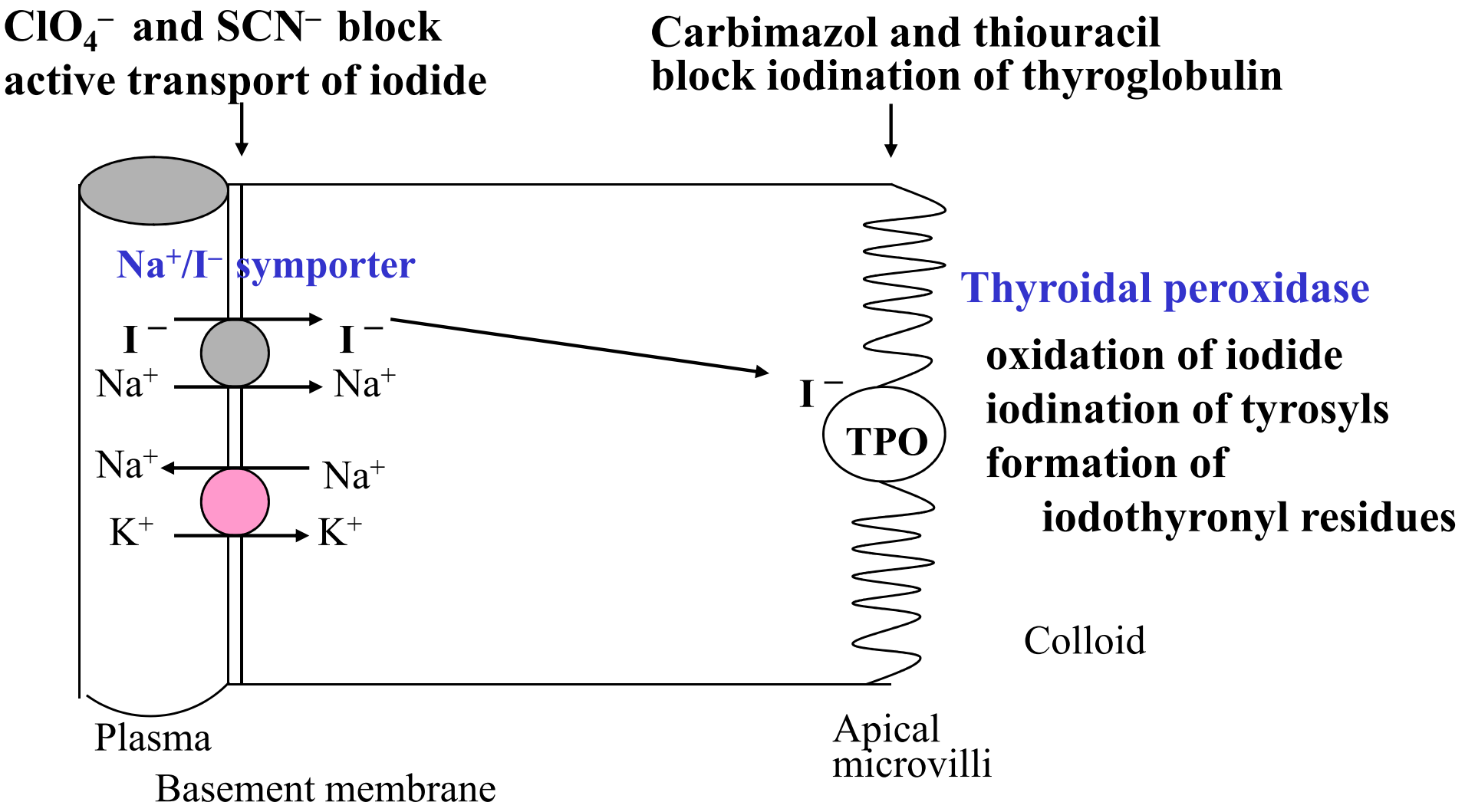
The thyroid gland

Clinical biochemistry

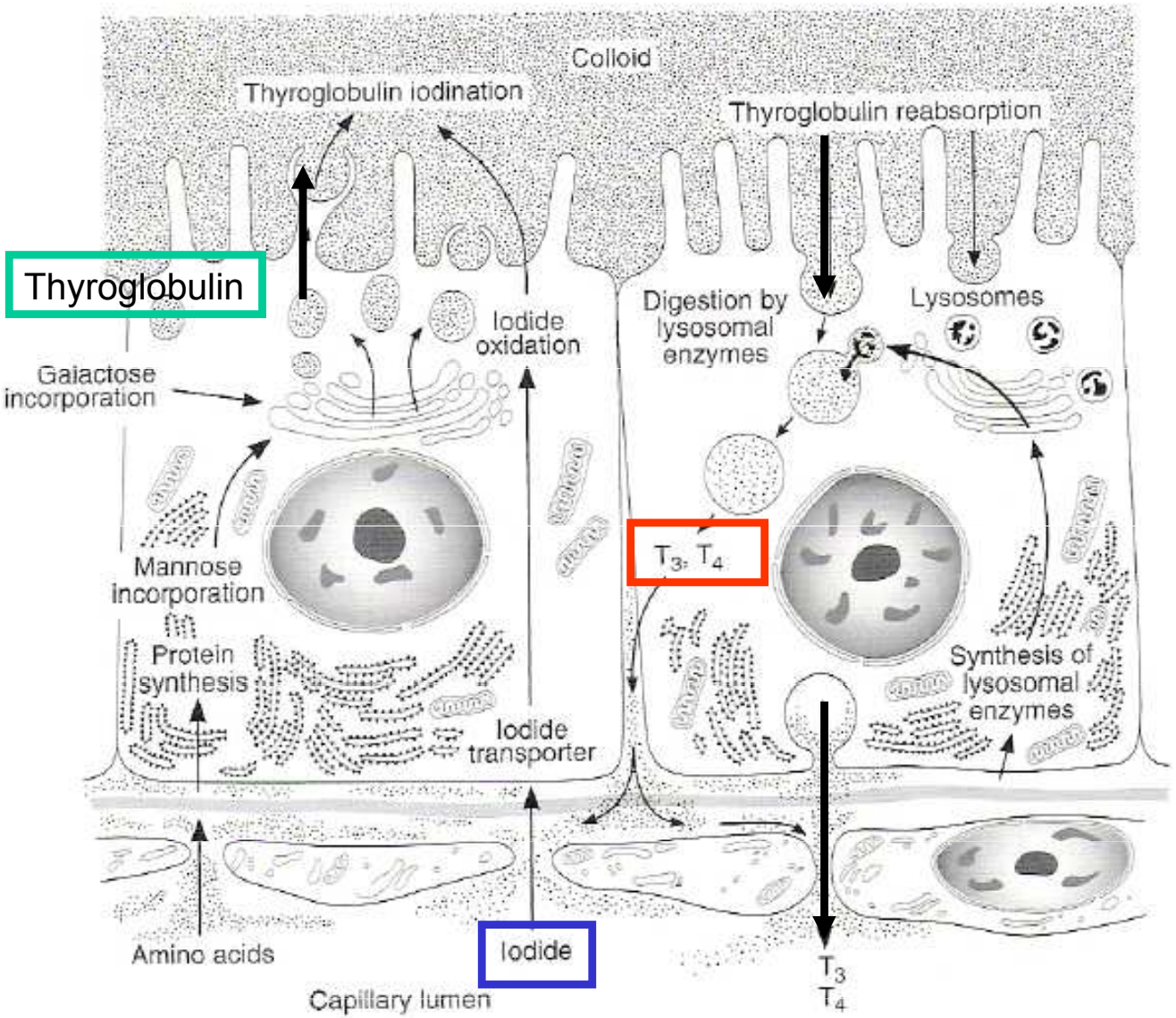
2008 (J.S.)

The thyroiodide trap

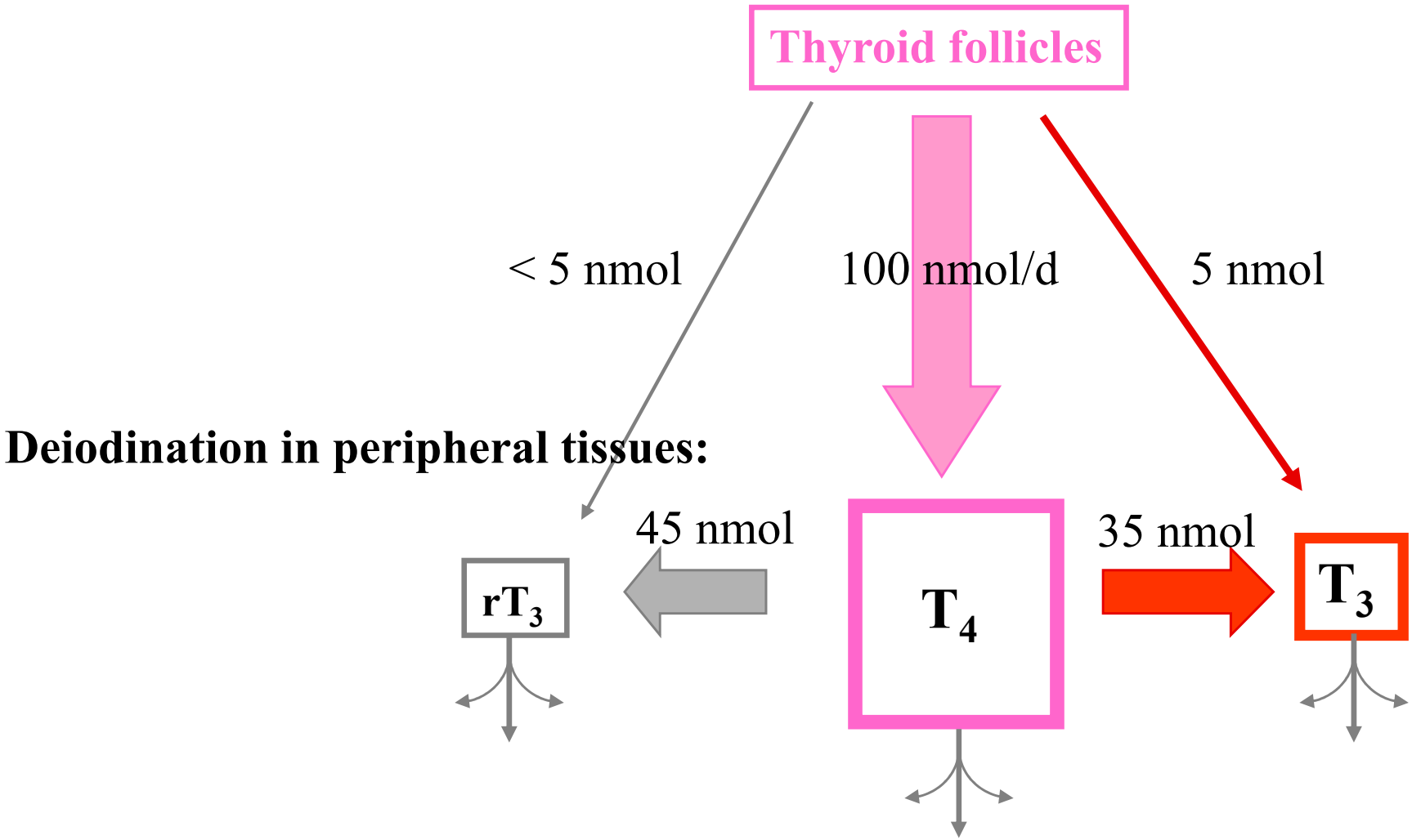
Blood serum iodide concentration about 150 µmol/l



Triiodothyronine synthesis in the thyroid follicles



Approximate daily secretion of iodothyronines, deiodination and metabolism in peripheral tissues



Metabolism (e.g. T_2, T_1, Tetrac, Triac) and **excretion**

Thyroid hormones in blood

Thyroxine T_4 is the main compound secreted by the thyroid gland. It may be taken as a prohormone.

Triiodothyronine T_3 is the thyroid hormone, being about four times more biologically active than T_4. It is formed mostly by peripheral conversion from T_4.

Deiodinases of several types are selenoproteins.

All iodothyronines are highly hydrophobic and transported in plasma bound to proteins: **thyroxine-binding globulin, TBG** (over 70 %), **albumin** (about 20 %), and **transthyretin** (prealbumin).

The biological activity of the hormone is determined by the free fraction that is much less than 1 % of the total circulating amount.

Control of thyroid secretion

Synthesis and release of triiodothyronines is controlled by **thyroid-stimulating hormone** (TSH, thyrotropin) produced by the anterior pituitary, the secretion of whgich is in turn regulated by **thyrotropin-releasing hormone** (TRH, thyroliberin), formed in the hypothalamus.

Ther is **negative feedback by T_3 and T_4** mainly on TSH and also on TRH secretion.

Laboratory tests of thyroid function

Thyrotropin	Serum **TSH**	0,5 - 5 mU/l
Free thyroxine	Serum **fT_4**	10 - 25 **pmol/l**
Free triiodothyronine	Serum fT_3	3 - 9 pmol/l

(obsolete tests: serum total T_4 $(t)T_4$ 55 - 150 **nmol/l**
total T_3 $(t)T_3$ 1,2 - 3,0 nmol/l
free thyroxine index FT_4 I 4 - 13)

Serum TBG (thyroxine-binding globulin) 6 - 25 mg/l
Serum thyroglobulin 3 - 12 µg/l, less than 60 µg/l

TRH stimulation test - 200 µg TRH i.v., increase in TSH by 2 - 25 mU/l after 20 min

Thyroperoxidase antibodies (TPOAb)
TSH-receptors stimulating antibodies (TRAb[stim])
Thyroglobulin antibodies (anti-TG)

Thyroid biopsy – activities of thyroid enzymes

Thyroid imaging - ultrasonography, magnetic resonance or radionuclide imaging

Clinical classification of thyreopathies

INBORN ERRORS of hormone synthesis – **neonatal hypofunction** (normal foetus development enabled by mother's triiodothyronines)

IODIDE DEFICIENCY

- **endemic cretinism** (children born with serious and irreversible somatic and mental defects),
- **abnormalities of somatic, sexual, and psychic development**,
- **goitre** (non-toxic struma) – euthyroid or hypothyroid.

NONTOXIC STRUMAE - benign forms and **malignant tumours**

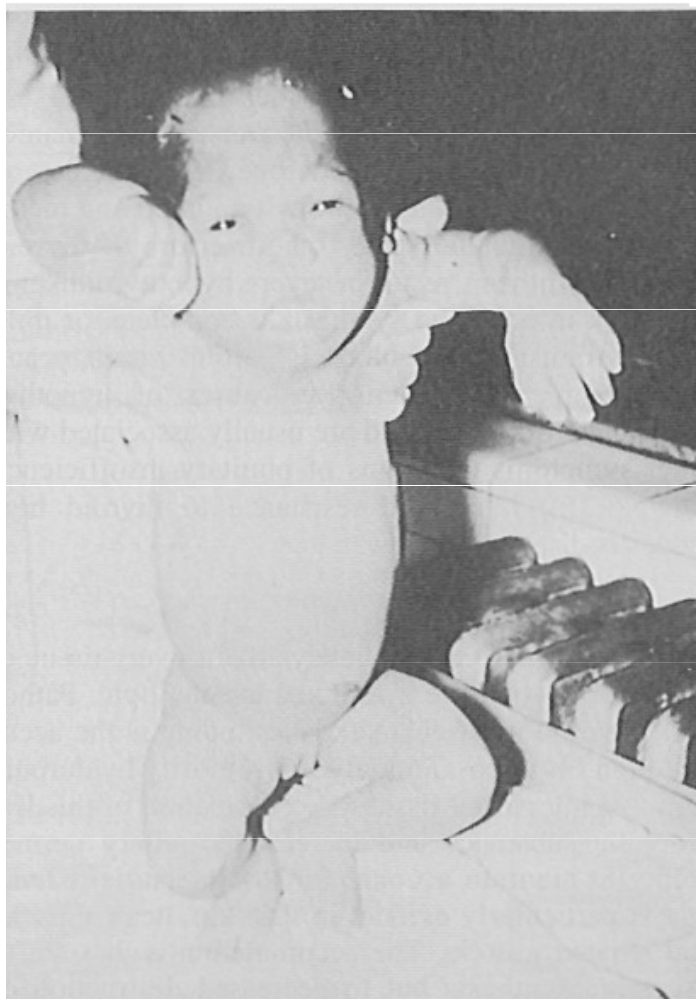
THYROIDITIS – subacute, more oft **chronic autoimmune thyroiditis** in women (incl. lymphocytary **Hashimoto´s** form,), etc.

DYSFUNCTIONS

- **hypothyroidism - primary** (peripheral) – consequence of chronic thyroiditis, artificial (radioactive iodine therapy, excessive iodide intake),
- **secondary** (central) due to hypopituitarism,
- **thyreotoxicosis** – e.g.. **autoimmune Graves´-Basedow´s disease** or rare **central** or **ectopic** form of thyreotoxicosis.

Cretinism

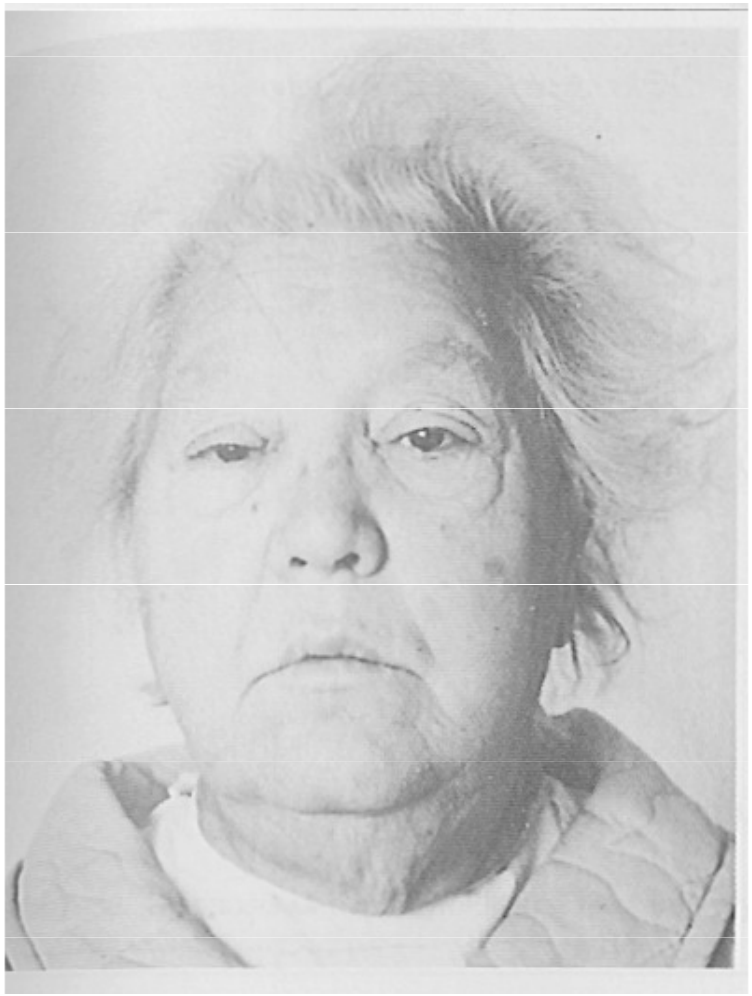
A 9-month-old infant – puffy face, protuberant abdomen, umbilical hernia, and muscle weakness (infant cannot sit up unassisted)



Endemic cretinism -

myxoedematous form
(eastern Moravia, in about 1930)

Hypothyroidism in adult individual (myxoedema)



Puffy face and eyes, frowsy hair, dull and apathetic appearance.

(A cool, rough, dry skin, a hoarse, husky voice, and slow reflexes.)

Bodies of adult individuals contain about 15 – 20 mg of iodine (70 - 80 % in the thyroid gland). Iodide anions are supplied in the diet..

For adults, the **recommended daily intake is 150 - 200 μg.**

Seafood and sea grass are rich sources of iodine (see table).

In inland areas, the intake of iodine depends mainly on iodide concentration in drinking water, which is oft insufficient.

Iodide deficiency causes hypothyroidism: in the school age, cognitional abilities may be diminished, up to mental, somatic, and sexual retardation, or goitre. The extreme form of iodine deficiency is cretinism in infants, myxoedema in adults.

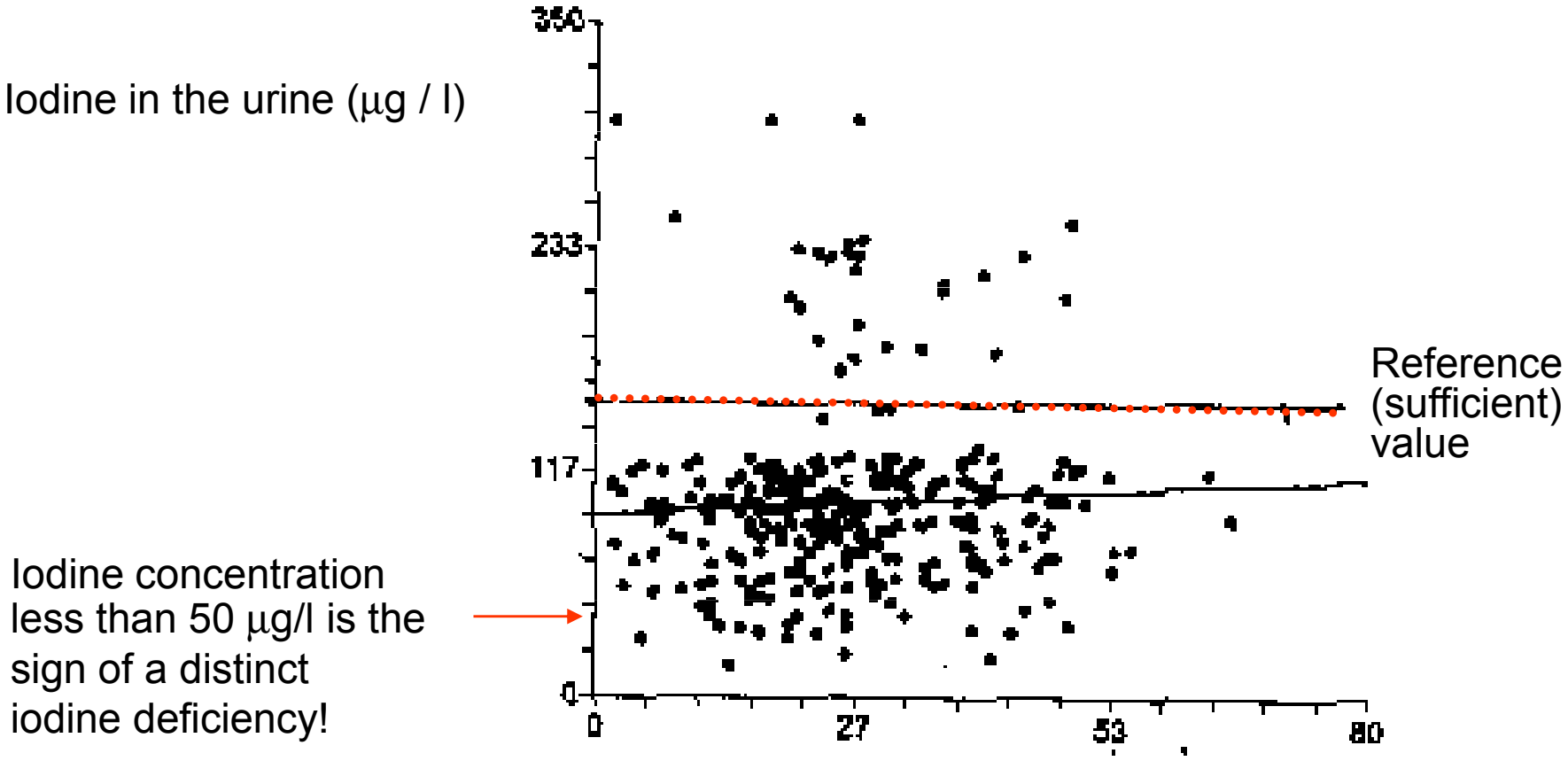
Inhabitants of many world territories are affected by iodine deficiency. A preventive measure against iodine deficiency is **iodizing of table salt** (on average, addition of 35 mg iodine, i.e. 60 mg KIO_3 per kilogram of table salt). However, it is also necessary to ensure an iodization of the **salt used in large-scale food production**, as well a sufficient iodine supply in **infant food** and to those who limit salting their meals or don't salt at all.

Iodine content in foodstuffs

	Iodine µg / 100 g		Iodine µg / 100 g
Cod-fish, mackerel (fresh, smoked)	120 - 240	Cabbage	12 - 15
Sardines in oil	20 - 30	Bread	2 - 8
Frozen fish fillet	5 - 30	Potatoes	0.5 - 4
Pork liver	14	Apples	2
Eggs	10	White bread	2
Milk, cheese	5 - 15		

About 67 % iodine is excreted into the urine, some non-polar thyronine metabolites are excreted into the bile.

The intake of iodine is usually assessed by means of **determination of iodine concentration in urine** (morning samples).



In insufficient iodine intake, a long-term supplementation with small doses of potassium iodide (about 150 µg daily) or sodium iodide is recommended.

The basal differential diagnosis of thyroid dysfunction