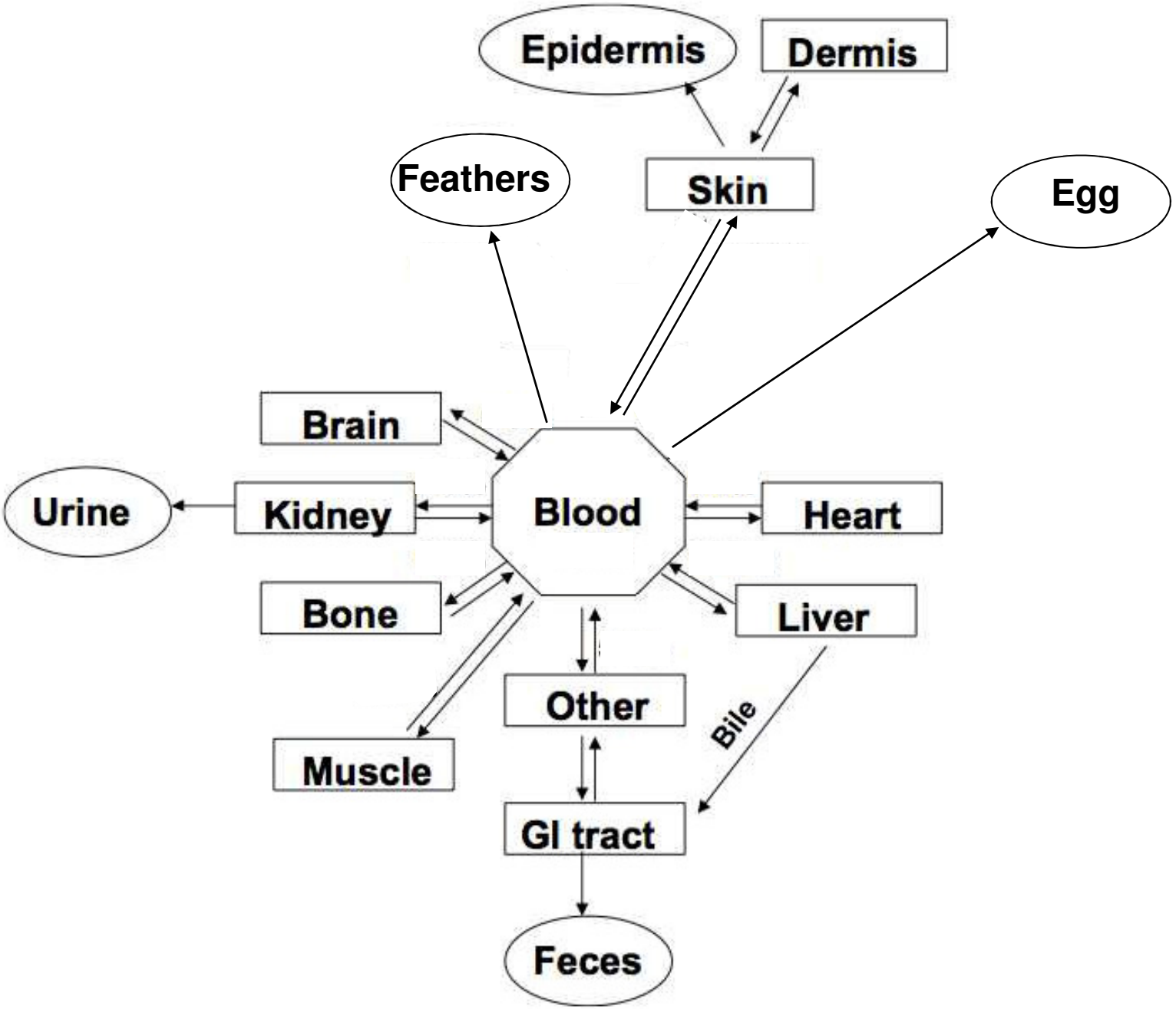
Katrina Knott- PhD thesis

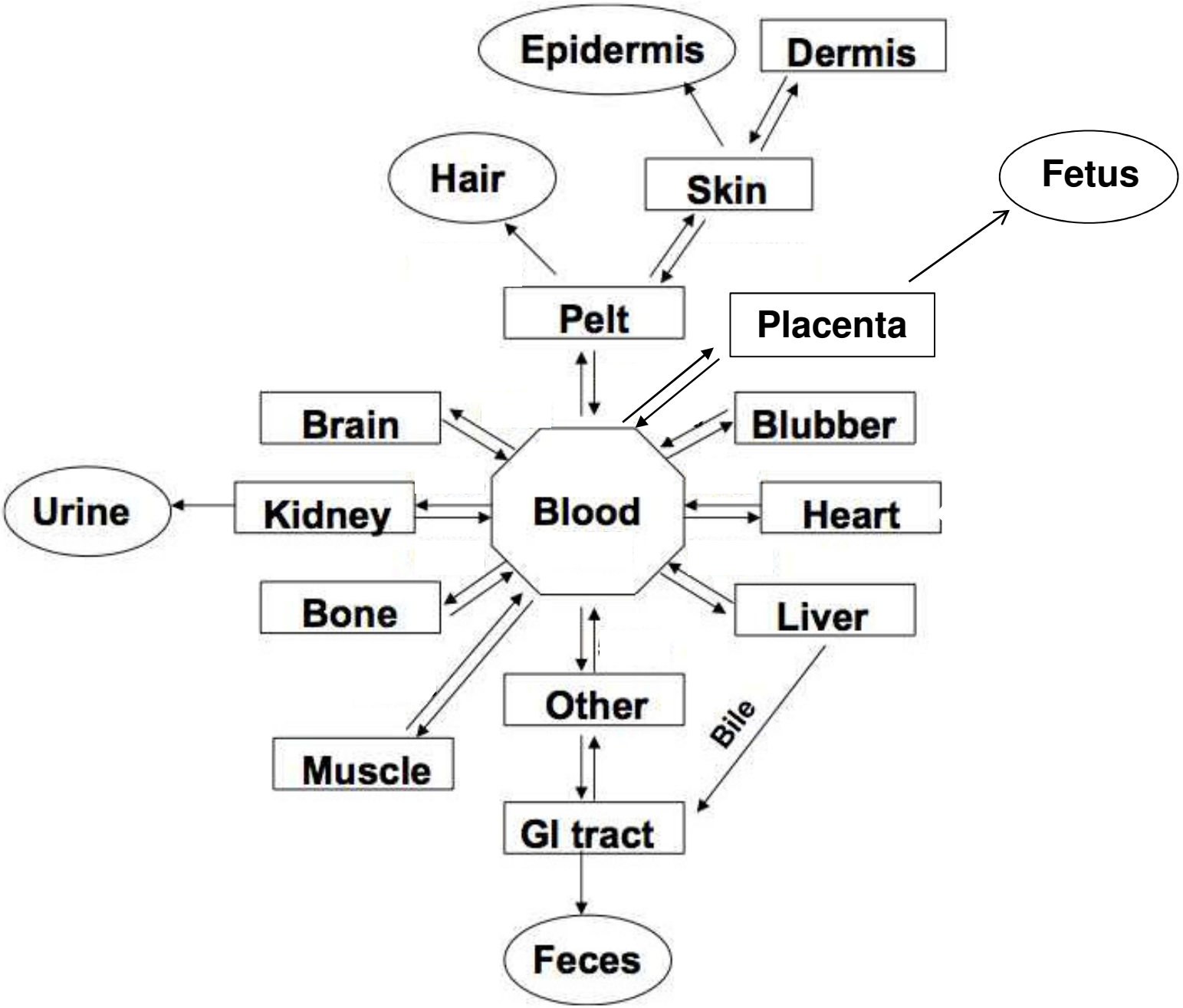
MeHg & THg Tissue Concentrations (ppm)

Species	Muscle	Liver	Kidney	Skin	Other
Beluga Wagemann, et al 1998	MeHg:1.32 THg: 1.33	1.87 27.06		0.69 0.78	Blubber THg: 0.103
Arctic Fox Knott, unpublished		0.193	0.352		
Wolf, AK ADFG, unpublished	0.004-0.546	0.057-7.3	0.011-4.6		
Wolf, Canada Poissant, et al 2008		0.03-1.45	0.18-1.06		
Polar Bear Woshner, et al 2001	MeHg: 0.07 THg: 0.09	0.49 14.22			
Ringed Seal Woshner, et al 2001	0.22	3.52	0.5		Blubber THg: 0.002
Black Scoter Rothschild et al 2005	0.135				Bone THg: 0.423
Bald Eagle Stout & Trust 2002		1.7-17.5	3.19-68		

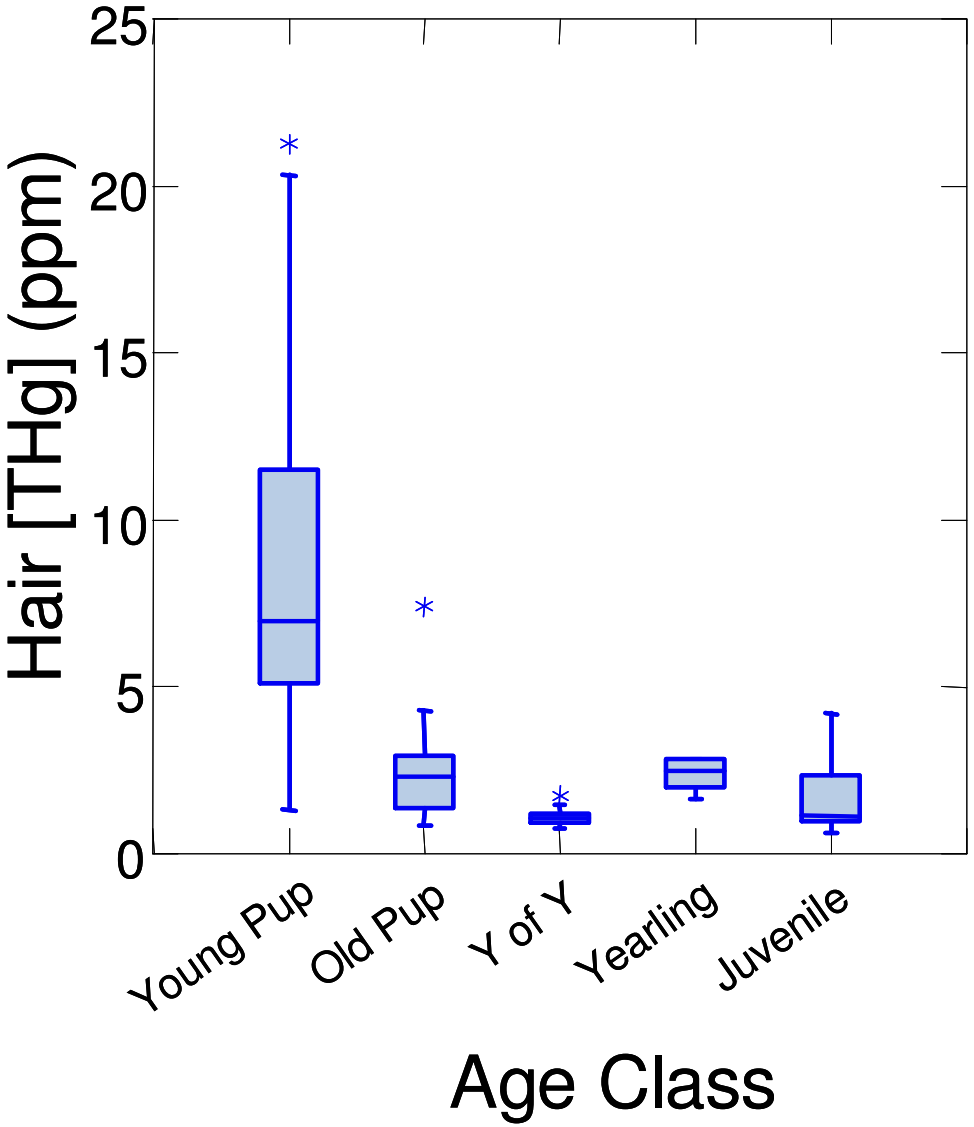
Sequestration &
Elimination


Epidermis
Dermis
Feathers
Skin
Brain
Urine
Kidney
Blood
Heart
Bone
Liver
Other
Bile
Muscle
GI tract
Feces

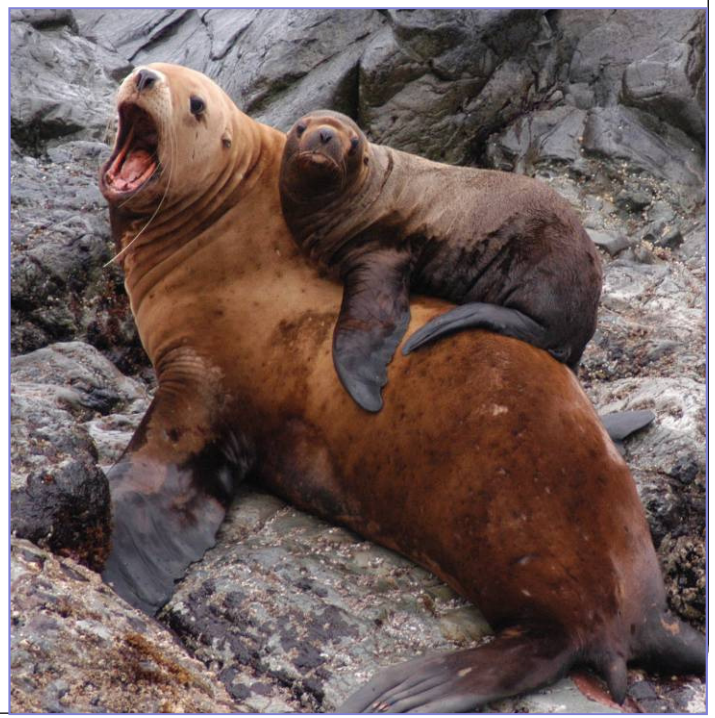

Epidermis
Dermis
Feathers
Skin
Egg
Brain
Urine
Kidney
Blood
Heart
Bone
Liver
Other
Bile
Muscle
GI tract
Feces

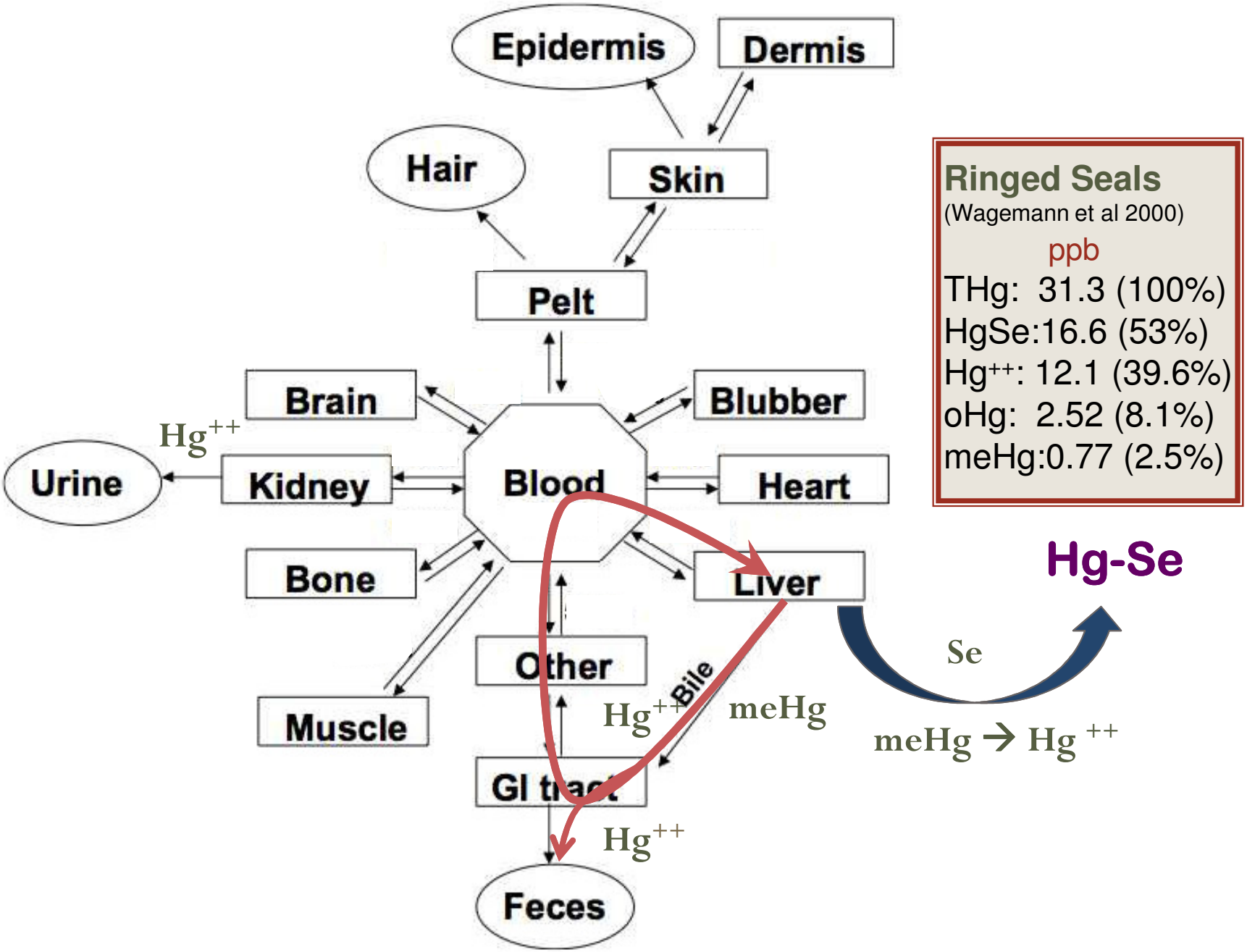

Epidermis
Dermis
Hair
Skin
Fetus
Pelt
Placenta
Brain
Blubber
Urine
Kidney
Blood
Heart
Bone
Liver
Other
Bile
Muscle
GI tract
Feces

Total Hg in Hair Across Age Classes in Prince William Sound



Young Pup	**≤3 mnth**
Old Pup	**~5 mnth**
Y of Y	**7-10 mnth**
Yearling	**14-15 mnth**
Juvenile	**~24 mnths**




Epidermis
Dermis
Hair
Skin
Pelt
Brain
Blubber
Hg++
Urine
Kidney
Blood
Heart
Bone
Liver
Other
Muscle
Hg++ Bile
meHg
GI tract
Hg++
Feces
Ringed Seals
(Wagemann et al 2000)
ppb
THg: 31.3 (100%)
HgSe:16.6 (53%)
Hg++: 12.1 (39.6%)
oHg: 2.52 (8.1%)
meHg:0.77 (2.5%)
Hg-Se
Se
meHg → Hg ++

In Summary

- MeHg is the major exposure pathway for mammals and birds
  - Bioaccumulates
- MeHg travels throughout the body via the blood stream
  - All forms of Hg can cross the placenta
- Tissue concentration varies by species
- MeHg can be excreted in keratinized tissues
  - hair, nails/claws, feathers
  - useful, non-invasive biomonitoring tools
- Some marine mammals and certain seabirds can transform MeHg back to inorganic Hg and store as mercury-selenide (Hg-Se) granules in the liver or kidney.
  - Important for animals with high MeHg exposure that cannot excrete MeHg (whales don't have hair!)

Katrina Knott

Questions?