



COD LIVER OIL

This monograph is intended to serve as a guide to industry for the preparation of Product Licence Applications (PLAs) and labels for natural health product market authorization. It is not intended to be a comprehensive review of the medicinal ingredient.

Notes

- Text in parentheses is additional optional information which can be included on the PLA and product label at the applicant's discretion.
- The solidus (/) indicates that the terms or the statements are synonymous. Either term or statement may be selected by the applicant.
- The use(s) or purpose(s) statements in this monograph are based on the efficacy of vitamin A, vitamin D, eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA) that are present in cod liver oil. The references used to support these statements refer to the efficacy of these individual constituents and are not specific to cod liver oil.
- Consult Appendix 1 for Adequate Intake (AI), Recommended Dietary Allowance (RDA) and Tolerable Upper Intake Level (UL) definitions for nutrient intake. Refer also to Table 8 in Appendix 2 for RDA and AI values for vitamin A, and to Table 9 in Appendix 3 for RDA and AI values for vitamin D.

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Proper name(s)

Cod liver oil (Ph.Eur. 2012; USP 35)

Common name(s)

Cod liver oil (Ph.Eur. 2012; USP 35)

Source material(s)

Oil from one or more of the following sources in its natural triglyceride/triacylglycerol form and/or its concentrated esterified form:

- ▶ Liver of Atlantic cod, *Gadus morhua* L. (Gadidae) (Ph.Eur. 2012; USP 35; ITIS 2004)
- ▶ Liver of Greenland cod, *Gadus ogac* Richardson (Gadidae) (Ph.Eur. 2012; USP 35; ITIS 2004)
- ▶ Liver of Pacific cod, *Gadus macrocephalus* Tilesius (Gadidae) (Ph.Eur. 2012; USP 35; ITIS 2004)
- ▶ Liver from Arctic cod, *Arctogadus glacialis* Peters (1872) (Gadidae) (Ph.Eur. 2012; USP 35; ITIS 2004)

- ▶ Liver from all species of Gadidae (Cod family) (BP 2012; Ph.Eur. 2012; USP 35)

Note

- ▶ “Atlantic cod, *Gadus morhua*”, “Greenland cod, *Gadus ogac*”, “Pacific cod, *Gadus macrocephalus*”, “Arctic cod, *Arctogadus glacialis*” or any other species of Gadidae must be indicated on the PLA and label as source material information.
- ▶ Refer to Appendix 4 for a complete listing of species in the Family Gadidae (Cod).

Route(s) of administration

Oral

Dosage form(s)

- ▶ The acceptable pharmaceutical dosage forms include, but are not limited to capsules, chewables (e.g. gummies, tablets), liquids, powders, strips or tablets.
- ▶ This monograph is not intended to include foods or food-like dosage forms such as bars, chewing gums or beverages.

Use(s) or Purpose(s)

Statement(s) to the effect of:

For products providing daily doses of vitamin A at or above the Recommended Dietary Allowance (RDA) or Adequate Intake (AI) (adjusted for the life stage groups):
Helps to prevent vitamin A deficiency (IOM 2006; Shils et al. 2006; Groff and Gropper 2000).

For products providing daily doses of vitamin D at or above the Recommended Dietary Allowance (RDA) or Adequate Intake (AI) (adjusted for the life stage groups):
Helps to prevent vitamin D deficiency (IOM 2011, 2006, 1997; Shils et al. 2006; Groff and Gropper 2000).

For products providing 138-3,000 µg retinol activity equivalents (RAE) (µg vitamin A/all-*trans* retinol (palmitate)), per day:

- ▶ Helps to maintain eyesight, skin membranes and immune function (IOM 2006; Shils et al. 2006; Groff and Gropper 2000).
- ▶ Helps in the development and maintenance of night vision (IOM 2006; Shils et al. 2006; Groff and Gropper 2000).
- ▶ Source of vitamin A, a factor in the maintenance of good health (IOM 2006)

For products providing 1.15-25 µg vitamin D₃/cholecalciferol, per day:

- ▶ Helps in the development and maintenance of bones and teeth (IOM 2011; Shils et al. 2006).
- ▶ Helps in the absorption and use of calcium and phosphorus (IOM 2011; Shils et al. 2006; Groff and Gropper 2000).
- ▶ Source of vitamin D, a factor in the maintenance of good health (IOM 2011).

For products providing 100-1,360 mg eicosapentaenoic acid (EPA) + docosahexaenoic acid (DHA), per day:

- ▶ Source of omega-3 fatty acids for the maintenance of good health (Simopoulos 2007; Oh 2005; IOM 2002; Simopoulos 1999)
- ▶ Source of eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA) for the maintenance of good health (Simopoulos 2007; Oh 2005; IOM 2002; Simopoulos 1999)

For products providing 100-1,360 mg EPA + DHA including at least 100 mg DHA, per day:
Helps support cognitive health and/or brain function (van de Rest et al. 2008; Freund-Levi et al. 2006; Fontani et al. 2005a,b; Haag 2003; Morris et al. 2003; IOM 2002).

For products providing 150-1,360 mg EPA + DHA including at least 150 mg DHA, per day (maximum doses of EPA + DHA in Table 4 below will apply):

Helps support the development of the brain, eyes and nerves in children up to 12 years of age (Agostini 2008; Helland et al. 2008; Ryan and Nelson 2008; Marszalek and Lodish 2005; Haag 2003; IOM 2002; Giedd et al. 1999; Mills 1999).

Dose(s)

Note

The potencies of vitamin A, vitamin D₃ and EPA + DHA must be indicated on the PLA and label, in addition to the dose of Cod liver oil.

Quantities

Table 1 Daily dose for cod liver oil¹

Life stage group		Cod liver oil			
		Minimum ²		Maximum ⁴	
		(ml/day) ⁵	(g/day)	(ml/day)	(g/day)
Infants	0-12 mo	0.83	0.77	0.87	0.80
Children	1-3 y	0.83	0.77	0.87	0.80
	4-8 y	0.83	0.77	1.3	1.2
Adolescents	9-13 y	0.83	0.77	2.4	2.2
	14-18 y	0.83	0.77	4.0	3.7
Adults ³	≥ 19 y	0.83	0.77	4.3	4.0

¹ BP 2012, Ph.Eur. 2012 or USP 35 grade Cod liver oil must be used to ensure that potencies of vitamin A, vitamin D₃ and EPA + DHA listed in Tables 2, 3 and 4 are met.

² The minimum dose of Cod liver oil is based on the minimum quantities of EPA + DHA required for efficacy.

³ Includes pregnant and breastfeeding women.

⁴ For all subpopulations, the maximum dose is based on the quantity of Cod liver oil providing the maximum daily amount of vitamin A, in µg RAE, according to the UL (IOM 2006).

⁵ Based on the specific gravity of Cod liver oil (USP 35)

Potencies

Table 2 Potency¹ for vitamin A palmitate/all-*trans* retinol palmitate in cod liver oil

Life stage group		Vitamin A (µg RAE/day)	
		Minimum ¹	Minimum ² / Maximum ³
Infants	0-12 mo	138	600
Children	1-3 y	138	600
	4-8 y	138	900
Adolescents	9-13 y	138	1,700
	14-18 y	138	2,800
Adults ⁴	≥ 19 y	138	3,000

¹ References for the potency of vitamin A are: BP 2012, Ph.Eur. 2012, and Tischer 1938.

² Calculated as the minimum amount of vitamin A available in 0.77 g Cod liver oil, which is based on the minimum quantities of EPA + DHA required for efficacy.

³ Maximum potency based on the UL (IOM 2006).

⁴ Includes pregnant and breastfeeding women.

Table 3 Potency¹ for vitamin D₃/cholecalciferol in cod liver oil

Life stage group		Vitamin D ₃ (µg/day)	
		Minimum ²	Maximum ³
Infants	0-12 mo	1.15	5.00
Children	1-3 y	1.15	5.00
	4-8 y	1.15	7.50
Adolescents	9-13 y	1.15	14.06
	14-18 y	1.15	23.12
Adults ⁴	≥ 19 y	1.15	25.00

¹ References for the potency of Vitamin D₃ are: BP 2012, Ph.Eur. 2012, and Green 1951.

² Based on the minimum amount of vitamin D₃ available in 0.77 g Cod liver oil, and supported by the RDA and AI for vitamin D₃ (IOM 2011, 2006). See Appendix 1 for definitions and Table 9 in Appendix 3 for RDA and AI values.

³ For all subpopulations, the maximum potencies are based on the amount of vitamin D₃ available in the quantity of Cod liver oil which provides the maximum daily amount of vitamin A, in µg RAE, according to the UL (IOM 2006).

⁴ Includes pregnant and breastfeeding women.

Table 4 Potency¹ for EPA + DHA in cod liver oil

Life stage group		EPA + DHA (mg/day)	
		Minimum ²	Maximum ³
Infants ⁴	0-12 mo	100	272
Children	1-3 y	100	272
	4-8 y	100	408
Adolescents	9-13 y	100	765
	14-18 y	100	1,258
Adults ⁵	≥ 19 y	100	1,360

¹ References for the potency of EPA + DHA are: BP 2012 and Ph.Eur. 2012.

² Restrictions to minimum potency may apply according to Use(s) or Purpose(s) section above.

³ For all subpopulations, the maximum potencies are based on the amount of EPA + DHA available in the quantity of Cod liver oil which provides the maximum daily amount of vitamin A, in µg RAE, according to the UL (IOM 2006).

⁴ USP 35; Rajakumar and Thomas 2005; Stene et al 2003; Linday et al. 2002.

⁵ Includes pregnant and breastfeeding women.

Duration(s) of use

No statement required.

Risk information

Caution(s) and warning(s)

No statement required.

Contraindication(s)

No statement required.

Known adverse reaction(s)

No statement required.

Storage condition(s) Statement(s) to the effect of:

For all products:

Store in airtight container, protected from light (Ph.Eur. 2012; USP 35).

For all products, except those encapsulated:

Refrigerate after opening (Wille and Gonus 1989).

Non-medicinal ingredients

Must be chosen from the current NHPD *Natural Health Products Ingredients Database* and must meet the limitations outlined in the database.

Specifications

- ▶ The finished product must comply with the minimum specifications outlined in the current NHPD *Compendium of Monographs*.
- ▶ The medicinal ingredient may comply with the specifications outlined in the pharmacopoeial monographs listed in Table 5 below.
- ▶ Peroxide, anisidine, and totox values of cod liver oil and omega-3 fatty acids derived from cod liver oil must be in accordance with the methods set out by the Association of Analytical Communities (AOAC) and/or Pharmacopoeial analytical methods. These specifications are necessary to ensure the oxidative stability of the cod liver oil and the omega-3 fatty acids from cod liver oil (HC 2007). Refer to Table 6 below.
- ▶ The dioxins, polychlorinated dibenzo-para-dioxins (PCDDs) and polychlorinated dibenzofurans (PCDFs); the dioxin-like polychlorinated biphenyls (DL PCBs); and the polychlorinated biphenyls (PCBs) are contaminants in marine oils. Testing for these contaminants are required and must be performed using either the analytical method of the European Commission Regulation EU 252/2012 (EU 2012) or the U.S. Environmental Protection Agency's method 1613B for PCDDs and PCDFs and method 1668A for PCBs (USP 35; US EPA 2010, 2008, 1994). Applicants are advised to consult the Council of the European Union document on these contaminants for further information (EU 2011). Refer to Table 7 below.

Table 5 Cod Liver Oil Monographs published in the American (USP), British (BP) and European (Ph.Eur.) Pharmacopoeias

Pharmacopoeia	Monograph
BP	Cod-Liver Oil (Type A) Cod-Liver Oil (Type B)
Ph.Eur.	Cod-Liver Oil, Farmed Cod-Liver Oil (Type A) Cod-Liver Oil (Type B)
USP	Cod Liver Oil

Table 6 Maximum values of oxidative stability parameters for oils from cod liver (HC 2007)

Oxidative stability parameter	Maximum value
Peroxide value (PV)	5 mEq/kg
<i>p</i> -Anisidine value (AV)	20
Totox value	26 (calculated as (2 x PV) + AV)

Table 7 Maximum levels of dioxins, dioxin-like polychlorinated biphenyls (DL PCB) and polychlorinated biphenyls (PCB) in oils from marine sources

Dioxin, DL PCB, and PCB contaminants	Maximum level	
	EU 1259/2011	USP 35
Dioxins (sum of PCDDs + PCDFs) ^{1,2}	1.75 pg/g	1.0 pg/g
Sum of dioxins and DL PCBs ^{1,3}	6 pg/g	
PCBs ⁴	200 ng/g	0.5 ppm ⁵

¹ Expressed in World Health Organization (WHO) toxic equivalents using WHO-toxic equivalent factors (TEFs). Analytical results relating to 17 individual dioxin congeners of toxicological concern are expressed in a single quantifiable unit: 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD) toxic equivalent concentration (TEQ) (USP 35; EU 2011).

² Sum of dioxins: WHO-PCDD/F-TEQ (USP 35; EU 2011)

³ Sum of dioxins and dioxin-like PCBs: WHO-PCDD/F-PCB-TEQ (EU 2011)

⁴ Sum of PCB congeners 28, 52, 101, 118, 138, 153 and 180 (USP 35; EU 2011)

⁵ Equivalence: 0.5 ppm = 500 ng/g

References cited

Agostoni C. 2008. Role of long-chain polyunsaturated fatty acids in the first year of life. *Journal of Pediatric Gastroenterology and Nutrition* 47(Suppl 2):S41-S44.

BP 2012: British Pharmacopoeia 2012. London (GB): The Stationary Office on behalf of the Medicines and Healthcare products Regulatory Agency (MHRA); 2011.

EU 2012: European Commission. Commission Regulation (EU) No 252/2012 of 21 March 2012 laying down the methods of sampling and analysis for the official control of levels of dioxins and dioxin-like PCBs and non-dioxin-like PCBs in certain foodstuffs and repealing Regulation (EC) No 1883/2006. *Official Journal of the European Union* L 84/1 23.3.2012 [Internet]. [Accessed 2012 June 29]. Available from: <http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2012:084:0001:0022:EN:PDF>

EU 2011: European Commission. Commission Regulation (EU) No 1259/2011 of 2 December 2011 amending Regulation (EC) No 1881/2006 as regards maximum levels for dioxins, dioxin-like PCBs and non dioxin-like PCBs in foodstuffs. *Official Journal of the European Union* L 320/18 3.12.2011 [Internet]. [Accessed 2012 June 29]. Available from: <http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2011:320:0018:0023:EN:PDF>

Fontani G, Corradeschi F, Felici A, Alfatti F, Bugarini R, Fiaschi AI, Cerretani D, Montorfano G, Rizzo AM, Berra B. 2005a. Blood profiles, body fat and mood state in healthy subjects on different diets supplemented with omega-3 polyunsaturated fatty acids. *European Journal of Clinical Investigation* 35(8):499-507.

Fontani G, Corradeschi F, Felici A, Alfatti F, Migliorini S, Lodi L. 2005b. Cognitive and physiological effects of omega-3 polyunsaturated fatty acid supplementation in healthy subjects. *European Journal of Clinical Investigation* 35(11):691-699.

Freund-Levi Y, Eriksdotter-Jonhagen M, Cederholm T, Basun H, Faxen-Irving G, Garlind A, Vedin I, Vessby B, Wahlund LO, Palmblad J. 2006. Omega-3 fatty acid treatment in 174 patients with mild to moderate Alzheimer disease: OmegAD study. *Archives of Neurology* 63(10):1402-1408.

Giedd JN, Blumenthal J, Jeffries NO, Castellanos FX, Liu H, Zijdenbos A, Paus T, Evans AC, Rapoport JL. 1999. Brain development during childhood and adolescence: a longitudinal MRI study. *Nature Neuroscience* 2(10):861-863.

Green J. 1951. The chemical determination of Vitamin D in fish-liver oils and other materials containing Vitamin A [online]. *Biochemistry Journal* 49(part 2):243-246. [Accessed 2012 January 12]. Available at: <http://www.biochemj.org/bj/049/0243/0490243.pdf>

Groff J, Gropper S. 2000. *Advanced Nutrition and Human Metabolism*, 3rd edition. Belmont (CA): Wadsworth/Thomson Learning.

Haag M. 2003. Essential fatty acids and the brain. *The Canadian Journal of Psychiatry* 48(3):195-203.

HC 2007: Health Canada. Evidence for Quality of Finished Natural Health Products Version 2.0 [Internet]. Ottawa (ON): Natural Health Products Directorate, Health Canada. [Accessed 2012 January 11]. Available from: http://www.hc-sc.gc.ca/dhp-mps/prodnatur/legislation/docs/eq-paq_e.html

Helland IB, Smith L, Blomén B, Saarem K, Saugstad OD, Drevon CA. 2008. Effect of supplementing pregnant and lactating mothers with n-3 very-long-chain fatty acids on children's IQ and body mass index at 7 years of age. *Pediatrics* 122(2):e472-e479.

IOM 2011: Institute of Medicine. Ross AC, Taylor CL, Yaktine AL, Del Valle HB, editors. 2011. *Dietary Reference Intakes for Calcium and Vitamin D*. Washington (DC): National Academies Press.

IOM 2006: Institute of Medicine. Otten JJ, Pitz Hellwig J, Meyers LD, editors. 2006. *Institute of Medicine Dietary Reference Intakes: The Essential Guide to Nutrient Requirements*. Washington (DC): National Academies Press.

IOM 2002: Institute of Medicine. Food and Nutrition Board. 2002. *Dietary Reference Intakes for Energy, Carbohydrate, Fiber, Fat, Fatty Acids, Cholesterol, Protein, and Amino Acids*. Washington (DC): National Academy Press.

IOM 1997: Institute of Medicine. Standing Committee on the Scientific Evaluation of Dietary Reference Intakes, Food and Nutrition Board, Institute of Medicine. 1997. *Dietary Reference Intakes for Calcium, Phosphorous, Magnesium, Vitamin D, and Fluoride*. Washington (DC): National Academies Press.

ITIS 2004: Integrated Taxonomic Information System database [Internet]. Arctic cod/polar cod, *Arctogadus glacialis* Peters(, 1872), Atlantic cod, *Gadus morhua* L., Greenland cod, *Gadus ogac* Richardson, and Pacific cod, *Gadus macrocephalus* Tilesius, other species of the family Gadidae. Washington (DC): Integrated Taxonomic Information System. [Accessed 2012 March 23]. Available from: <http://www.itis.gov>.

Linday LA, Dolitsky JN, Shindledecker RD, Pippenger CE. 2002. Lemon-flavored cod liver oil and a multivitamin-mineral supplement for the secondary prevention of otitis media in young children: pilot research. *Annals of Otolaryngology, Rhinology and Laryngology* 111(7 Pt 1):642-52.

Marszalek JR, Lodish HF. 2005. Docosahexaenoic acid, fatty acid-interacting protein, and neuronal function: breastmilk and fish are good for you. *Annual Review of Cell and Developmental Biology* 21:633-657.

Mills, MD. 1999. The eye in childhood. *American Family Physician* 60(3):907-918.

Morris MC, Evans DA, Bienias JL, Tangney CC, Bennett DA, Wilson RS, Aggarwal N, Schneider J. 2003. Consumption of fish and n-3 fatty acid and risk of incident Alzheimer disease. *Archives of Neurology* 60(7):940-946.

Nelson JS. 2006. *Fishes of the World*, 4th edition. Hoboken (NY): John Wiley & Sons.

Oh R. 2005. Practical applications of fish oil (Omega-3 fatty acids) in primary care. *Journal of the American Board of Family Practice* 18(1):28-36.

Ph.Eur. 2012: *European Pharmacopoeia*, 8th edition. Strasbourg (FR): Directorate for the Quality of Medicines and HealthCare of the Council of Europe (EDQM), 2012.

Rajakumar K, Thomas SB. 2005. Reemerging nutritional rickets: a historical perspective. *Archives of Pediatrics & Adolescent Medicine* 159(4):335-341.

Ryan AS, Nelson EB. 2008. Assessing the effect of docosahexanoic acid on cognitive functions in heal preschool children: a randomized, controlled, double-blind study. *Clinical Pediatrics* 47(4):355-362.

Shils ME, Olson JA, Shike M, Ross AC, Caballero B, Cousins RJ, editors. 2006. *Modern Nutrition in Health and Disease*, 10th edition. Philadelphia (PA): Lippincott Williams & Wilkins.

Simopoulos AP. 2007. Omega-3 fatty acids and athletics. *Current Sports Medicine Reports* 6(4):230-236.

Simopoulos AP. 1999. Essential fatty acids in health and chronic disease. *The American Journal of Clinical Nutrition* 70(3 Suppl):560S-569S.

Stene LC, Joner G. 2003. Use of cod liver oil during the first year of life is associated with lower risk of childhood-onset type 1 diabetes: a large, population-based, case-control study. *The American Journal of Clinical Nutrition* 78(6):1128-1134.

Tischer AO. 1938. The Nature of Vitamin A in Cod Liver Oil [Internet]. *Journal of Biological Chemistry* 125:475-477. [Accessed 2012 January 11]. Available from: <http://www.jbc.org/content/125/2/475.full.pdf+html>

US EPA 2010: United States Environmental Protection Agency. April 2010. Method 1668C: Chlorinated Biphenyl Congeners in Water, Soil, Sediment, Biosolids, and Tissue by HRGC/HRMS [Internet]. Washington (DC): Engineering and Analysis Division, Office of Science and Technology, Office of Water, U.S. Environmental Protection Agency. [Accessed 2012 March 23]. Available from: http://water.epa.gov/scitech/methods/cwa/upload/M1668C_11June10-PCB_Congeners.pdf

US EPA 2008: United States Environmental Protection Agency. November 2008. Method 1668B: Chlorinated Biphenyl Congeners in Water, Soil, Sediment, Biosolids, and Tissue by HRGC/HRMS [Internet]. Washington (DC): Engineering and Analysis Division, Office of Science and Technology, Office of Water, U.S. Environmental Protection Agency. [Accessed 2012 March 23]. Available from: http://water.epa.gov/scitech/methods/cwa/bioindicators/upload/2009_01_07_methods_method_1668.pdf

US EPA 1994: United States Environmental Protection Agency. October 1994. Method 1613, Revision B: Tetra- through Octa-Chlorinated Dioxins and Furans by Isotope Dilution HRGC/HRMS [Internet]. Washington (DC): Engineering and Analysis Division, Office of Water, U.S. Environmental Protection Agency. [Accessed 2012 March 23]. Available from: http://water.epa.gov/scitech/methods/cwa/organics/dioxins/upload/2007_07_10_methods_method_dioxins_1613.pdf

USP 35: United States Pharmacopeia and the National Formulary (USP 35 - NF 30). Rockville (MD): The United States Pharmacopeial Convention; 2012.

van de Rest O, Geleijnse JM, Kok JF, van Staveren WA, Dullemeijer C, OldeRikkert MGM, Beekman ATF, de Groot CPGM. 2008. Effect of fish oil on cognitive performance in older subjects: a randomized, controlled trial. *Neurology* 71(6):430-438.

Wille HJ, Gonus P. 1989. Preparation of Fish Oil for Dietary Applications. In: Galli C, Simopolous AP, editors. *Dietary ω 3 and ω 6 Fatty Acids. Biological Effects and Nutritional Essentiality*. New York (NY): Plenum Press.

References reviewed

Bisby FA, Roskov YR, Orrell TM, Nicolson D, Paglinawan LE, Bailly N, Kirk PM, Bourgoin T, Baillargeon G, editors. 2009. *Species 2000 & ITIS (Integrated Taxonomic Information System)*

Catalogue of Life: 2009 Annual Checklist. *Gadus morhua*. [online]. Reading (GB): Species 2000 & ITIS. [Accessed 2012 January 11]. Available at: http://www.catalogueoflife.org/show_species_details.php?record_id=6225413

Brox J, Olaussen K, Osterud B, Elvevoll EO, Bjørnstad E, Brattebø G, Iversen H. 2001. A long-term seal- and cod-liver-oil supplementation in hypercholesterolemic subjects. *Lipids* 36(1):7-13.

Brunborg LA, Madland TM, Lind RA, Arslan G, Berstad A, Frøyland L. 2008. Effects of short-term oral administration of dietary marine oils in patients with inflammatory bowel disease and joint pain: a pilot study comparing seal oil and cod liver oil. *Clinical Nutrition* 27(4):614-622.

Commission of the European Communities. Commission Regulation (EC) No 1883/2006 of 19 December 2006 laying down the methods of sampling and analysis for the official control of levels of dioxins and dioxin-like PCBs in certain foodstuffs. *Official Journal of the European Union* L 364/32 20.12.2006 [Internet]. [Accessed 2012 March 23]. Available from: <http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2006:364:0032:0043:EN:PDF>

Commission of the European Communities. Commission Regulation (EC) No 1881/2006 of 19 December 2006 setting maximum levels for certain contaminants in foodstuffs. *Official Journal of the European Union* L 364/5 20.12.2006 [Internet]. [Accessed 2012 March 23]. Available from: <http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2006:364:0005:0024:EN:PDF>

Committee on the Status of Endangered Wildlife in Canada (COSEWIC) [Internet]. Ottawa (ON): Environment Canada, Canadian Wildlife Service, 2011. [Atlantic cod last examined April 2010; Accessed 2012 February 28]. Available from: <http://www.cosewic.gc.ca>

Council for Responsible Nutrition. March 2006. VOLUNTARY MONOGRAPH for Omega-3 DHA, Omega-3 EPA, Omega-3 DHA & EPA. [Accessed 2012 January 11]. Available at: <http://www.crnusa.org/pdfs/O3FINALMONOGRAPHdoc.pdf>

Environment Canada. Species at Risk Public Registry. [Internet]. Ottawa (ON): Environment Canada. 2008. [Atlantic cod Date Modified: 09/07/2011; Accessed 2012 February 28]. Available from: <http://www.sararegistry.gc.ca>
http://www.sararegistry.gc.ca/search/advSearchResults_e.cfm?stype=species&advkeywords=Atlantic%20cod

European Union. Commission Regulation (EC) No 2375/2001 of 29 November 2001 amending Regulation (EC) No 466/2001 setting maximum levels for certain contaminants in foodstuffs. *Official Journal of the European Communities* L 321/1 6.12.2001. [Internet]. [Accessed 2012 March 23]. Available from: <http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2001:321:0001:0005:EN:PDF>

Galarraga B, Ho M, Youssef HM, Hill A, McMahon H, Hall C, Ogston S, Nuki G, Belch JJ. 2008. Cod liver oil (n-3 fatty acids) as a non-steroidal anti-inflammatory drug sparing agent in rheumatoid arthritis. *Rheumatology (Oxford)* 47(5):665-669.

Giacoa GP, Taylor-Zapata P, Mattison D. Eunice Kennedy Shriver National Institute of Child Health and Human Development Pediatric Formulation Initiative: selected reports from working groups. *Clinical Therapeutics* 2008;30(11):2097-2101.

Hansen JB, Berge LN, Svensson B, Lyngmo V, Nordøy A. 1993. Effects of cod liver oil on lipids and platelets in males and females. *European Journal of Clinical Nutrition* 47(2):123-131.

Helland IB, Smith L, Saarem K, Saugstad OD, Drevon CA. 2003. Maternal supplementation with very-long-chain n-3 fatty acids during pregnancy and lactation augments children's IQ at 4 years of age. *Pediatrics* 111(1):e39-e44.

Helland IB, Saugstad OD, Smith L, Saarem K, Solvoll K, Ganes T, Drevon CA. 2001. Similar effects on infants of n-3 and n-6 fatty acids supplementation to pregnant and lactating women. *Pediatrics* 108(5):E82.

Osterud B, Elvevoll E, Barstad H, Brox J, Halvorsen H, Lia K, Olsen JO, Olsen RL, Sissener C, Rekdal O, et al. 1995. Effect of marine oils supplementation on coagulation and cellular activation in whole blood. *Lipids* 30(12):1111-1118.

Skúladóttir GV, Gudmundsdóttir E, Olafsdóttir E, Gudmundsson TV, Hardarson T, Kristinsson A, Asvaldsdóttir H, Snorrason SP, Gudbjarnason S. 1990. Influence of dietary cod liver oil on fatty acid composition of plasma lipids in human male subjects after myocardial infarction. *Journal of Internal Medicine* 228(6):563-568.

Stene LC, Ulriksen J, Magnus P, Joner G. 2000. Use of cod liver oil during pregnancy associated with lower risk of Type I diabetes in the offspring. *Diabetologia* 43(9):1093-1098.

US FDA 2005: United States Food and Drug Administration 2005. 21 CFR 184 Rules and Regulations: Final rule. Substances Affirmed as Generally Recognized as Safe: Menhaden Oil. Federal Register: March 23, 2005 Volume 70, Number 55:14530-14532. Docket No. 1999P-5332 [Internet]. Silver Spring (MD): United States Department of Health and Human Services, United States Food and Drug Administration. [Accessed 2012 January 11]. Available from: <http://www.fda.gov/OHRMS/DOCKETS/98fr/05-5641.pdf>

Vognild E, Elvevoll EO, Brox J, Olsen RL, Barstad H, Aursand M, Osterud B. 1998. Effects of dietary marine oils and olive oil on fatty acid composition, platelet membrane fluidity, platelet responses, and serum lipids in healthy humans. *Lipids* 33(4):427-436.

Appendix 1 Definitions

Adequate Intake (AI): The recommended average daily intake level based on observed or experimentally determined approximations or estimates of nutrient intake by a group (or groups) of apparently healthy people that are assumed to be adequate. An AI is used when a Recommended Dietary Allowance (RDA) cannot be determined (IOM 2006).

Recommended Dietary Allowance (RDA): The average daily dietary nutrient intake level sufficient to meet the nutrient requirements of nearly all (97-98%) healthy individuals in a particular life stage and gender group (IOM 2006).

Tolerable Upper Intake Level (UL): The highest average daily nutrient intake level that is likely to pose no risk of adverse health effects to almost all individuals in the general population. As intake increases above the UL, the potential risk of adverse effects may increase (IOM 2006).

Appendix 2 Recommended Dietary Allowance (RDA) and Adequate Intake (AI) for vitamin A

Table 8 RDA and AI* values for vitamin A based on life stage group (IOM 2006)

Life stage group		Vitamin A (μg RAE/day)
Infants	0-6 mo	400*
	7-12 mo	500*
Children	1-3 y	300
	4-8 y	400
Adolescent males	9-13 y	600
	14-18 y	900
Adult males	≥ 19 y	900
Adolescent females	9-13 y	600
	14-18 y	700
Adult females	≥ 19 y	700
Pregnancy	14-18 y	750
	19-50 y	770
Breastfeeding	14-18 y	1,200
	19-50 y	1,300

Appendix 3 Recommended Dietary Allowance (RDA) and Adequate Intake (AI) for vitamin D

Table 9 RDA and AI* values for vitamin D based on life stage group (IOM 2011)

Life stage group		Vitamin D (µg/day)
Infants	0-6 mo	10*
	7-12 mo	10*
Children	1-3 y	15
	4-8 y	15
Adolescent Males	9-13 y	15
	14-18 y	15
Adult Males	19-30 y	15
	31-50 y	15
	51-70 y	15
	>70 y	20
Adolescent Females	9-13 y	15
	14-18 y	15
Adult Females	19-30 y	15
	31-50 y	15
	51-70 y	15
	>70 y	20
Pregnancy	14-18 y	15
	19-50 y	15
Breastfeeding	14-18 y	15
	19-50 y	15

Appendix 4 Species of the Family Gadidae (Nelson 2006)

Subfamily Gadinae

- Genus *Arctogadus* (Dryagin, 1932)
 - East Siberian cod (*Arctogadus borisovi*) (Dryagin, 1932)
 - Arctic cod (*Arctogadus glacialis*) (Peters, 1872)
- Genus *Boreogadus* (Günther, 1862)
 - Polar cod (*Boreogadus saida*) (Lepechin, 1774)
- Genus *Eleginus* (Fischer, 1813)
 - Saffron cod (*Eleginus gracilis*) (Tilesius, 1810)
 - Navaga (*Eleginus nawaga*) (Koelreuter, 1770)
- Genus *Gadiculus* (Guichenot, 1850)
 - Silvery cod (*Gadiculus argenteus argenteus*) (Guichenot, 1850)
 - *Gadiculus argenteus thori* (Schmidt, 1914)
- Genus *Gadus* (Linné, 1758)
 - Pacific cod (*Gadus macrocephalus*) (Tilesius, 1810)
 - Atlantic cod (*Gadus morhua*) (Linnaeus, 1758)
 - Greenland cod (*Gadus ogac*) (Richardson, 1836)

- Genus *Melanogrammus* (Gill, 1862)
 - Haddock (*Melanogrammus aeglefinus*) (Linnaeus, 1758)
- Genus *Merlangius* (Garsault, 1764)
 - Whiting (*Merlangius merlangus*) (Linnaeus, 1758)
- Genus *Microgadus* (Gill, 1865)
 - Pacific tomcod (*Microgadus proximus*) (Girard, 1854)
 - Atlantic tomcod (*Microgadus tomcod*) (Walbaum, 1792)
- Genus *Micromesistius* (Gill, 1863)
 - Southern blue whiting (*Micromesistius australis*) (Norman, 1937)
 - Blue whiting (*Micromesistius poutassou*) (Risso, 1827)
- Genus *Pollachius* (Nilsson, 1832)
 - Atlantic pollock (*Pollachius pollachius*) (Linnaeus, 1758)
 - Saithe (*Pollachius virens*) (Linnaeus, 1758)
- Genus *Theragra* (Lucas in Jordan & Evermann, 1898)
 - Alaska pollock (*Theragra chalcogramma*) (Pallas, 1814)
 - Norwegian pollock (*Theragra finnmarchica*) (Koefoed, 1956)
- Genus *Trisopterus* (Rafinesque, 1814)
 - Norway pout (*Trisopterus esmarkii*) (Nilsson, 1855)
 - Pouting (*Trisopterus luscus*) (Linnaeus, 1758)
 - Poor cod (*Trisopterus minutus*) (Linnaeus, 1758)

Subfamily Ranicipitinae

- Genus *Raniceps* (Oken, 1817)
 - Tadpole fish or tadpole cod (*Raniceps raninus*) (Linnaeus, 1758)

Subfamily Lotinae (cuskfishes)

- Genus *Lota* (Oken, 1817)
 - Burbot (*Lota lota*) (Linnaeus, 1758)
- Genus *Brosme* (Oken, 1817)
 - Brosme (cusk) (*Brosme brosme*) (Ascanius, 1772)
- Genus *Molva* (three species) (Lesueur, 1819)
 - Blue ling (*Molva dypterygia*) (Pennant, 1784)
 - Mediterranean ling (*Molva macrophthalma*) (Rafinesque, 1810)
 - European ling/drizzie (*Molva molva*) (Linnaeus, 1758)