V 4.1 (2013)

Mercury and health

NIMD

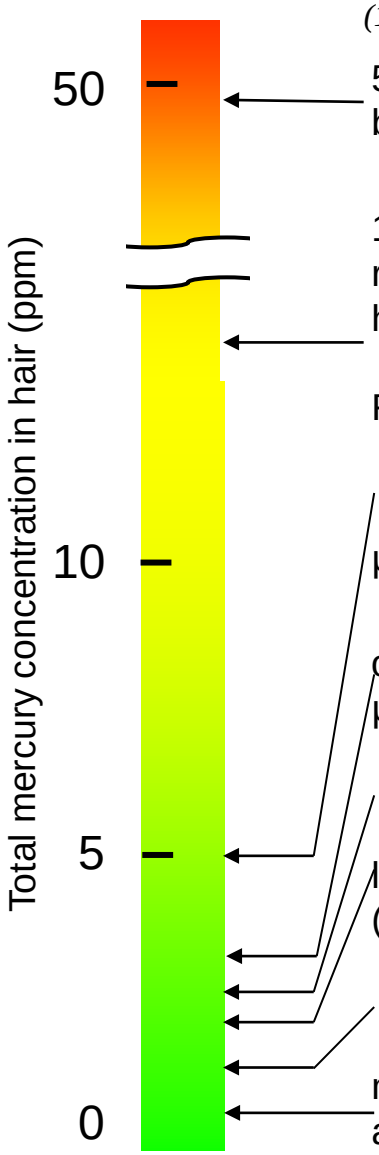
Ministry of the Environment

National Institute for Minamata Disease
Minamata Disease Archives

55-10 Myojin, Minamata, Kumamoto 867-0055
Phone : +81-966-69-2400/ Fax: +81-966-62-8010
E-mail: mail@nimd.go.jp

REFERENCE FOR HAIR MERCURY CONCENTRATION

1 ppm mercury means that 0.001 g mercury is contained in 1,000 g (1/1, 000, 000).



50 ppm: No neurological adverse effect has been found among adults below this level (WHO,1976; 1990)

14 ppm: The concentration in maternal hair reflects methylmercury exposures that would have no appreciable adverse effect on the offspring in two study populations of Faroes Islands and Seychelles (JECFA, 2004)

5 ppm: A former safe exposure level of methylmercury for adults (3.3 µg/kg/week) (WHO, 1973)

2.8 ppm: Provisional tolerable weekly intake level of methylmercury in Japan (2.0 µg/kg/week) (JECFA, 2004) **

2.5 ppm: Mean level of males in Japan*

2.2 ppm: Provisional tolerable weekly intake level of methylmercury (1.6 µg/kg/week) (JECFA, 2004) ***

1.6 ppm: Mean level of females in Japan*

1.0 ppm: Reference Dose level of methylmercury (0.1 µg/kg/day) without an appreciable risk of deleterious effects during a lifetime (US-EPA, 2001) ****

** Multi-site survey in Japan (NIMD, 2000-2004)*

*** The domestic provisional tolerable weekly intake (PTWI) is 2.0 µg/kg body weight/week, and was derived from the non-observable-adverse-effect (NOAEL) /benchmark dose (BMDL) level, 11 ppm in maternal hair on the fetus development and uncertainty factor 4 (Food Safety Committee of Japan, 2005).*

**** The provisional tolerable weekly intake (PTWI) is 1.6 µg/kg body weight/week, and was derived from the non-observable-adverse-effect (NOAEL) /benchmark dose (BMDL) level, 14 ppm in maternal hair on the fetus development and uncertainty factor 6.4 (JECFA, 2004).*

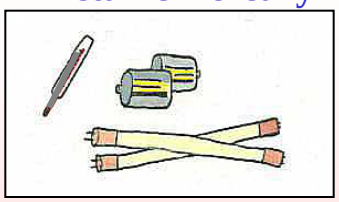
***** The Reference Dose (RfD) is 0.1 µg/kg body weight/day, and was derived from benchmark dose (BMDL) level, 46-79 ppb in maternal blood and uncertainty factor 10 (NRC, 2000, US-EPA, 2001)*

WHAT IS `MERCURY` ?

Mercury has been widely used in our life. Mercury is roughly divided into three chemical forms: metallic mercury, inorganic mercury, and organic mercury ($R\text{-}Hg^{+}$). Methylmercury (MeHg) is considered to be an exclusive organic mercury generated in the natural environment. The three chemical forms are inter-converted in the natural environment.

Hg^0

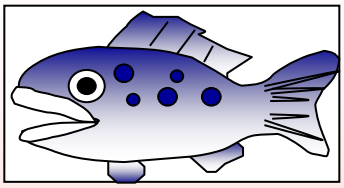
Metallic mercury



Metallic mercury is liquid, and easy to vaporize. It has been used for clinical equipment and fluorescent lamps, etc. It is also used in artisanal small-scale gold mining operation.

$MeHg^+$

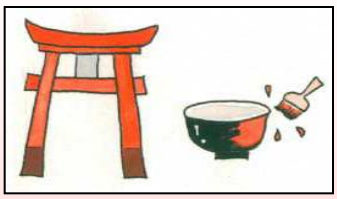
Methylmercury



Methylmercury is naturally generated from inorganic mercury by certain bacteria in the water environment, and accumulates in fish and mammals through the food web.

Hg^{2+}

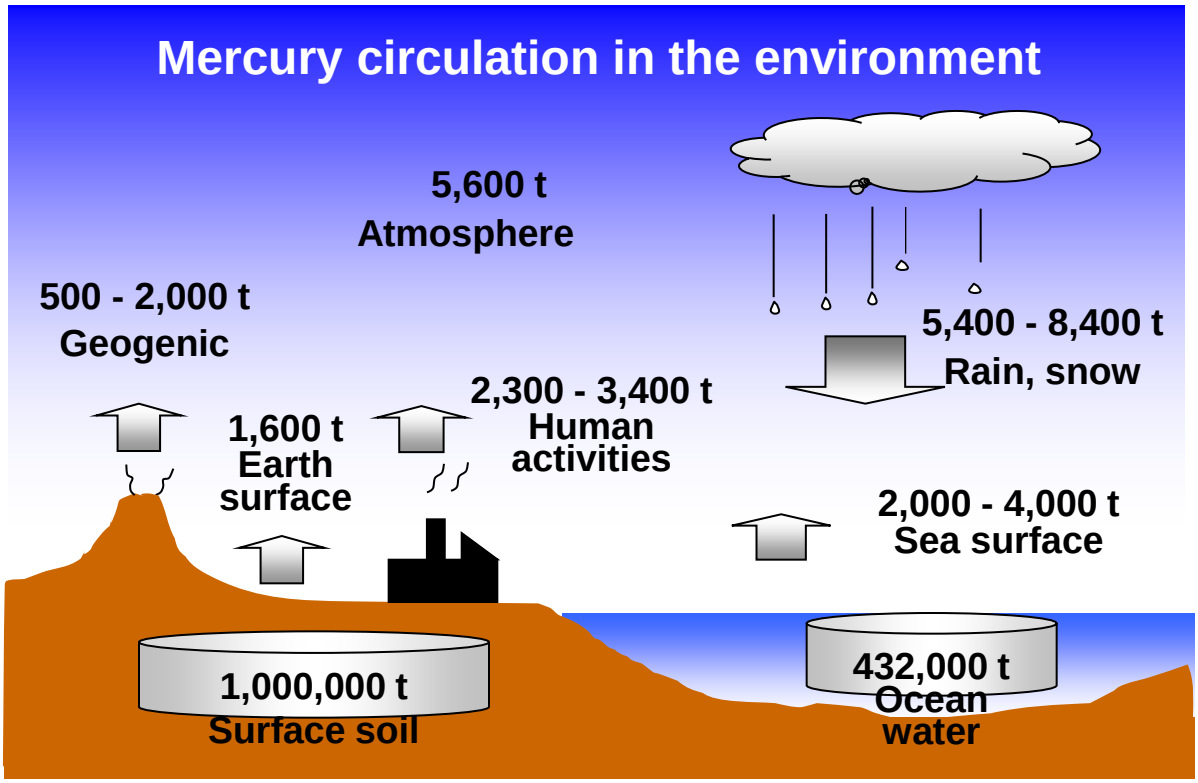
Inorganic mercury



Inorganic mercury includes mercuric oxide, mercuric sulfide, etc. Mercuric sulfide had been used as a pigment cinnabar and as a germicide since ancient times.

MERCURY IN THE NATURAL ENVIRONMENT

Mercury has been coming out from under the earth crust to the surface by volcanic explosion throughout the long history of the earth. Mercury currently is widely distributed in the environment; air, water, and soils. Mercury compounds circulate throughout the environment including vaporization from the surface of land and sea into the air, and precipitation from the atmosphere to the sea and land. The predominant chemical forms of mercury are inorganic and metallic mercury in the environment.



Source: Technical background report to the global atmospheric mercury assessment (UNEP, 2008)

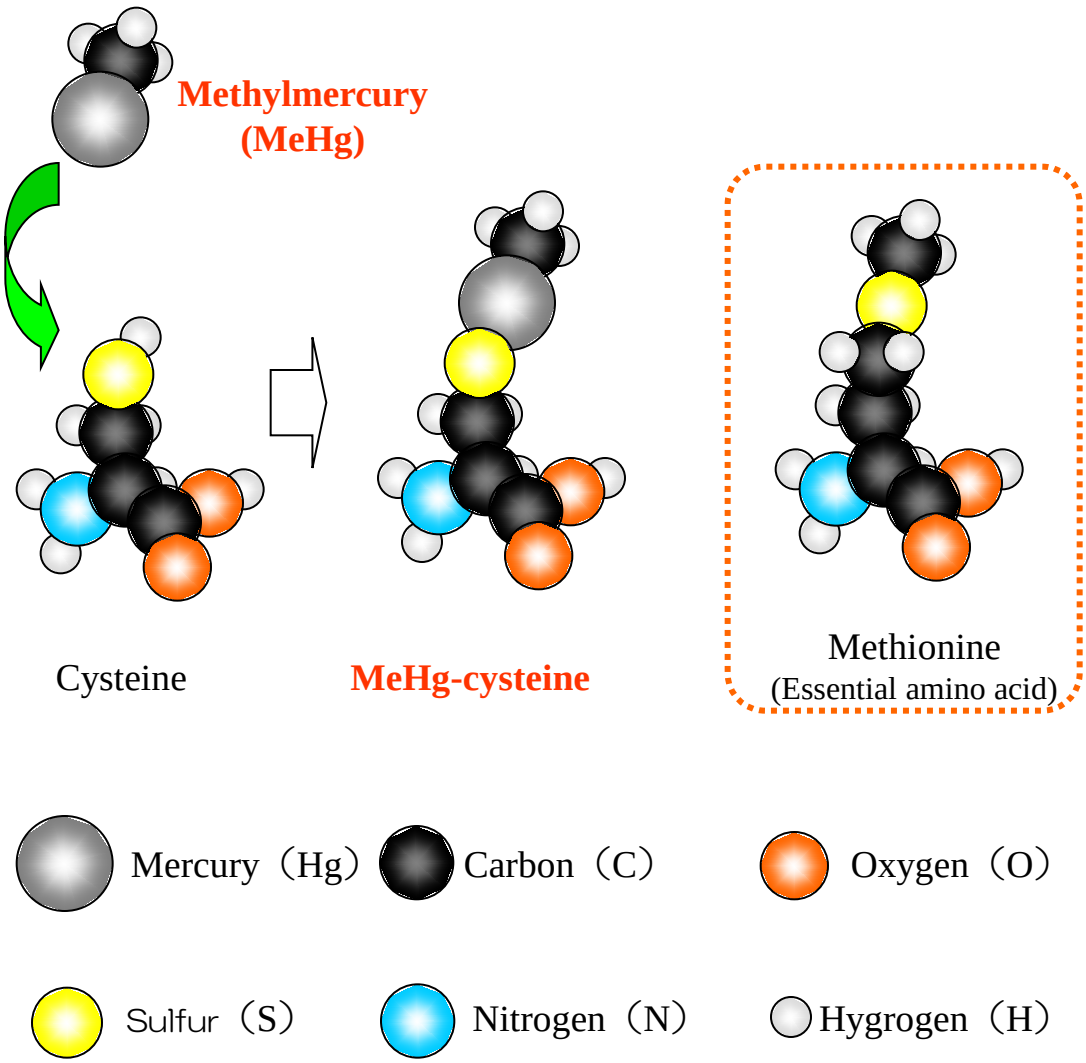
International efforts for the reduction of mercury discharge

Recently, mercury emission and release into the environment have been increasing by human activities including coal combustion and artisanal small-scale gold mining. An international convention of mercury is now being prepared to reduce mercury usage and load to the environment and to prevent the pollution and health damage.

HOW CAN MERCURY ENTER THE HUMAN BODY?

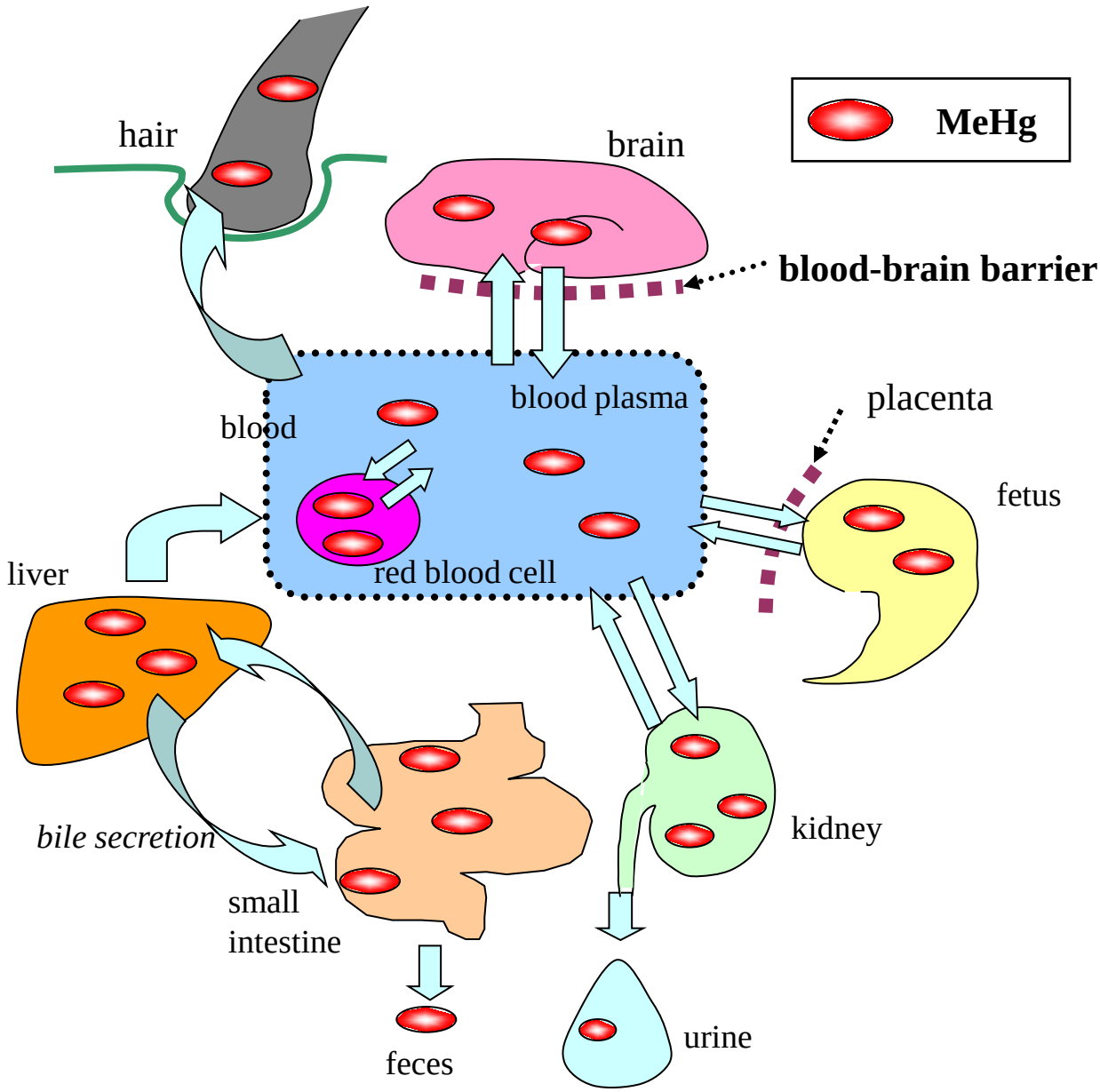
Among mercury species, methylmercury (MeHg) and metallic mercury vapor easily enter the human body from the intestinal tract and lung, respectively. MeHg binds to cysteine (a kind of amino acid) to form a complex whose structure is similar to methionine, an essential amino acid, and then incorporated into tissues including brain and fetus via an amino acid transporter.

Dental amalgams are thought to produce metallic mercury vapor, but the body burden of the metallic mercury generated from the amalgams may be relatively low.



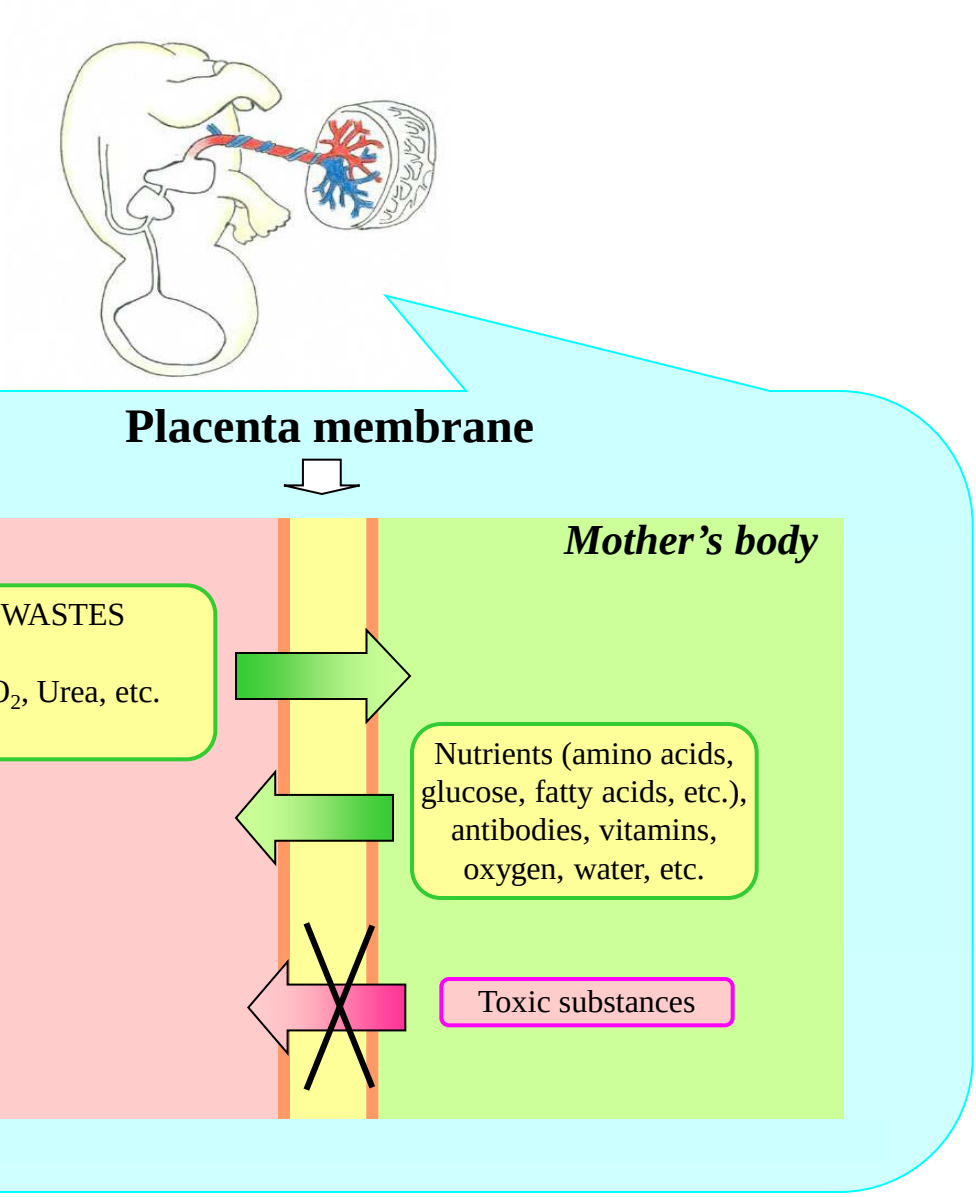
FATE OF METHYLMERCURY IN THE BODY

Methylmercury (MeHg) is distributed among various organs in the body after the absorption through gastrointestinal tract, and high accumulation is found in liver and kidney. Although the blood-brain barrier protects the brain against xenobiotic toxic substances, the MeHg-cysteine complex easily passes through the barrier. On the other hand, MeHg is excreted from the human body with an averaged daily excretion rate of 1.4% resulting a biological half-life of 50 to 70 days. Since a part of MeHg is taken up in the hair protein, hair mercury can be conventionally used to estimate MeHg exposure levels.



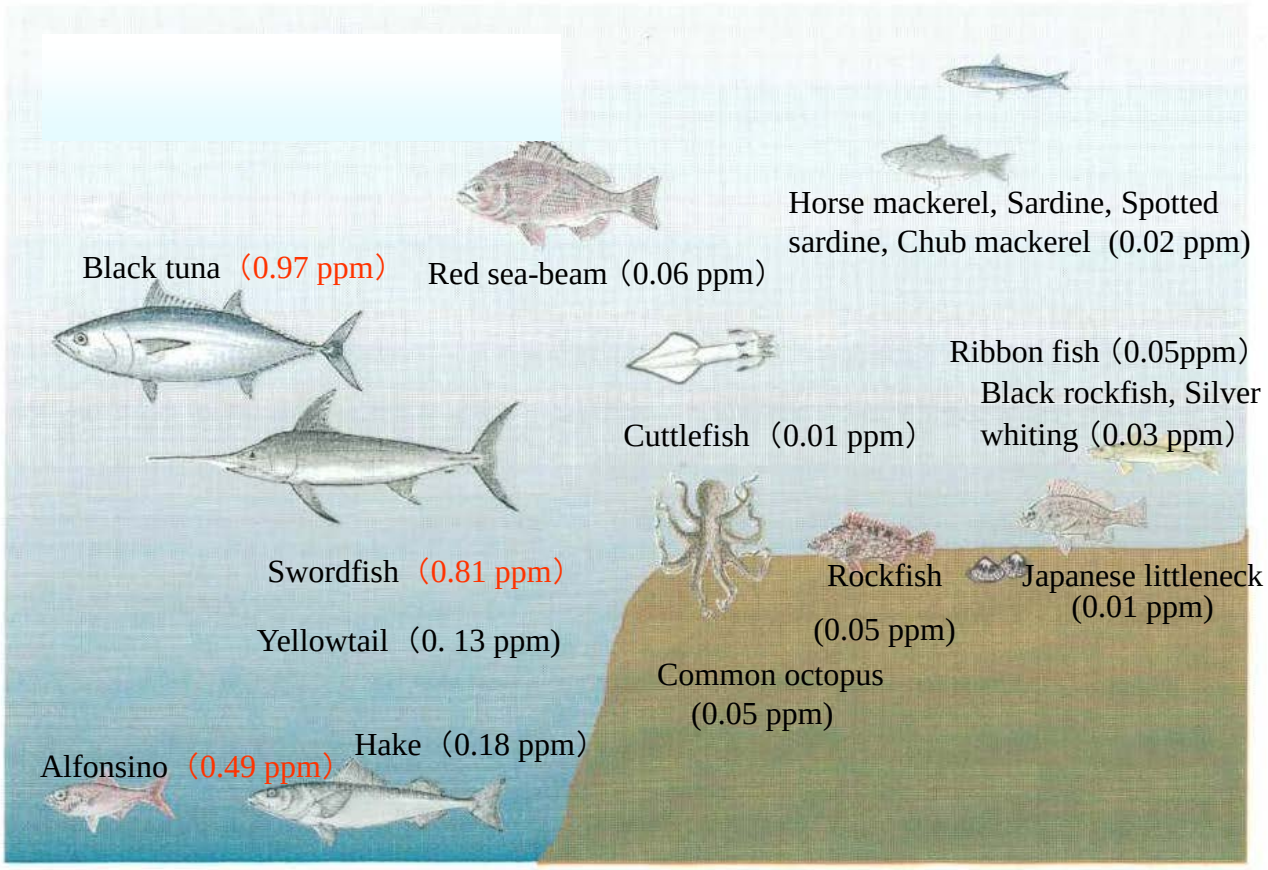
TAKE SPECIAL CARE CONCERNING MERCURY EXPOSURE FOR PREGNANT WOMEN

The placenta functions to filter toxic substances in the mother's blood to prevent them entering the baby. However, MeHg easily passes through the placenta as cysteine-conjugate (see p.3), and accumulates in the fetus. Since developing nervous tissue of fetus is most susceptible to MeHg, Japanese Food Safety Commission determined, in 2005, that a safe exposure level (PTWI, provisional tolerable weekly intake) for pregnant woman was 2 μg/kg/week. It is correspond to hair mercury level about 2.8 ppm (see p.1). PTWI was calculated using the maternal hair level 11 ppm, that is supposed to the highest level without adverse effect on the fetus, and uncertainty factor 4. Research on the fetal effects of low levels MeHg is still in progress.



INTAKE OF SEAFOOD

MeHg is generated by microorganisms from inorganic mercury in the aquatic environment, then accumulated in marine organisms via the food web. Accordingly, the major route of human exposure to MeHg is the ordinary consumption of fish and shellfish. However, there is a wide variation in mercury levels among species. Large carnivorous fishes, including tuna, swordfish and shark, often contain MeHg at high concentrations. Marine mammals including tooth whales and dolphins also show high levels. Pregnant women are recommended to avoid excessive consumption of such fishes, because the developing nervous system of the fetus is highly susceptible to MeHg. Since fish and shellfish are also rich in valuable nutrients, the appropriate consumption of seafood is useful to encourage child growth and to maintain good health.



The concentration is average of total mercury level and was taken from reports of Tokyo Metropolitan Government Bureau of Public Health and National Institute for Minamata Disease. Values may vary with fish size and habitat.

Red values are above Japanese provisional regulatory standards of total mercury (0.4 ppm) in fish and shellfish..

Japanese government announced, in 2005, a revised advisory for pregnant and may be pregnant women on the intake of certain fishes and shellfishes including swordfish, black tuna, and walleyed tuna.