

# TastyKelp, processing, arsenic and iodine

ALGET 2 - WEBINAR

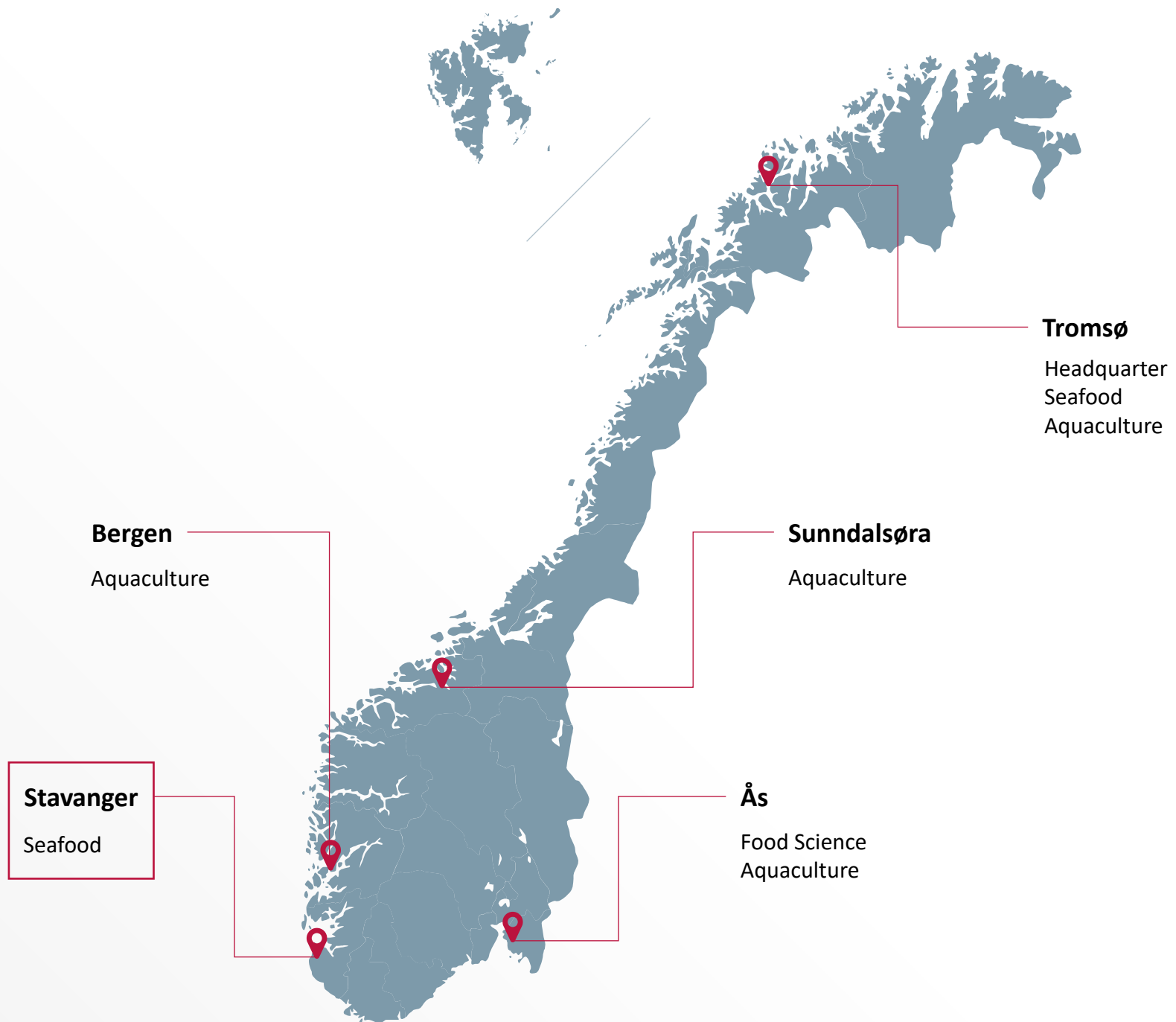
14.01.2021



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Post doc researcher







# Facts about Nofima



**PROJECTS**

**599**

in which Nofima  
is engaged in 2019



**CUSTOMERS FROM**

**32**

different countries



**EMPLOYEES**

**394**

60% women and 40% men  
**171 have a PhD.**



**TURNOVER**

**676**

Million NOK in 2019

The image shows two men on a pier or boat, engaged in a task. The man on the left is wearing a red waterproof jacket with reflective yellow stripes and a dark cap. The man on the right is wearing a bright yellow-green waterproof jacket and a matching beanie. They are both looking at a large, dark, rectangular sample of kelp that is being held up. The background features a body of water, a pier structure with railings, and a large white and blue vessel in the distance under an overcast sky.

# The TastyKelp project

A photograph of two fishermen on a pier. The fisherman on the left is wearing a red waterproof jacket and a dark cap, looking towards the other man. The fisherman on the right is wearing a bright yellow-green waterproof jacket and a matching beanie, and is holding a large roll of dark seaweed. In the background, a white boat is docked at the pier, and the water is calm. The overall scene is overcast and foggy.

**Building competency for solving the major obstacles of the seaweed food industry!**



# TastyKelp

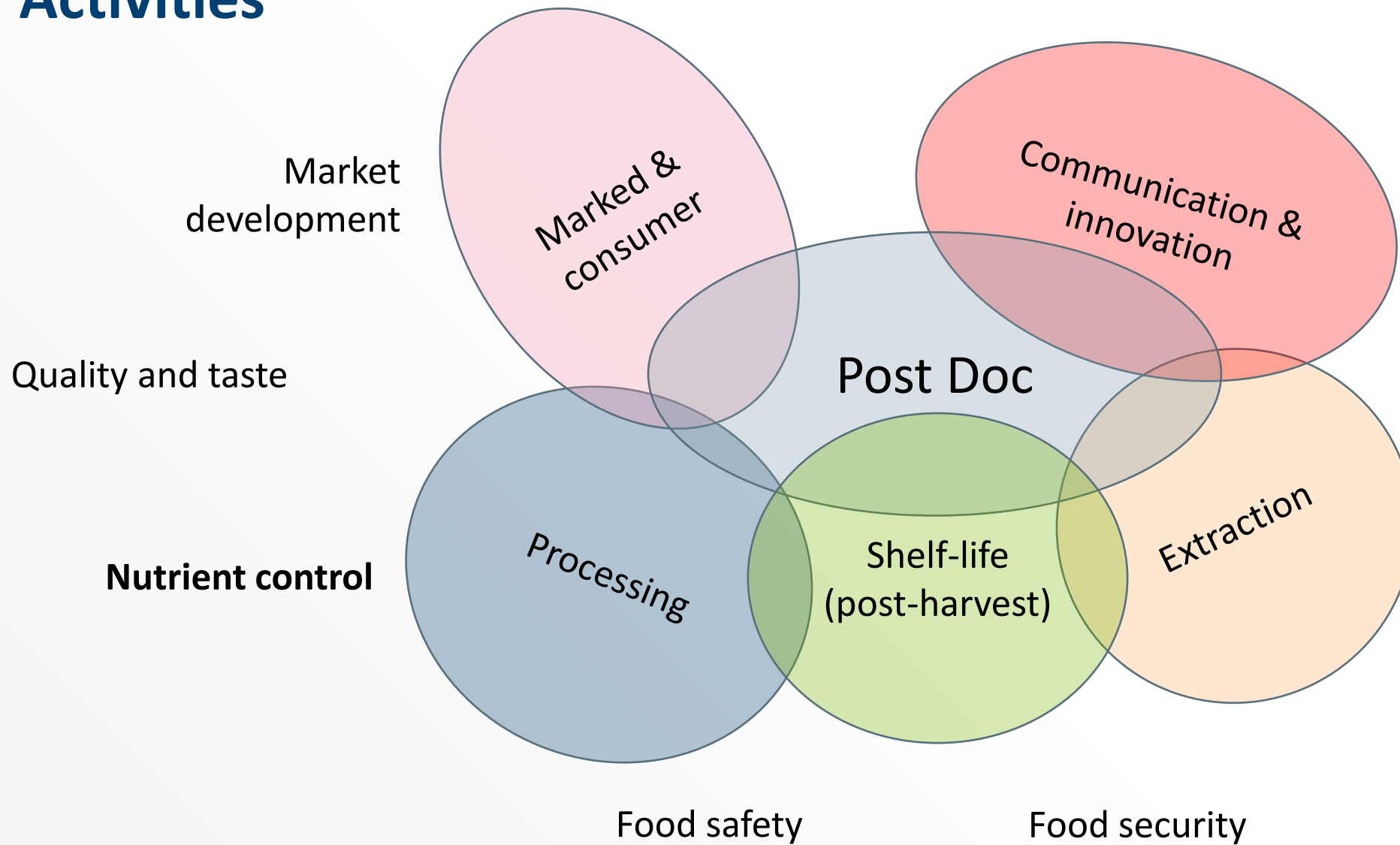
Competency for sustainable utilization of seaweeds

- Internal, strategic project in Nofima's Seafood division
- Jan 2019 – Dec 2021
- Post doc – processing

Participating departments:

- Seafood industry
- Market and consumer research
- Marine Biotechnology
- Process technology

# Activities







VINNER AV  
NM I SUNN FASTFOOD  
2018

#mer av grovt, grønt og fisk



HEART  
SMART  
MEALS

## Mango-curry burger

Fiskeburger m/tare, i valgfritt brød, toppet med tomat, sylteagurk, rødløk, polarsalat og mango-curry dressing  
Serveres med søtpotet fries, løkringer og beger aioli dipp.

Allergener; gluten (hvete), sesamfrø, fisk, egg, melk



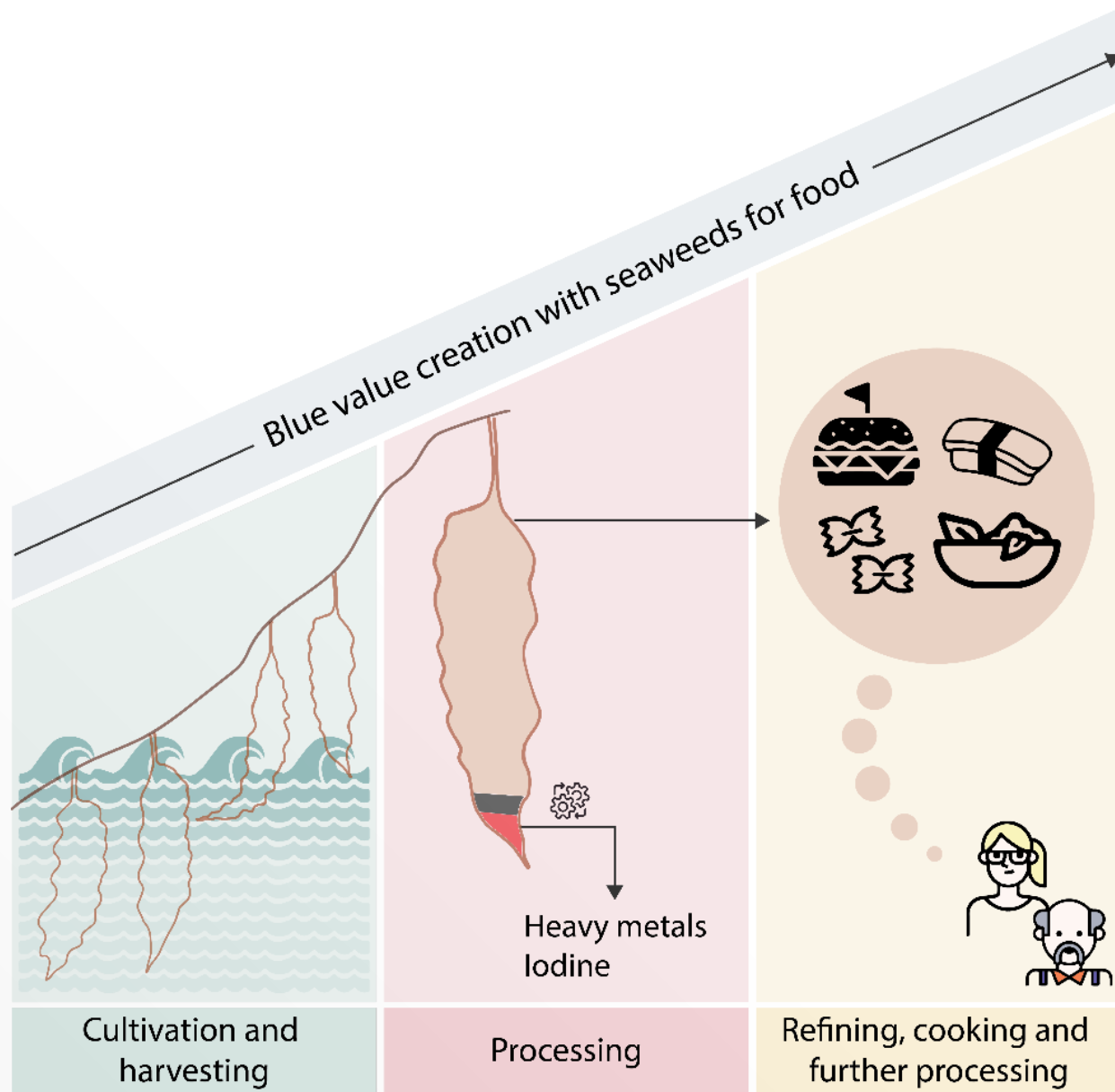


# IODINE

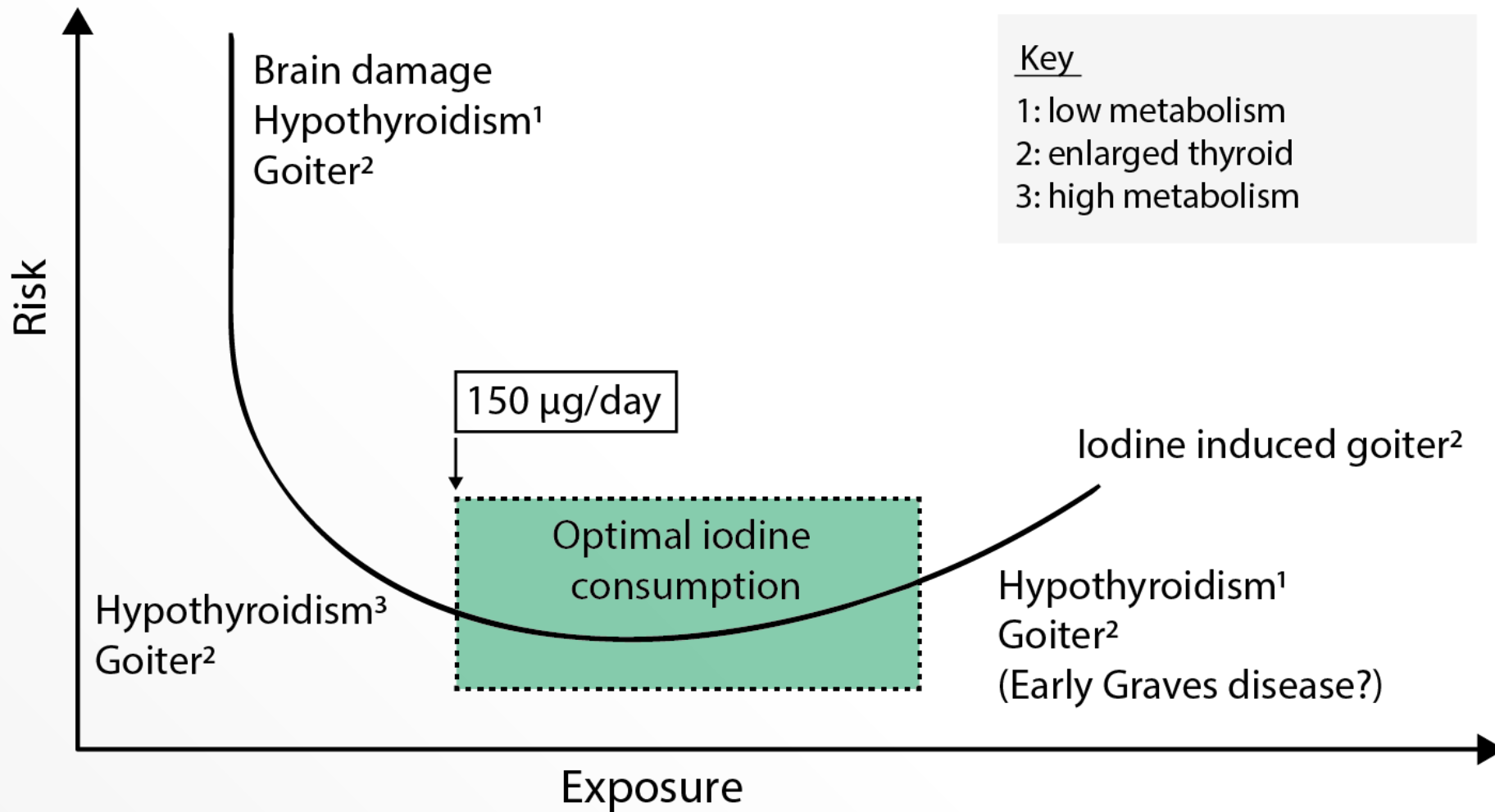
1 H																	2 He										
3 Li	4 Be											5 B	6 C	7 N	8 O	9 F	10 Ne										
11 Na	12 Mg											13 Al	14 Si	15 P	16 S	17 Cl	18 Ar										
19 K	20 Ca	21 Sc											22 Ti	23 V	24 Cr	25 Mn	26 Fe	27 Co	28 Ni	29 Cu	30 Zn	31 Ga	32 Ge	33 As	34 Se	35 Br	36 Kr
37 Rb	38 Sr	39 Y											40 Zr	41 Nb	42 Mo	43 Tc	44 Ru	45 Rh	46 Pd	47 Ag	48 Cd	49 In	50 Sn	51 Sb	52 Te	53 I	54 Xe
55 Cs	56 Ba	57 La	58-71	72 Hf	73 Ta	74 W	75 Re	76 Os	77 Ir	78 Pt	79 Au	80 Hg	81 Tl	82 Pb	83 Bi	84 Po	85 At	86 Rn									
87 Fr	88 Ra	89 Ac	90-103	104 Rf	105 Db	106 Sg	107 Bh	108 Hs	109 Mt	110 Ds	111 Rg	112 Cn	113 Nh	114 Fl	115 Mc	116 Lv	117 Ts	118 Og									

58 Ce	59 Pr	60 Nd	61 Pm	62 Sm	63 Eu	64 Gd	65 Tb	66 Dy	67 Ho	68 Er	69 Tm	70 Yb	71 Lu
90 Th	91 Pa	92 U	93 Np	94 Pu	95 Am	96 Cm	97 Bk	98 Cf	99 Es	100 Fm	101 Md	102 No	103 Lr





The final consumer should not take up too much iodine from the food



## TRUE OR FALSE? (Q&A 1a)

It is OK that one portion of a seaweed food product (or meal) contain more than the daily requirement of iodine, **since iodine from seaweed is not very available** during digestion.





## TRUE OR FALSE? (Q&A 1b)

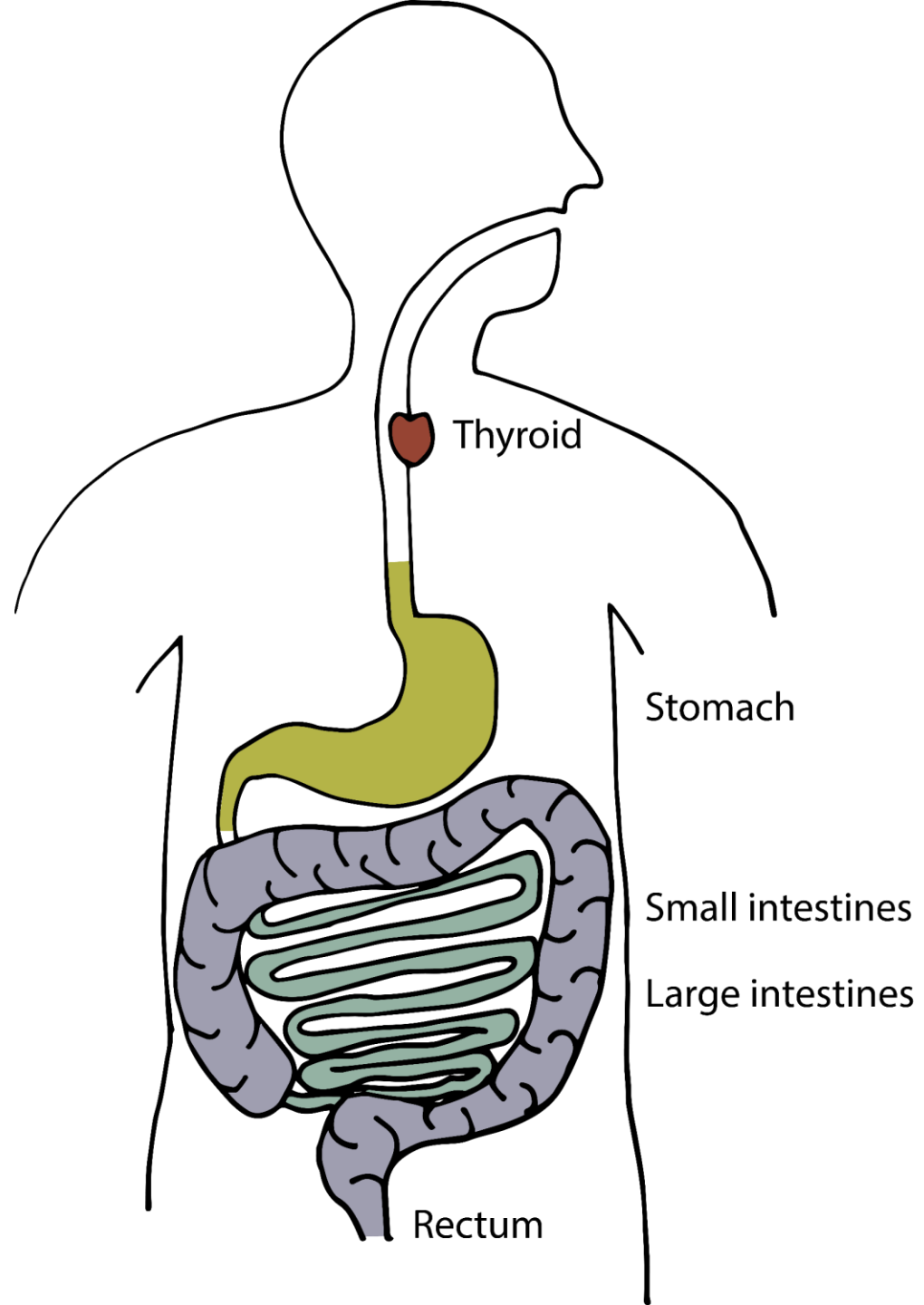
It is OK that one portion of a seaweed food product (or meal) contain more than the maximum recommended daily intake of iodine **since iodine from seaweed is not very available** during digestion.

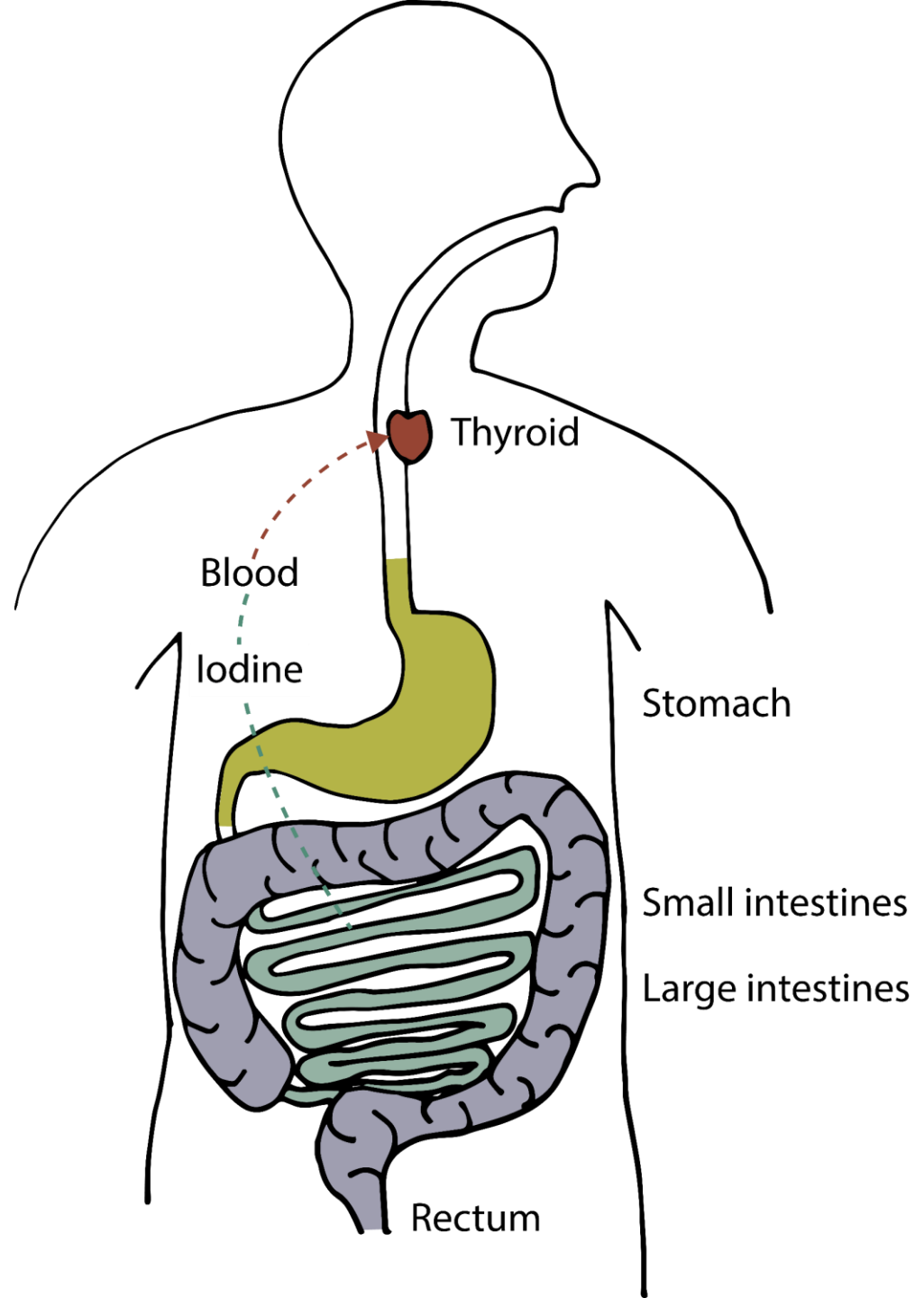


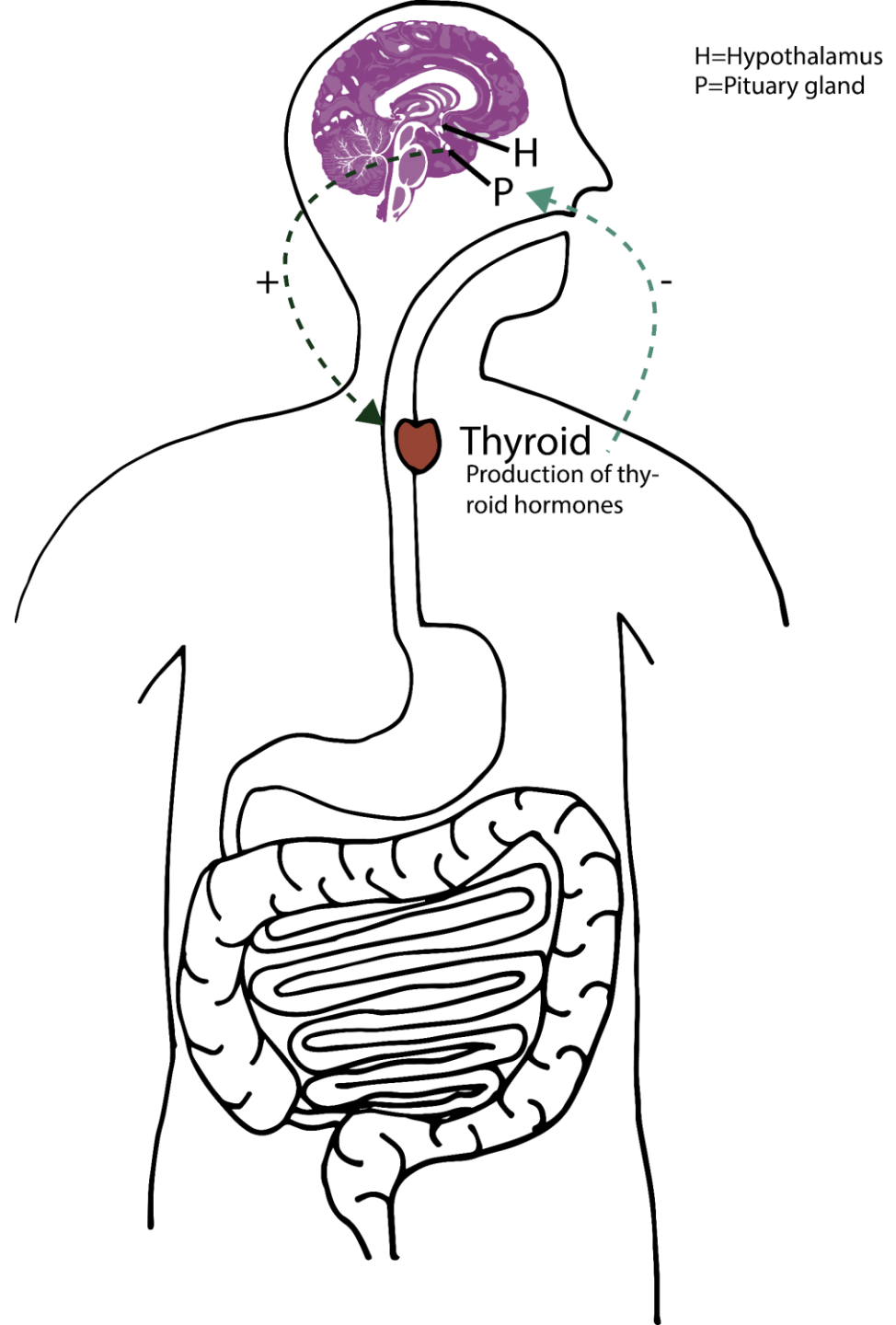


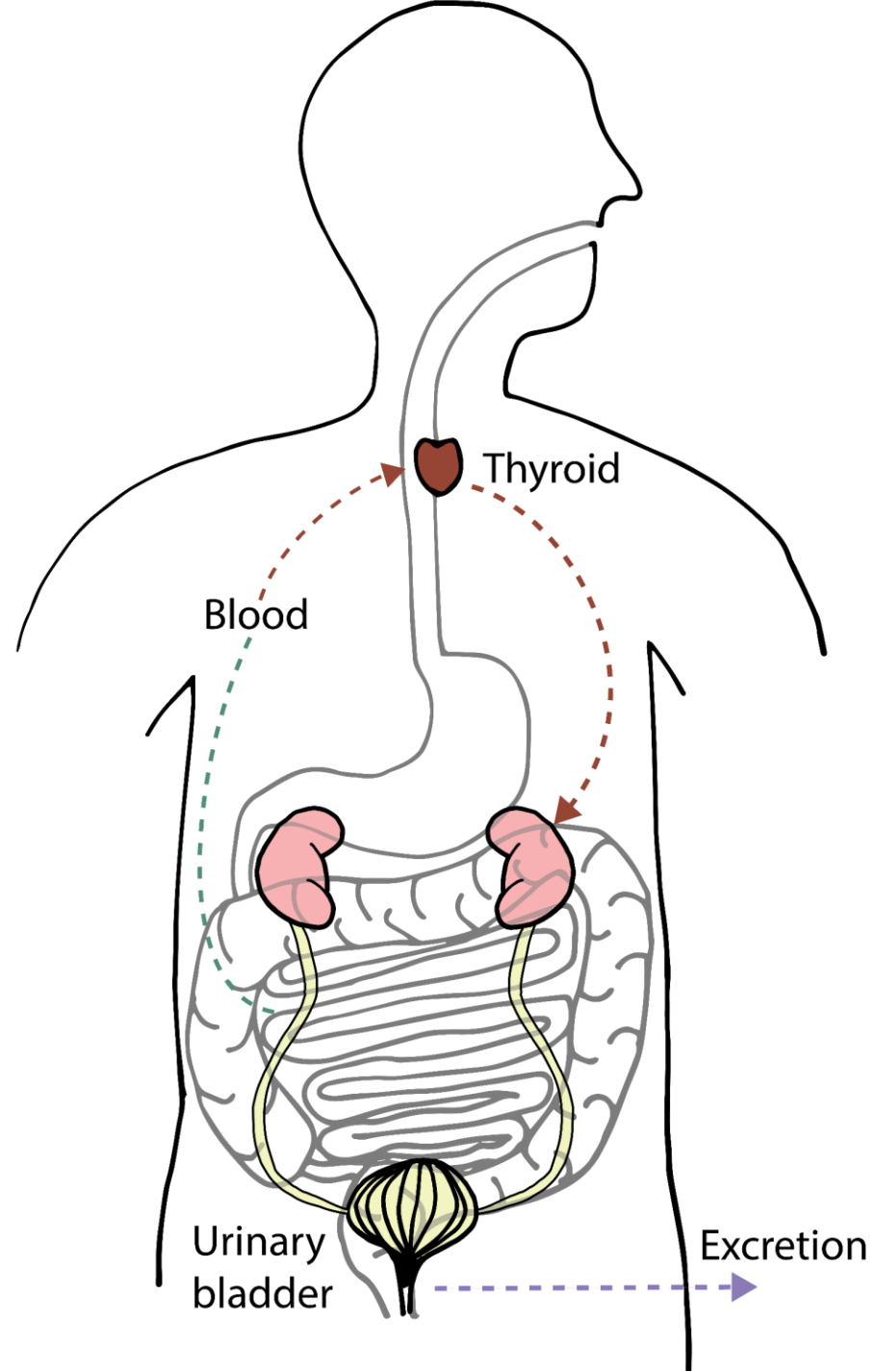
**FALSE.**

**33-90 % is bioavailable**



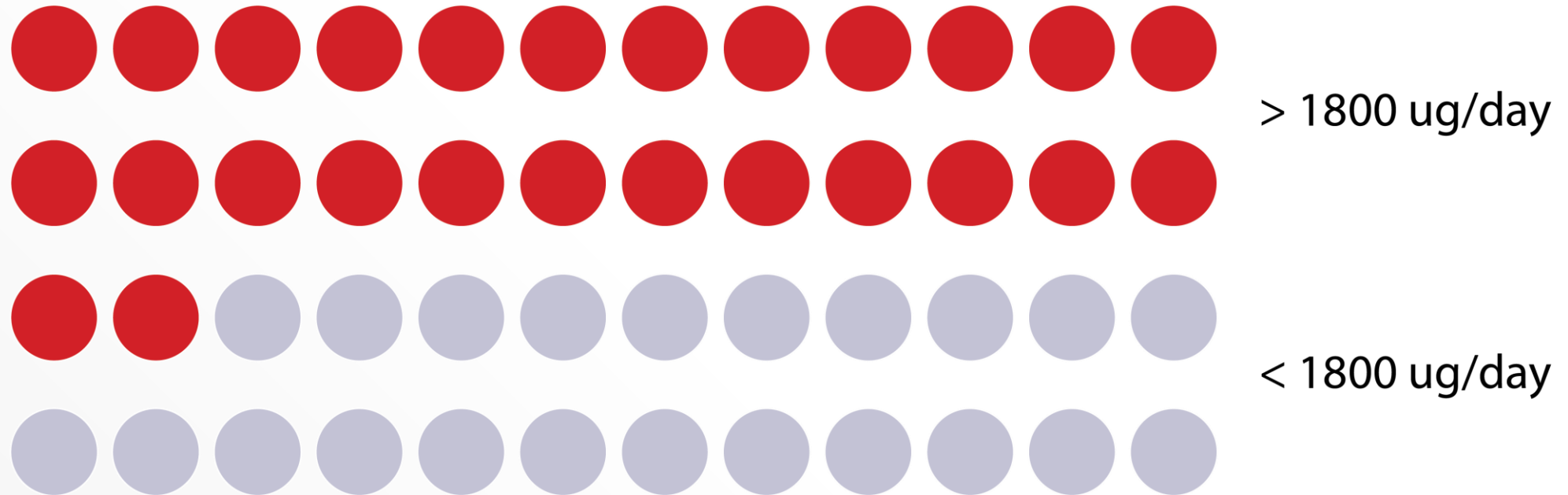








55 % of seaweed eaters (n=44) in the study by Aakre et al (2020) consumed more than 1800 ug iodine/day, which is the lowest observed adverse effect level.





50 cm

**Sugar kelp**

*Saccharina latissima*

1556 – 7208



50 cm

**Winged kelp**

*Alaria esculenta*

180 – 1070



10 cm

**Dulse**

*Palmaria palmata*

72 – 293

Iodine mg/kg  
dry weight:

# EFFECT OF PROCESSING

Method	Species	Iodine reduction	Source
<b>Boiling/blanching</b>	Sugar kelp	38-94 %	Luning & Mortensen (2015); Bruhn et al. (2019); Nielsen et al. (2020)
<b>Soaking (30-32 °C)</b>	Sugar kelp	78 - 85%	Stevant et al. (2018); Nielsen et al. (2020)
<b>Washing</b>	Winged kelp	Approx. 10%	Nitschke & Stengel (2016)
<b>Drying, soaking and boiling</b>	Winged kelp	75%	Nitschke & Stengel (2016)
<b>Drying (70 °C)</b>	Sugar kelp	25%	Stevant et al. (2018)
<b>Fermenting</b>	Sugar kelp	65%	Bruhn et al. (2019)



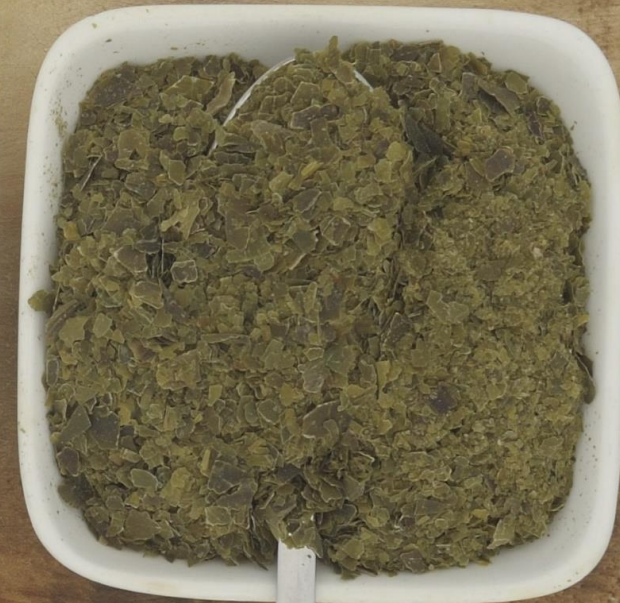
HOW MUCH IODINE IS ON THIS TEA SPOON?

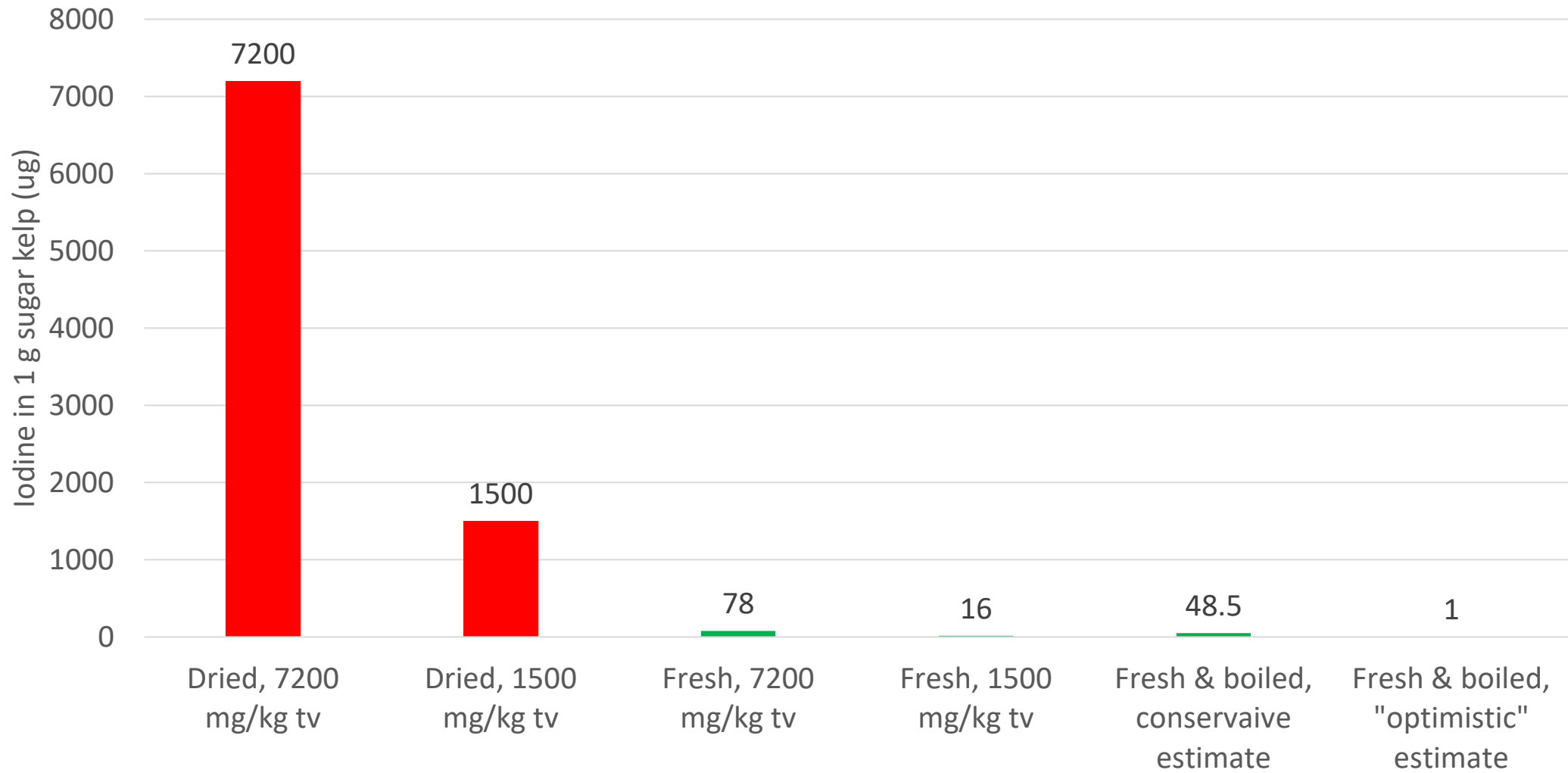
(Q&A 2)

0.1 g

1 g

10 g







# 1 gram sugar kelp contains between 7200 and 1 µg iodine\*

- Dried: 7200 - 1500 µg.
- Norway & harvested in season, dried: 3500 – 5500 µg
- Fresh: 78 - 16 µg
- Iodine can be reduced by processing\*\*



\* Data for dried and fresh seaweed, raw and processed.

\*\* Blansjering/koking: 38-92 %, fermentering: ca. 65 % (Nielsen et al, 2020; Bruhn et al, 2019)



**TINE**

**Lettmelk**

1,0% fett

FRA GÅRDER NÆR DEG

— Naturlig —  
**proteinrik**



150 µg jod

9 dl melk

150 µg jod

160 g torsk

150 µg jod

0.03 g tørket sukkertare



1L

# ARSENIC

1 H																	2 He									
3 Li	4 Be											5 B	6 C	7 N	8 O	9 F	10 Ne									
11 Na	12 Mg											13 Al	14 Si	15 P	16 S	17 Cl	18 Ar									
19 K	20 Ca	21 Sc										22 Ti	23 V	24 Cr	25 Mn	26 Fe	27 Co	28 Ni	29 Cu	30 Zn	31 Ga	32 Ge	33 As	34 Se	35 Br	36 Kr
37 Rb	38 Sr	39 Y										40 Zr	41 Nb	42 Mo	43 Tc	44 Ru	45 Rh	46 Pd	47 Ag	48 Cd	49 In	50 Sn	51 Sb	52 Te	53 I	54 Xe
55 Cs	56 Ba	57 La	58-71	72 Hf	73 Ta	74 W	75 Re	76 Os	77 Ir	78 Pt	79 Au	80 Hg	81 Tl	82 Pb	83 Bi	84 Po	85 At	86 Rn								
87 Fr	88 Ra	89 Ac	90-103	104 Rf	105 Db	106 Sg	107 Bh	108 Hs	109 Mt	110 Ds	111 Rg	112 Cn	113 Nh	114 Fl	115 Mc	116 Lv	117 Ts	118 Og								

58 Ce	59 Pr	60 Nd	61 Pm	62 Sm	63 Eu	64 Gd	65 Tb	66 Dy	67 Ho	68 Er	69 Tm	70 Yb	71 Lu
90 Th	91 Pa	92 U	93 Np	94 Pu	95 Am	96 Cm	97 Bk	98 Cf	99 Es	100 Fm	101 Md	102 No	103 Lr



## TRUE OR FALSE? (Q&A 3)

It is sufficient to distinguish between **inorganic** and **organic** arsenic to know the potential toxicity of arsenic in seaweeds.



## TRUE OR FALSE? (Q&A 3)

It is sufficient to distinguish between **inorganic** and **organic** arsenic to know the potential toxicity of arsenic in seaweeds.

**FALSE.**



# INORGANIC ARSENIC (iAs)

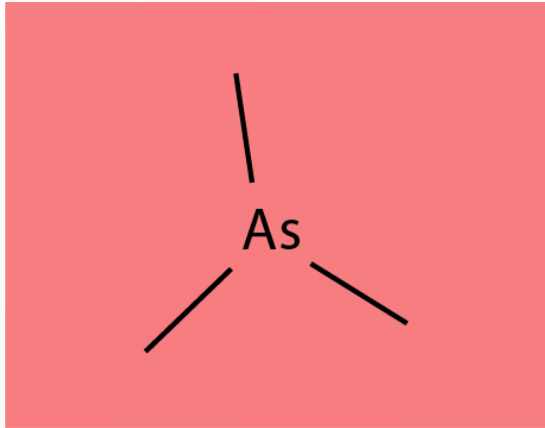
As(III)

As(V)

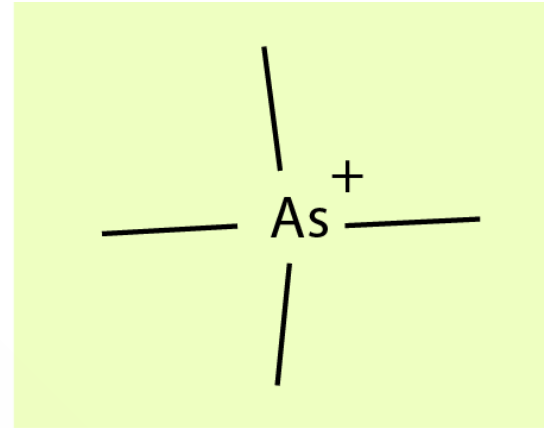




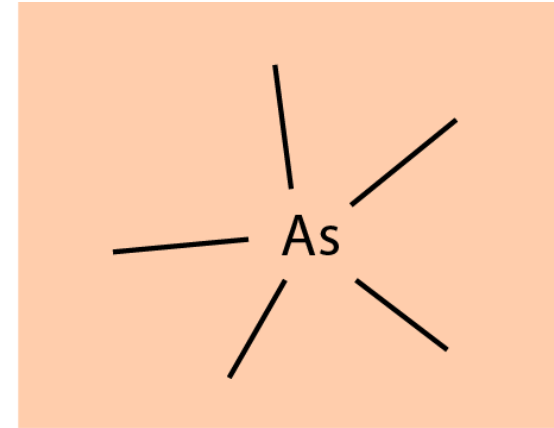
# ORGANIC ARSENIC



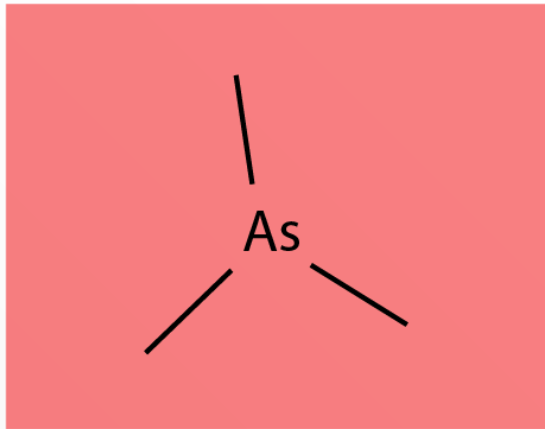
EXTREMELY  
TOXIC  
e.g. DMA(III)-sugar



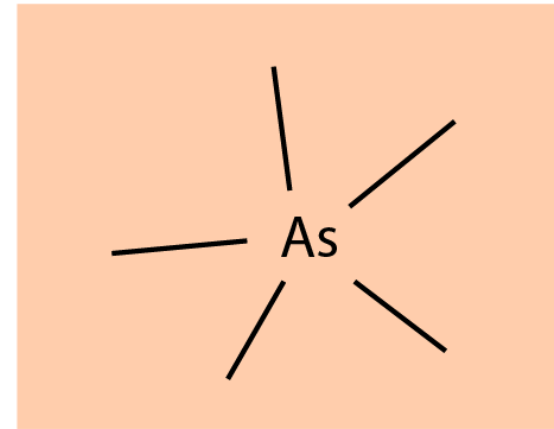
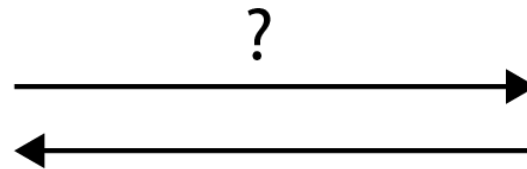
GENERALLY  
LOW TOXICITY  
e.g. arsenobetain



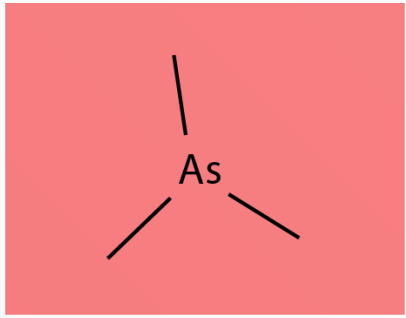
LESS TOXIC  
e.g. DMA(V)-sugar



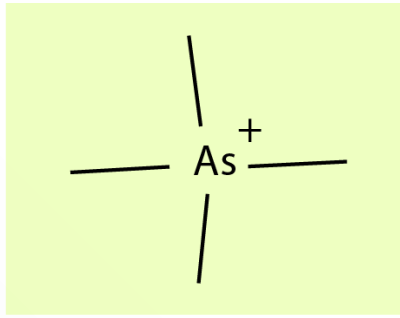
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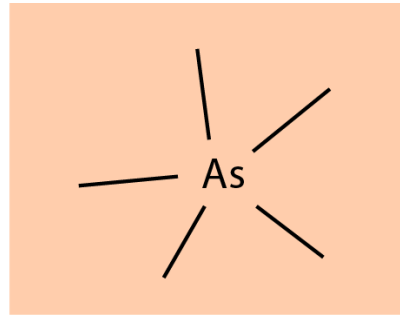
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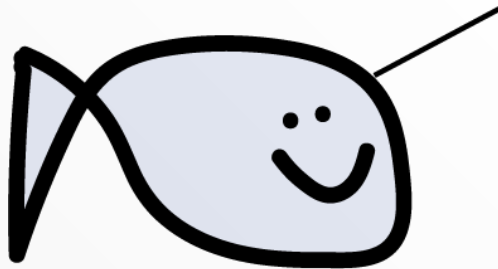
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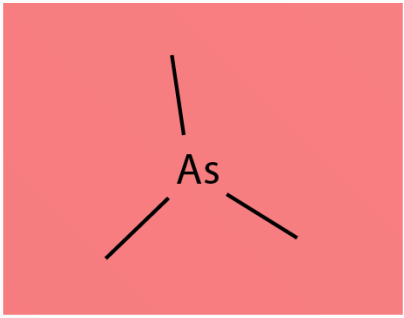
GENERALLY  
LOW TOXICITY  
e.g. arsenobetain



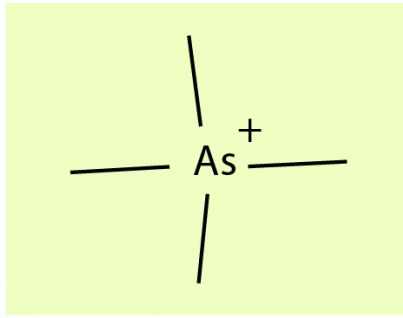
LESS TOXIC  
e.g. DMA(V)-sugar



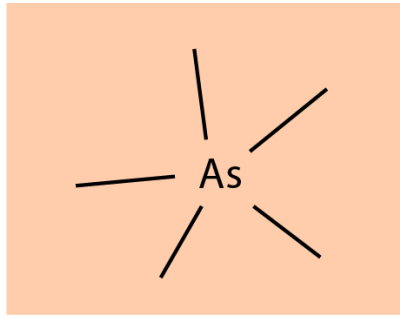
2 % iAs  
85 % arsenobetain  
13 % other organic arsenic



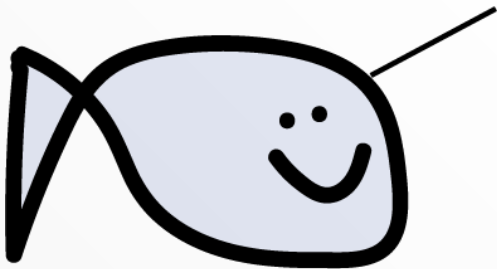
EXTREMELY TOXIC  
e.g. DMA(III)-sugar



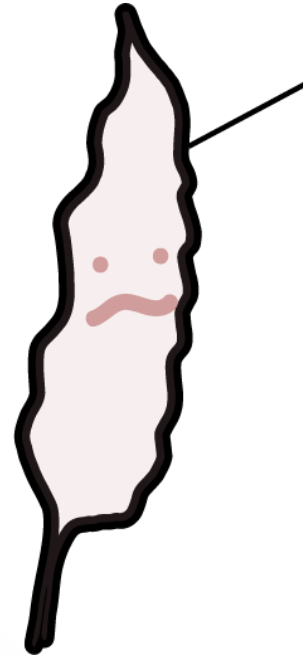
GENERALLY LOW TOXICITY  
e.g. arsenobetain



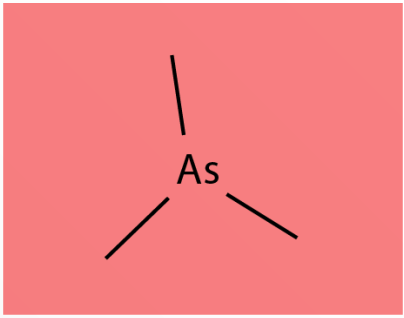
LESS TOXIC  
e.g. DMA(V)-sugar



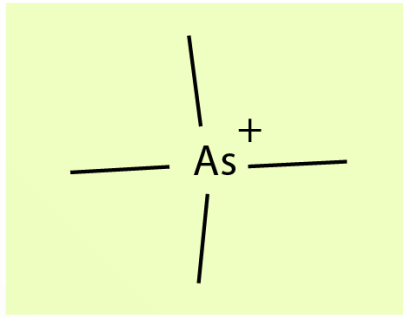
2 % iAs  
85 % arsenobetain  
13 % other organic arsenic



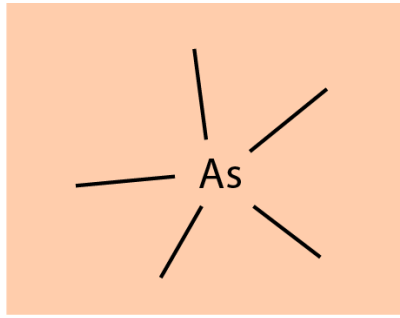
1 % iAs  
1 % arsenobetain  
98 % other organic arsenic



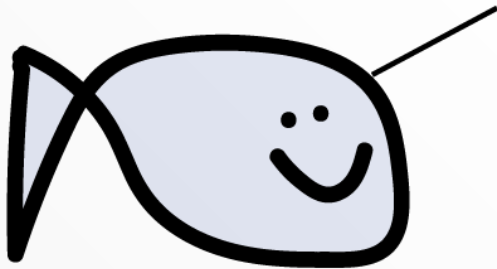
EXTREMELY  
TOXIC  
e.g. DMA(III)-sugar



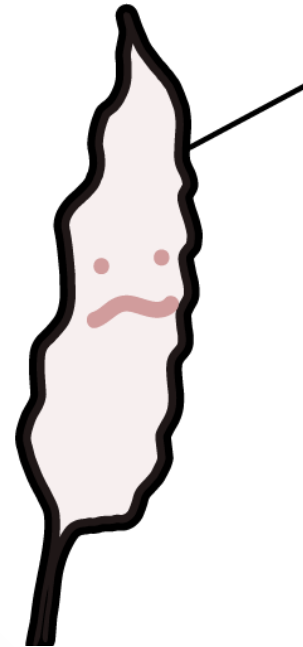
GENERALLY  
LOW TOXICITY  
e.g. arsenobetain



LESS TOXIC  
e.g. DMA(V)-sugar



2 % toxic  
85 % non-toxic  
13 % potentially toxic

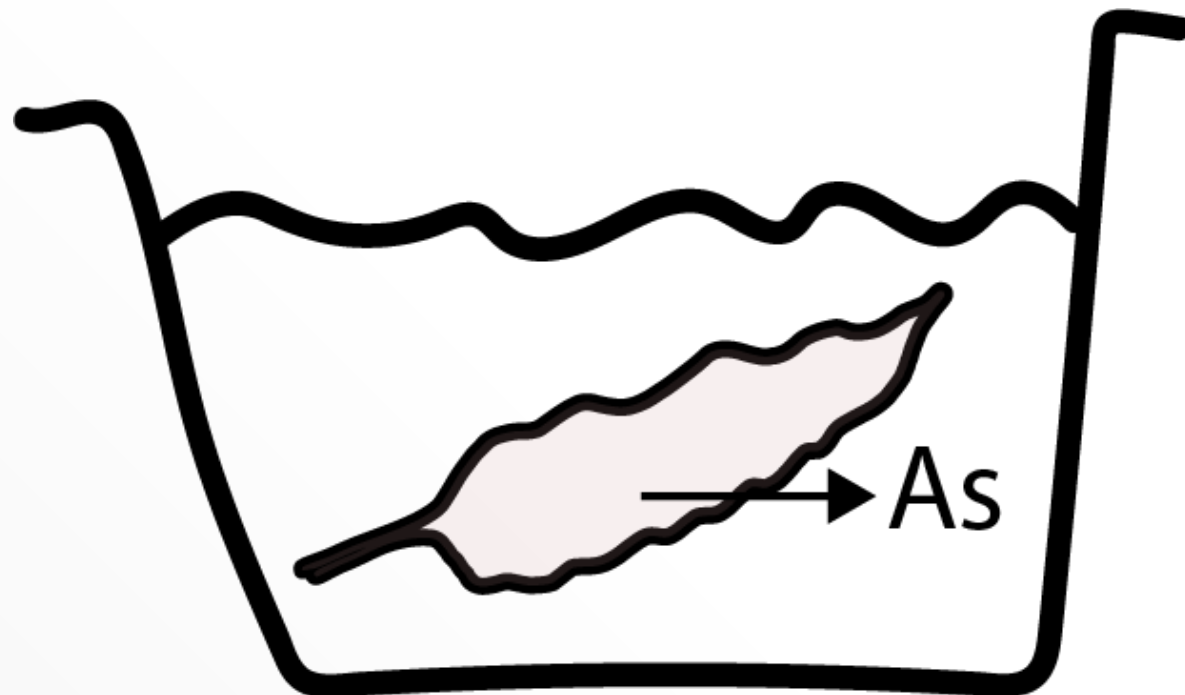


1 % toxic  
1 % non-toxic  
98 % potentially toxic



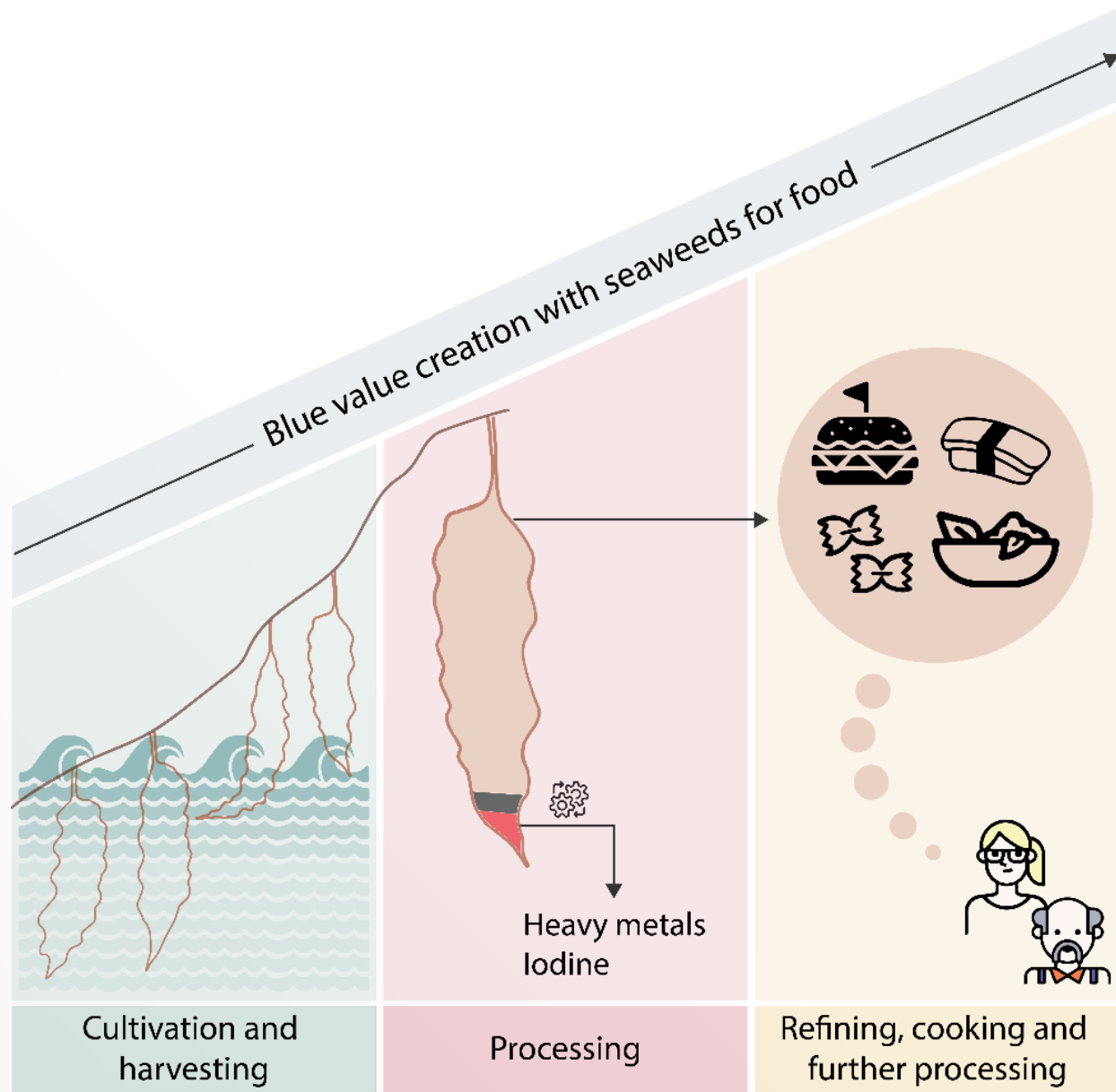
	<b>Total arsenic (tAs)</b>	<b>Inorganic arsenic (iAs)</b>	<b>Sources</b>
<b>Sugar kelp</b> (µg/g dry weight)	39-66	0,03 - 0,4	Bruhn et al. (2019), Maulvault et al. (2015), Duinker et al. (2014), Stevant et al. (2018); Sharma et al. (2018)
<b>Winged kelp</b> (µg/g dry weight)	48-93	0,09 - 8,5	Mæhre et al. (2014); Biancarosa et al. (2018); Kleppe (2017, masteroppgave)

## EFFECT OF PROCESSING



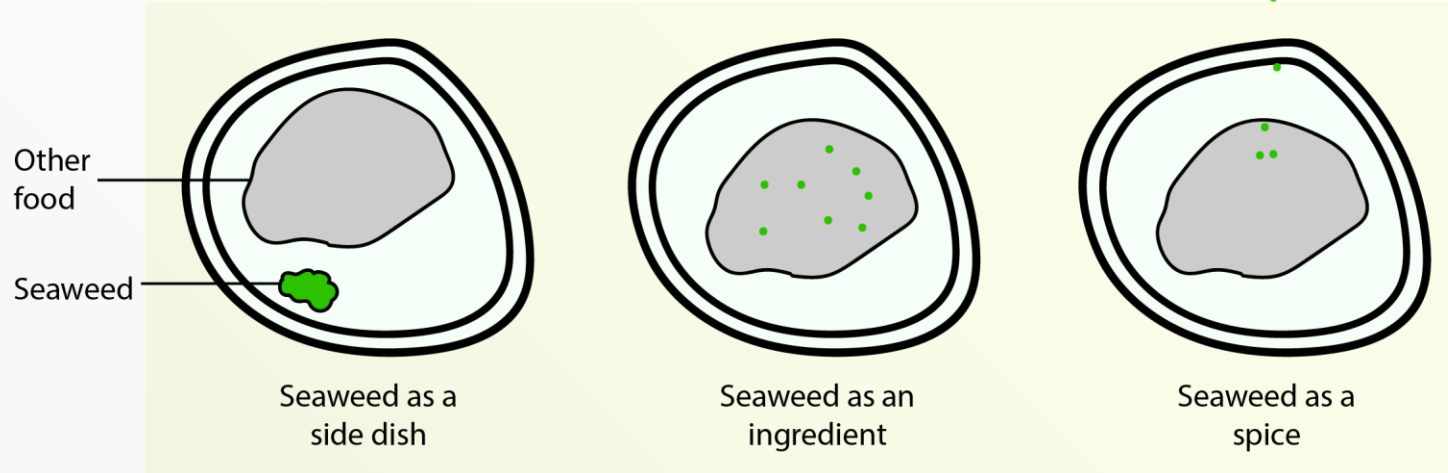


**What does this mean, in practice?**

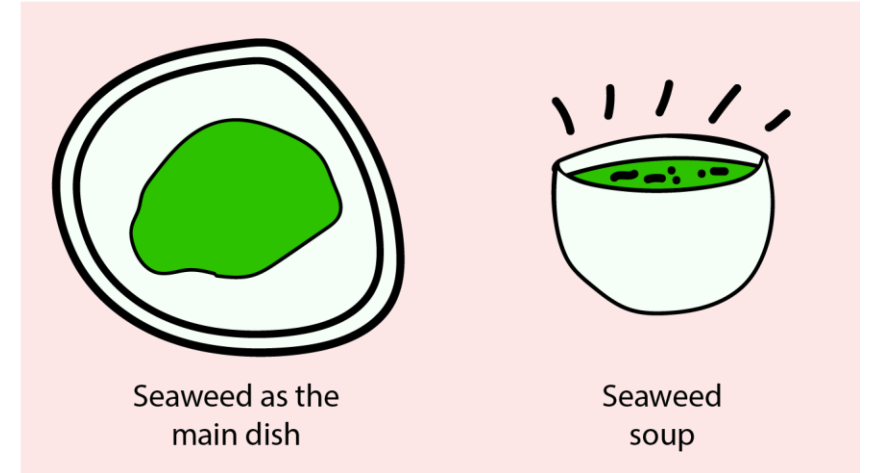




Perhaps!



Perhaps not!





**TINE**

**Lettmelk**

1,0% fett

FRA GÅRDER NÆR DEG

— Naturlig —  
**proteinrik**



**NO FOOD IS AN ISLAND!**

150 µg jod

9 dl melk

150 µg jod

160 g torsk

150 µg jod

0.03 g tørket sukkertare

1L

A large, light blue circular graphic containing a stylized brown kelp frond. The text "CREATE TASTY, NUTRITIOUS & SAFE FOODS FROM KELP" is centered over the frond in a bold, yellow-green, sans-serif font. The word "SAFE" is underlined.

**CREATE TASTY,  
NUTRITIOUS & SAFE  
FOODS FROM KELP**

 [facebook.com/nofima/](https://facebook.com/nofima/)

 [twitter.com/nofima/](https://twitter.com/nofima/)

 [Linkedin.com/company/nofima/](https://linkedin.com/company/nofima/)

 [Vimeo.com/nofima/](https://vimeo.com/nofima/)

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 [nofima.no](https://nofima.no)