Iodine, selenium and thyroid hormone

......and shellfish as an excellent source of both elements.........

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Iodine, selenium and thyroid hormone

• Why you need thyroid hormone
• Why you need iodine and selenium
• Why certain populations are at risk of iodine insufficiency
• What are normally good sources of both
• Why shellfish are particularly useful sources in the current context.
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Without a minimum of thyroid hormone, at the right time, a tadpole fails to become a frog and a human baby becomes a cretin.

Jacques Legrand 1976
Other thyroid pathologies

Goitre

Nanisme
Not only during childhood

- Also need thyroid hormone during
  - Adolescence
  - Pregnancy
  - Normal adulthood
  - Aging

- Every cell in one’s body has receptors for thyroid hormone and needs thyroid hormone to maintain normal function.
Thyroid Function

TRH hypothalamus

TSH pituitary

Peripheral organs
- Brain
- Bone
- Liver
- Heart
- Muscle
- Skin

T4; T3
Iodine, selenium and thyroid hormone

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Iodine is an essential component of thyroid hormones

representing

3,5,3',5'-tétra-iodo-L-thyronine
or Thyroxine or T4

65%

3,5,3'-tri-iodo-L-thyronine
or Triiodothyronine or T3

59%
To activate gene transcription T4 must be converted into T3 (loss of one iodine atom)
Deiodinases are seleno-proteins
Contain selenium....
Selenium is implicated in

- Thyroid hormone activation
- Thyroid hormone synthesis in the thyroid gland
- Anti-oxidant effects
- Maintenance of fertility (particularly males)
- Immune responses
- Insulin-mimetic properties
- Anti-cancer effects?
Daily requirements for Se

• 55 -75 µg / day
• Certain authors suggest 200µg/ day as anticancer effects of Selenium operate around these levels..

• But like iodine, selenium is a trace element....
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• Iodine ($^{127}$I) is the heaviest and largest element in the periodic table to be found in a naturally occurring biological molecule

• Iodine is a rare element, 64th in abundance (approximately $1-3 \times 10^{-5}$ % of the earth’s mantel).

• Sea water contains 50-60 µg iodine per litre, tap water contains less than 0.1 µg/L.

• Daily requirements for iodine are significant (100-200µg/d)
Daily requirements for Iodine

- Baby: 50 µg per day
- Child: 1-6 years 90µg per day
- Child: 7-12 years 120 µg per day
- Adolescent/Adult: 150µg per day
- Pregnancy, lactation: 200-300µg per day
- (WHO 1996)
Global impact of iodine

WHO first looked at iodine deficiency in 1960.

Associated pathologies

Goiter (hypothyroidisme) - Reduced fertility - Increased perinatal fertility - Slow growth (nanisme) Mental retardation

WHO Estimation 1990 (130 countries)

Populations at risk
28.9% of the total population (1.57 billion)
   Goiter
   12% (655 million)
   Cretinism
   2% (11.2 million)
   Mental retardation
   7% (43 million)
The International Expert Network of the International Council for Control of Iodine Deficiency Disorders (ICCIDD)

The Bilateral Agencies especially:
The Austrian Agency for International Development
The Canadian International Development Agency
The Netherlands Ministry for Development Cooperation
The Swedish International Development Agency
The United States Agency for International Development

The International Council for Control of Iodine Deficiency Disorders (ICCIDD) is a nonprofit non-governmental organization dedicated to the sustainable elimination of iodine deficiency disorders (IDD) throughout the world. The ICCIDD was granted an official status as an International NGO at the 47th World Health Assembly held in Geneva in 1994. Its activities are supported by donation/grants from the Australian Agency for International Development (AusAID), the Canadian International Development Agency (CIDA), the Micronutrient Initiative (MI), the Netherlands Ministry for Development Cooperation, the Swedish International Development Agency (SIDA), the United Nations Children Fund (UNICEF), the United States Agency for International Development (USAID), the World Bank, the World Health Organization (WHO), and others.

http://www.people.virginia.edu/~jtd/iccidd/
A recent European study showed

- Many young women have a mild iodine lack
- Risk: accentuated lack during pregnancy
- Children may have up to 10 IQ points less than children born to mothers with sufficient iodine supply
- Recommendation: iodine supplements (as for iron) during pregnancy.
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The fallacy of iodine in sea salt

- 10 to 100 times less iodine than iodinated salt
- ( <1µg /gram)
- I⁻ Volatised during evaporation of sea water
- During pregnancy need 200µg/ day (often limited salt intake)
- So: need food rich in iodine or supplements
- Small preventive cost
- Social cost of mental retardation: enormous.
Two detailed studies

- **Fisher & L'Abbe (1980) (Canada)**
  - 1.2 - 1.4 μg iodine/gram unsupplemented sea salt
  - 52.9 - 84.6 μg iodine/gram iodine-supplemented table salt

- **Aquaron (2000) (multiple countries).**
  - 0.71 μg iodine/gram unsupplemented sea salt
  - De 7.65 - 100 μg iodine/gram iodine-supplemented table salt (according to the legislation in effect in each country).

- Green: 90% or more
- Yellow: 50% to 89%
- Red: Less than 49%
- White: No recent data

Source: UNICEF 2002
Iodine lack affects >800 million people

- Most often pregnant women, children: risk of mental retardation as developing brain most sensitive to lack of thyroid hormone
- Major problem in many societies
- To synthesise thyroid hormone you need iodine
- To activate thyroid hormone you need selenium
- The easiest way to provide iodine is iodised salt, NOT sea salt.
- BUT……
BUT

• Pregnant women often need to reduce their salt intake
• Iodised salt does not cover selenium requirements.

• So…. Need alternative sources
• Artificial food supplements, (with iron)

• Or natural sources.. such as shellfish and crustacea……
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Because Shellfish and Crustacea are excellent sources of BOTH iodine and selenium...
### Iodine and selenium contents of selected Fish and Shellfish

<table>
<thead>
<tr>
<th>Seafood</th>
<th>Iodine (μg/100g)</th>
<th>Selenium (μg/100g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Herring</td>
<td>29</td>
<td>35</td>
</tr>
<tr>
<td>Plaice</td>
<td>33</td>
<td>37</td>
</tr>
<tr>
<td>Mackerel</td>
<td>140</td>
<td>30</td>
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<tr>
<td>Salmon</td>
<td>76</td>
<td>24</td>
</tr>
<tr>
<td>Oyster</td>
<td>60</td>
<td>23</td>
</tr>
<tr>
<td>Mussel</td>
<td>140</td>
<td>51</td>
</tr>
<tr>
<td>Lobster (boiled)</td>
<td>100</td>
<td>130</td>
</tr>
<tr>
<td>Shrimp (boiled)</td>
<td>100</td>
<td>46</td>
</tr>
</tbody>
</table>

*Holland et al. 1993, HMSO*
Comparison with other foods

• Daily requirements
  – Iodine 150-200µg/day
  – Selenium 75 µg/day*

• Cereals /meat
  – 10-12 µg selenium /100g
  – and only 3 -10µg Iodine/100g

• Mussels
  140µg Iodine and 50µg Selenium/100g

• Lobster
  100µg Iodine and 130µg Selenium/100g
Conclusion

- Rare elements **Iodine** and **Selenium** are needed for normal **brain** development and function throughout life....(fertility, immune system etc..)

**Mussels** provide a particularly rich source of both Iodine and Selenium, as do **oysters** and **lobster**....
So.............

Mussel up your brain!