Joint FAO/WHO Expert Consultation on Human Vitamin and Mineral Requirements

FAO, Bangkok, Thailand

September 21–30, 1998

PRELIMINARY REPORT ON
RECOMMENDED NUTRIENT INTAKES
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**Introduction**

A Joint FAO/WHO Expert Consultation on Human Vitamin and Mineral Requirements was held in the FAO Regional Office for Asia and the Pacific, Bangkok, Thailand, from 21 to 30 September 1998. The purpose of the consultation was to complement the information which had been provided through previous consultations for different nutrients, in order to provide current knowledge on all essential nutrients as the first step towards the production of a new edition of the Manual on Human Nutritional Requirements. The current edition of this publication dates back to 1974, and was therefore in need of re-editing.

The short preliminary report provided here gives only the practical endpoint of the work of the consultation, i.e. the recommended nutrient intakes (RNI) for essential vitamins and some minerals. This information has been put into 2 tables which are attached to this document as **Annexes 1a and 1b**. This information needs to be considered **provisional**, until the full report of the Expert Consultation on the subject has been released. Thus, the RNI information provided in tabular form is given as a preview of information to come with the final report. This **provisional report has been developed to meet the needs of a forthcoming meeting of the Codex Alimentarius Committee on Nutrition and Foods for Special Dietary Use which will meet in Berlin, June 19-23.** The full report of the Expert Consultation is expected to be available soon on the WHO web site with links from the FAO web site, and eventually in hard copy.

**Background**

For the purpose of preparation of the background papers, the following working definition of a recommended nutrient intake (RNI) was used. The RNI is the intake level sufficient to meet the daily nutrient requirements of most individuals in a specific life-stage and gender group, based on an estimated average nutrient requirement (EAR) plus two standard deviations above the mean: \( RNI = EAR + 2\text{SD}_{EAR} \).

Written documents providing the criteria that were used in the past to develop the FAO/WHO RNIs were made available to the Experts. These documents included the 1974 **FAO/WHO Handbook on Human Nutritional Requirements**, the 1988 **FAO/WHO Expert Consultation Report on the Requirements for Vitamin A, Iron, folate, and Vitamin B₁₂**, and the 1996 **FAO/WHO/IAEA Report on Trace Elements in Human Nutrition and Health**.

**Format and Terms of Reference**

The presentations addressed changes in the scientific knowledge base for each essential vitamin and mineral nutrient since the most recent FAO/WHO review of those nutrients was released. The Expert Panel made recommendations for the nutrient requirements, identified key issues for future research, and made preliminary recommendations for the handbook.

The terms of reference for the Expert Panel were the following:

- To review the full scope of vitamin and mineral requirements, including their role in normal human physiology and metabolism and in deficiency disease conditions. To focus on the requirements of the essential vitamins and
minerals, including vitamins A, C, D, E, and K; the B vitamins; calcium; iron; magnesium; zinc; selenium; and iodine.

➢ To draft and adopt a report which would provide recommended nutrient intakes for vitamins A, C, D, E, and K; the B vitamins; calcium; iron; magnesium; zinc; selenium; and iodine. The report is to provide practical advice and recommendations which will constitute an authoritative source of information to those from member countries who work in the area of nutrition, agriculture, food production and distribution, and health promotion. This report will form, in large part, the basis for a new edition of the FAO/WHO Handbook on Human Nutritional Requirements that was published in 1974 and last re-issued in 1980.

➢ To identify key issues for future research and make preliminary recommendations for the handbook.

Report of the Consultation

The Consultation was opened by Dr Prem Nath, Assistant Director-General/ Regional Representative for Asia and the Pacific, FAO, who welcomed the participants on behalf of the Director-General of FAO.

In welcoming the participants, Dr Nath recalled previous consultations on nutrients and made reference to the 1974 edition of the Handbook. Consultations such as this are part of a continuing commitment by both FAO and WHO to promote a reliable, nutritious, and safe food supply and to provide scientifically sound nutritional advice to member nations. This commitment was recently reaffirmed at the World Food Summit held in November 1996 in Rome.

Dr Nath spoke of the increasing evidence for the important role which vitamins and minerals play in preventing disease and promoting overall health. Indeed, the understanding of the role of micronutrients in foods and nutrition has significantly increased over the past 24 years. For many years the basic assumption upon which nutritionists make their projections, and which may still be the best assumption, has been that all nutrients can be obtained from a diet containing a variety of foods. There are some challenges to this assumption, however, and they rest in the complexities and diversity of world-wide realities, culture, and tradition. One important influence in this respect is the adoption of sedentary lifestyles and their health consequences.

Dr Nath pointed out that for many people with access to an adequate energy intake there is an extensive freedom of choice in the selection of food. However, the existence of widespread poverty in a majority of countries precludes the opportunity to consume adequate energy, let alone a diet balanced in micronutrients. He observed that the increase in the availability of a wide variety of foods and especially “fast foods” in almost every country in the world, coupled with the increasing pace of urban lifestyles across all cultures and countries, does not necessarily result in adequate vitamin and mineral intake.

The existence of the dichotomies in lifespan was also mentioned by Dr Nath. In different parts of the world and in different segments of society within the same countries, there are broad ranges of lifespans in part due to nutritional adequacy. Especially in urban populations, as lifespan increases as a result of nutritional adequacy and despite improved access to health care, an increase has been recorded in all regions
of the globe in obesity, diabetes, some forms of cancer, and cardiovascular disease. Although epidemiological studies do not provide us with cause-and-effect explanations, they do provide impetus for future research into the role of vitamins and minerals in the prevention and management of some non-communicable diseases.

Dr Nath reminded the participants that they had been invited to the Consultation as independent experts and that their participation in the Consultation was to be in their individual capacity and not as a representative of any organisation, affiliation, or government. He underscored the importance of drawing conclusions and making recommendations based on science which is traceable to studies conducted largely in humans. This is necessary for correct food labelling and relevant health claims and for the better use of foods in the dietary management and prevention of non-communicable diseases. These issues have economic implications for agricultural production, the food industry, and public health policy.

Dr Sultana Khanum, Regional Adviser/Nutrition, SEARO (South East Asia Regional Office), WHO, added her welcome on behalf of the Regional Director for South-East Asia Region, Dr. Uton Muchtar Rafel. Dr. Khanum noted the significance of South-East Asia as the site of the Expert Consultation, since some of the most tangible successes and achievements have occurred within this geographical region in the realm of identifying, preventing, reducing, and eliminating many forms of malnutrition.

Dr. Khanum noted that the FAO and WHO have a long history of collaboration at the country, regional and global levels towards combating food and nutritional problems. She underlined the importance of using science as the basis of the standard-setting process which took place during the consultation.

Dr Graeme Clugston, Director, WHO Nutrition Programmes, added his welcome to the participants on behalf of the Director-General of WHO, Dr Gro Harlem Brundtland. Dr Clugston pointed out that the formulation and implementation of science-based dietary guidelines has become a central issue for the nutritional sciences as well as a major challenge for governments worldwide, especially since the International Conference on Nutrition held in Rome in December 1992.

Dr Clugston expressed confidence that this Expert Consultation would lead to scientifically sound, up-to-date recommendations for vitamin and mineral requirements in human nutrition. FAO and WHO would then ensure that these recommendations would be passed on to all member states, providing them with the best possible guidance for developing their own appropriate dietary guidelines for health promotion, good nutrition and disease prevention.

The Consultation elected Dr Donald McCormick as Chairman and Professor Chen Chunming as Vice-Chair. Dr Glenville Jones and Dr Colin Mills were appointed jointly as Rapporteurs. Dr McCormick in his response indicated the importance of this Consultation and outlined the scope of the issues that would be discussed and on which the two agencies, FAO and WHO, were seeking expert guidance from the Consultation.

**Participants and Contributors**
The members of the Expert Panel are listed in Annex 2, while those who contributed background papers are listed in Annex 3. The reviewers for the background papers can be found in Annex 4, and the members of the Secretariat are included in Annex 5.
Table 1: Recommended Nutrient Intakes – Minerals

<table>
<thead>
<tr>
<th>Age</th>
<th>Calcium</th>
<th>Magnesium</th>
<th>Selenium</th>
<th>Zinc</th>
<th>Iron (h)</th>
<th>Iodine</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>mg/day</td>
<td>mg/day</td>
<td>μg/day</td>
<td>High bioavailability</td>
<td>Moderate bioavailability</td>
<td>Low bioavailability</td>
</tr>
<tr>
<td>Infants</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0 - 6 months</td>
<td>300 (a)</td>
<td>26 (a)</td>
<td>6</td>
<td>1.1 (d)</td>
<td>2.8 (e)</td>
<td>6.6 (f)</td>
</tr>
<tr>
<td>7-12 months</td>
<td>400 (b)</td>
<td>36 (b)</td>
<td>10</td>
<td>0.8 (d)</td>
<td>2.5 (g)</td>
<td>4.1 (g)</td>
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<tr>
<td>Children</td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
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<td>1-3 years</td>
<td>500</td>
<td>60</td>
<td>22</td>
<td>2.9</td>
<td>4.8</td>
<td>9.6</td>
</tr>
<tr>
<td>4-6 years</td>
<td>600</td>
<td>76</td>
<td>22</td>
<td>2.9</td>
<td>4.8</td>
<td>9.6</td>
</tr>
<tr>
<td>7-9 years</td>
<td>700</td>
<td>100</td>
<td>21</td>
<td>3.3</td>
<td>5.6</td>
<td>11.2</td>
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<td>Adolescents</td>
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</tr>
<tr>
<td>Males 10 - 18 years</td>
<td>1,300 (c)</td>
<td>230</td>
<td>32</td>
<td>5.1</td>
<td>8.6</td>
<td>17.1</td>
</tr>
<tr>
<td>Females 10 - 18 years</td>
<td>1,300 (c)</td>
<td>220</td>
<td>26</td>
<td>4.3</td>
<td>7.2</td>
<td>14.4</td>
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<tr>
<td>Adults</td>
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<tr>
<td>Males 19 - 65 years</td>
<td>1,000</td>
<td>260</td>
<td>34</td>
<td>4.2</td>
<td>7.0</td>
<td>14.0</td>
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<tr>
<td>Females</td>
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<td></td>
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<tr>
<td>19 - 50 years (pre-menopausal)</td>
<td>1,000</td>
<td>220</td>
<td>26</td>
<td>3.0</td>
<td>4.9</td>
<td>9.8</td>
</tr>
<tr>
<td>51 - 65 years (menopausal)</td>
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<td>220</td>
<td>26</td>
<td>3.0</td>
<td>4.9</td>
<td>9.8</td>
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<tr>
<td>Older adults</td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Males 65 + years</td>
<td>1,300</td>
<td>224</td>
<td>33</td>
<td>4.2</td>
<td>7.0</td>
<td>14.0</td>
</tr>
<tr>
<td>Females 65 + years</td>
<td>1,300</td>
<td>190</td>
<td>25</td>
<td>3.0</td>
<td>4.9</td>
<td>9.8</td>
</tr>
<tr>
<td>Pregnancy</td>
<td></td>
<td></td>
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<td></td>
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<tr>
<td>First trimester</td>
<td>1,200</td>
<td>220</td>
<td>30</td>
<td>6.0</td>
<td>10.0</td>
<td>20.0</td>
</tr>
<tr>
<td>Second trimester</td>
<td>1,200</td>
<td>220</td>
<td>28</td>
<td>4.2</td>
<td>7.0</td>
<td>14.0</td>
</tr>
<tr>
<td>Third trimester</td>
<td>1,200</td>
<td>220</td>
<td>30</td>
<td>6.0</td>
<td>10.0</td>
<td>20.0</td>
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<tr>
<td>Lactation</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>0-3 months</td>
<td>1,000</td>
<td>270</td>
<td>35</td>
<td>5.8</td>
<td>9.5</td>
<td>19.0</td>
</tr>
<tr>
<td>3-6 months</td>
<td>1,000</td>
<td>270</td>
<td>35</td>
<td>5.3</td>
<td>8.8</td>
<td>17.5</td>
</tr>
<tr>
<td>7-12 months</td>
<td>1,000</td>
<td>270</td>
<td>42</td>
<td>4.3</td>
<td>7.2</td>
<td>14.4</td>
</tr>
</tbody>
</table>
Notes - Minerals

(a) Human breast milk.

(b) Infant formula.

Calcium:

(c) Particularly during the growth spurt.

Zinc:

(d) Human-milk fed infants only.

(e) Formula-fed infants, moderate zinc bioavailability.

(f) Formula-fed infants, low zinc bioavailability due to infant consumption of phytate rich cereals and vegetable protein based formula.

(g) Not applicable to infants consuming human milk only.

Iron:

(h) There is evidence that iron absorption can be significantly enhanced when each meal contains a minimum of 25 mg of Vitamin C, assuming three meals per day. This is especially true if there are iron absorption inhibitors in the diet such as phytate or tannins.

(i) Neonatal iron stores are sufficient to meet the iron requirement for the first six months in full term infants. Premature infants and low birth weight infants require additional iron.

(k) Bioavailability of dietary iron during this period varies greatly.

(l) Non-menstruating adolescents.

(m) It is recommended that iron supplements in tablet form be given to all pregnant women because of the difficulties in correctly evaluating iron status in pregnancy. In the non-anaemic pregnant woman, daily supplements of 100 mg of iron (e.g., as ferrous sulphate) given during the second half of pregnancy are adequate. In anaemic women higher doses are usually required.

Iodine

(n) The RNI value has been established from requirements expressed per kg body weight per day. Where appropriate, these values have been used to calculate daily requirements based on standard body weights, and rounded off. The standard body weights have been derived from the 50th percentile of NCHS data until adult weights of 65 kg for male and 55kg for females have been reached. The latter upper limits were selected because they are frequently used as values for “standard” adults. Nevertheless, the need for data expressed on a kg body weight basis exists, and this data is as follows:

- premature infants = 30 μg/kg/day
- children 0-12 months = 19 μg/kg/day
- children 1 - 6 years = 6 μg/kg/day
- children 7 - 11 = 4 μg/kg/day
- adolescents and adults 12 + years = 2 μg/kg/day
- pregnancy and lactation = 3.5 μg/kg/day

(o) In view of the high variability in body weights at these ages the RNIs are expressed as μg/kg body weight/day.

(p) The RNI has been calculated on the basis of NCHS data, 50th percentile, for a 16 year old boy.

(q) The RNI has been calculated on the basis of NCHS data, 50th percentile, for a 15 year old girl.

## Table 2: Recommended Nutrient Intakes (g) (h) – Water and Fat Soluble Vitamins [PROVISIONAL]

<table>
<thead>
<tr>
<th>Age</th>
<th>Thiamin (mg/day)</th>
<th>Riboflavin (mg/day)</th>
<th>Niacin (NE/day)</th>
<th>Pantothenate (mg/day)</th>
<th>Biotin (µg/day)</th>
<th>Folate (µg DFE/day)</th>
<th>Vit. B₁₂ (µg/day)</th>
<th>Vit. C (g/day)</th>
<th>Vit. A (µg/day)</th>
<th>Vit. D (µg/day)</th>
<th>Vit. E (mg α-TE/day)</th>
<th>Vit. K (µg/day)</th>
</tr>
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<tbody>
<tr>
<td><strong>Infants</strong></td>
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<tr>
<td>0 - 6 months</td>
<td>0.2</td>
<td>0.3</td>
<td>2 (b)</td>
<td>0.1</td>
<td>1.7</td>
<td>5</td>
<td>80</td>
<td>0.4</td>
<td>25</td>
<td>375</td>
<td>5</td>
<td>2.7</td>
</tr>
<tr>
<td>7-12 months</td>
<td>0.3</td>
<td>0.4</td>
<td>4</td>
<td>0.3</td>
<td>1.8</td>
<td>6</td>
<td>80</td>
<td>0.5</td>
<td>30</td>
<td>400</td>
<td>5</td>
<td>2.7</td>
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<tr>
<td><strong>Children</strong></td>
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<tr>
<td>1-3 years</td>
<td>0.5</td>
<td>0.5</td>
<td>6</td>
<td>0.5</td>
<td>2</td>
<td>8</td>
<td>160</td>
<td>0.9</td>
<td>30</td>
<td>400</td>
<td>5</td>
<td>5 (k)</td>
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<tr>
<td>4-6 years</td>
<td>0.6</td>
<td>0.6</td>
<td>8</td>
<td>0.6</td>
<td>3</td>
<td>12</td>
<td>200</td>
<td>1.2</td>
<td>30</td>
<td>450</td>
<td>5</td>
<td>5 (k)</td>
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<tr>
<td>7-9 years</td>
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<td>0.9</td>
<td>12</td>
<td>1.0</td>
<td>4</td>
<td>20</td>
<td>330</td>
<td>1.8</td>
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<td>500</td>
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<td>7 (k)</td>
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<td>10-18 years</td>
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<tr>
<td>Males</td>
<td>1.2</td>
<td>1.3</td>
<td>16</td>
<td>1.3</td>
<td>5</td>
<td>25</td>
<td>400</td>
<td>2.4</td>
<td>40</td>
<td>600</td>
<td>5</td>
<td>10</td>
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<tr>
<td>Females</td>
<td>1.1</td>
<td>1.0</td>
<td>16</td>
<td>1.2</td>
<td>5</td>
<td>25</td>
<td>400</td>
<td>2.4</td>
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<td>600</td>
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<tr>
<td><strong>Adults</strong></td>
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<tr>
<td>Males, 19 - 65 years</td>
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<td>1.3</td>
<td>16</td>
<td>1.3 (19-50 yrs)</td>
<td>5</td>
<td>30</td>
<td>400</td>
<td>2.4</td>
<td>45 (d)</td>
<td>600</td>
<td>5 (19-50 yrs)</td>
<td>10</td>
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<tr>
<td>Females</td>
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<td>19-50 years (pre-</td>
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<td>1.1</td>
<td>14</td>
<td>1.3</td>
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<td>30</td>
<td>400</td>
<td>2.4</td>
<td>45 (d)</td>
<td>500</td>
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<td>7.5</td>
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<td>50 - 65 years</td>
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<td>(menopausal)</td>
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<td>14</td>
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<tr>
<td>Males</td>
<td>1.2</td>
<td>1.3</td>
<td>16</td>
<td>1.7</td>
<td>5</td>
<td>400</td>
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<td>600</td>
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<td>Females</td>
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<td>1.1</td>
<td>14</td>
<td>1.5</td>
<td>5</td>
<td>400</td>
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<td>15</td>
<td>7.5</td>
<td>55</td>
</tr>
<tr>
<td><strong>Pregnancy</strong></td>
<td>1.4</td>
<td>1.4</td>
<td>18</td>
<td>1.9</td>
<td>6</td>
<td>30</td>
<td>600</td>
<td>2.6</td>
<td>55 (d)</td>
<td>800</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>Lactation</td>
<td>1.5</td>
<td>1.6</td>
<td>17</td>
<td>2.0</td>
<td>7</td>
<td>35</td>
<td>500</td>
<td>2.8</td>
<td>70 (e)</td>
<td>850</td>
<td>5</td>
<td></td>
</tr>
</tbody>
</table>
Notes - Vitamins

Niacin
(a) NE = niacin equivalents, 60-to-1 conversion factor for tryptophan to niacin.
(b) Preformed niacin.

Folate
(c) DFE = dietary folate equivalents; µg of DFE provided = [µg of food folate + (1.7 x µg of synthetic folic acid)].

Vitamin C
(d) An RNI of 45 mg was calculated for adult men and women and 55 mg recommended during pregnancy. It is recognised however that larger amounts would promote greater iron absorption if this can be achieved.
(e) An additional 25 mg is needed for lactation.

Vitamin A:
(f) Recommended safe intake µg RE/day, 1 µg retinol=1 RE; 1 µg β-carotene=0.167 µg RE; 1 µg other provitamin A carotenoids=0.084 µg RE.
(g) Vitamin A values are "recommended safe intakes" instead of RNIs. This level of intake is set to prevent clinical signs of deficiency, allow normal growth, but does not allow for prolonged periods of infections or other stresses.

Vitamin E:
(h) Data were considered insufficient to formulate recommendations for this vitamin so that "acceptable intakes" are listed instead. This represents the best estimate of requirements, based on the currently acceptable intakes that support the known function of this vitamin.
(i) Breast milk substitutes should not contain less than 0.3 mg α-tocopherol equivalents (TE)/100 ml of reconstituted product, and not less than 0.4 mg TE/g PUFA. Human breast milk vitamin E is fairly constant at 2.7 mg for 850 ml of milk.
(k) Values based on a proportion of the adult acceptable intakes.

Vitamin K:
(l) The RNI for each age group is based on a daily intake of 1 µg/kg/day of phylloquinone, the latter being the major dietary source of Vitamin K.
(m) This intake cannot be met by infants who are exclusively breast-fed. To prevent bleeding due to vitamin K deficiency, all breast fed babies should receive vitamin K supplementation at birth according to nationally approved guidelines.
ANNEX 2

PARTICIPANTS

PROFESSOR CHEN CHUNMING (vice-chair)
Senior Adviser
Chinese Academy of Preventive Medicine
27 Nan Wei Road
Beijing 100050 CHINA

COLIN F. MILLS, Ph.D.
Director
Postgraduate Studies
Rowett Research Institute
Bucksburn AB21 9SB, Scotland, UK

C. GOPALAN, M.D., Ph.D.
President
Nutrition Foundation of India
C-13 Qutab Institutional Area
New Delhi 110 016 INDIA

B. CHRISTOPHER NORDIN, M.D., Ph.D., D.Sc.
Institute of Medical and Veterinary Sciences
Clinical Biochemistry Division
PO Box 14 Rundle Mall
Adelaide 5000 AUSTRALIA

LEIF HALLBERG, M.D., Ph.D.
Department of Clinical Nutrition
Göteborg University
Annedalsklinikerna
Sahlgrenska University Hospital
S-413-45 Göteborg, SWEDEN

RUTH ONIANG’O, Ph.D.
Jomo Kenyatta University of Agriculture and Technology
P.O. Box 62000
Nairobi KENYA

GLENVILLE JONES, Ph.D.
Department of Biochemistry - Medicine
Room 668 Botterell Hall
Queen's University
Kingston, Ontario
CANADA K7L 3N6

CHANDRAKANT S. PANDAV, M.D., M.Sc.
Regional Coordinator
South-Asia and Pacific International Council for Control of Iodine Deficiency Disorders
Additional Professor
Center for Community Medicine
All India Institute of Medical Sciences
New Delhi, INDIA

DONALD B. McCORMICK, Ph.D. (Chairman)
Department of Biochemistry
Emory University School of Medicine
4013 Rollins Research Center
Atlanta, GA 30322-3050, USA

BRITTMARIE SANDSTRÖM, Ph.D.
Research Department of Human Nutrition
The Royal Veterinary and Agricultural University
Rolighedsvej 30
Frederiksberg
DK-1958 DENMARK
JOHN SCOTT, Ph.D., D.Sc.
Department of Biochemistry
Trinity College
Dublin 2 IRELAND

RICARDO UAUY, M.D., Ph.D.
Director
Institute of Nutrition and Food Technology (INTA)
University of Chile
Casilla 138-11
Santiago CHILE

MARTIN J. SHEARER, Ph.D.
Vitamin K Research Unit of the Haemophilia Centre
The Rayne Institute
4th floor, Lambeth Wing
St Thomas Hospital
London SE1 7EH, UK

BARBARA UNDERWOOD, Ph.D.
Scholar-in-Residence
Food and Nutrition Board
Institute of Medicine, NAS
2101 Constitution Ave. N.W. (Fo 3049)
Washington, DC 20418, USA

DAVID THURNHAM, Ph.D.
Howard Professor of Human Nutrition
School of Biomedical Sciences
Northern Ireland Center for Diet and Health
University of Ulster
Coleraine, Co. Londonderry
Northern Ireland BT52 1SA UK

PARVIN ZANDI, Ph.D.
Head, Department of Food Science and Technology
National Nutrition & Food Technology Research Institute
P.O. Box 19395-4741
Tehran
ISLAMIC REPUBLIC OF IRAN
BACKGROUND PAPERS

DELANGE, M.D.
Executive Director
International Council for Control of Iodine Deficiency Disorders
New Delhi, INDIA

COLIN F. MILLS, Ph.D.
Director, Postgraduate Studies
Rowett Research Institute
Bucksburn AB21 9SB, Scotland,
UNITED KINGDOM

LEIF HALLBERG, M.D., Ph.D.
Department of Clinical Nutrition
Göteborg University
Annedalsklinikerna
Sahlgrenska University Hospital
S-413-45 Göteborg, Sweden

B. CHRISTOPHER NORDIN, M.D., Ph.D., D.Sc.
Institute of Medical and Veterinary Sciences
Clinical Biochemistry Division
PO Box 14 Rundle Mall
Adelaide 5000 AUSTRALIA

GLENVILLE JONES, Ph.D.
Department of Biochemistry - Medicine
Room 668 Botterell Hall
Queen's University, Kingston,
Ontario, CANADA K7L 3N6

MARIA THERESA OYARZUM, M.S.
Institute of Nutrition and Food Technology (INTA)
University of Chile
Casilla 138-11
Santiago, CHILE

MADHU KARMARKAR, Ph.D.
Senior Advisor
International Council for Control of Iodine Deficiency Disorders
New Delhi 110 029 INDIA

CHANDRAKANT S. PANDAV, M.D., M.Sc.
Regional Coordinator,
South-Asia and Pacific International Council for Control of Iodine Deficiency Disorders
Additional Professor,
Center for Community Medicine
All India Institute of Medical Sciences
New Delhi 110 029 INDIA

MARK A. LEVINE, M.D.
NIDDK, NIH
Bldg 10, Rm 4D52
MSC1372
Bethesda, MD 20892-1372, USA

BRITTMARIE SANDSTRÖM, Ph.D.
Research Department of Human Nutrition
The Royal Veterinary and Agricultural University
Rolighedsvej 30
Frederiksberg
DK-1958 DENMARK

DONALD B. MCCORMICK, Ph.D.
Department of Biochemistry
Emory University School of Medicine
4013 Rollins Research Center
Atlanta, GA 30322-3050, USA

JOHN SCOTT, Ph.D., D.Sc.
Department of Biochemistry
Trinity College
Dublin 2, IRELAND
MARTIN J. SHEARER, Ph.D.
Vitamin K Research Unit of the Haemophilia Centre
The Rayne Institute
4th Floor, Lambeth Wing
St Thomas's Hospital
London SE1 7EH, UK

RICARDO UAUY, M.D., Ph.D.
Director
Institute of Nutrition and Food Technology (INTA)
University of Chile
Casilla 138-11
Santiago, CHILE

AJAY SOOD, M.D., D.M.
Assistant Professor
Department of Endocrinology and Metabolism
All India Institute of Medical Sciences
New Delhi 110 029 INDIA

BARBARA UNDERWOOD, Ph.D.
Scholar-in-Residence
Food and Nutrition Board
Institute of Medicine, NAS
2101 Constitution Ave. N.W. (Fo 3049)
Washington, DC 20418, USA

DAVID THURNHAM, Ph.D.
Howard Professor of Human Nutrition
School of Biomedical Sciences
Northern Ireland Center for Diet and Health
University of Ulster
Coleraine, Co. Londonderry
Northern Ireland BT52 1SA, UK

CEES VERMEER, Ph.D.
Faculteit der Geneeskunde Biochemie
Department of Biochemistry (Room 4.354)
University of Maastricht
Post Office Box 616
6200 MD Maastricht
THE NETHERLANDS

MARET G. TRABER, Ph.D.
Linus Pauling Institute
Department of Nutrition and Food Management
Oregon State University
571 Weniger Hall
Corvallis, OR 97331-6512 USA
REVIEWERS

CHRISTOPHER BATES, Ph.D.
Medical Research Council
Downham's Lane
Milton Road
Cambridge, CB4 1XJ, UK

C. GOPALAN, M.D., Ph.D.
President
Nutrition Foundation of India
C-13 Qutab Institutional Area
New Delhi 110 016, INDIA

ROBERT E. BLACK, Ph.D.
Department of International Health
Johns Hopkins School of Hygiene and Public Health
615 N. Wolfe Street, Room 5039
Baltimore, MD 21205-2179 USA

ROBERT P. HEANEY, M.D.
Creighton University Medical Center
601 N. 30th Street (suite 4841)
Omaha, NE 68131, USA

JAMES BLANCHARD, Ph.D.
Pharmacy, Room 106
Department: Pharmacology and Toxicology
Professor, Pharmaceutical Sciences
University of Arizona
Tucson, Arizona 85721, USA

BASIL S. HETZEL, M.D.
c/o Children’s Health Development Foundation, 8th Floor
Samuel Way Building
Women’s and Children’s Hospital
72 King William Road
North Adelaide, 5006 AUSTRALIA

THOMAS H. BOTHWELL, M.D.
Faculty of Medicine
University of the Witwatersrand
Private Bag 3
Wits. 2050, SOUTH AFRICA

WALTER MERTZ, MD
12401 St. James Road
Rockville, MD 20850, USA

PROFESSOR CHEN CHUNMING
Senior Adviser
Chinese Academy of Preventive Medicine
27 Nan Wei Road
Beijing 100050, CHINA

RUTH ONIANG’O, Ph.D.
Jomo Kenyatta University of Agriculture and Technology
P.O. Box 6200
Nairobi, KENYA

WILLIAM COHN, Ph.D
F. Hoffmann-La Roche Ltd,
Division of Vitamins
Research and Technology Development
Building 72/47a
CH-4070 Basel, SWITZERLAND

ROBERT S. PARKER, Ph.D.
Associate Professor
Division of Nutritional Sciences
Cornell University
113 Savage Hall
Ithaca, NY 14853, USA
ROBERT M. RUSSELL, M.D.
Professor of Medicine and Nutrition
Assoc. Dir., HNRC on Aging
Tufts University, USDA, ARS,
711 Washington St,
Boston, MA 02111-1525, USA

HENK VAN DEN BERG, Ph.D.
TNO
Nutrition and Food Research Institute
Utrechtseweg 48
Zeist, 3700 AJ, THE NETHERLANDS

TATSUO SUDA, Ph.D.
Department of Biochemistry
Showa University School of Dentistry
1-5-8 Hatanodai, Shinagawa-ku
Tokyo 142-8555, JAPAN

KEITH WEST, Jr., D.P.H., R.D.
Johns Hopkins School of Hygiene and Public Health
Division of Human Nutrition
615 N. Wolfe Street
Baltimore, MD 21205-2179 USA

JOHN W. SUTTIE, Ph.D.
Dept. of Biochemistry
University of Wisconsin-Madison
420 Henry Mall
Madison, WI 53706-1569, USA
SECRETARIAT AND CONSULTANTS

Food and Agriculture Organization of the United Nations

JOAN MARIE CONWAY, Ph.D., R.D.
Food and Agriculture Organization of the UN
Viale Delle Terme Di Caracalla
00100 Rome ITALY; and
USDA: Agricultural Research Service
Beltsville Human Nutrition Research Center
Beltsville, MD 20705 USA

JOHN R. LUPIEN
Director, Food and Nutrition Division
Food and Agriculture Organization of the UN
Viale Delle Terme di Caracalla
00100 Rome ITALY

BIPLAB NANDI, Ph.D.
Senior Food and Nutrition Officer
FAO Regional Office for Asia & the Pacific
Bangkok 10200 THAILAND

GUY NANTEL, Ph.D.
Senior Officer, Food and Nutrition Division
Food and Agriculture Organization of the UN
Viale Delle Terme di Caracalla
00100 Rome ITALY

ZEINA SIFRI, M.Sc.
Consultant, Food and Nutrition Division
Food and Agriculture Organization of the UN
Viale Delle Terme di Caracalla
00100 Rome ITALY

World Health Organization of the United Nations

RATKO BUZINA, M.D., Ph.D.
Programme of Nutrition
World Health Organization of the UN
CH-1211
Geneva 27 SWITZERLAND

GRAEME CLUGSTON, M.D., Ph.D.
Director, Programme of Nutrition
World Health Organization of the UN
CH-1211
Geneva 27 SWITZERLAND

SULTANA KHANUM, M.D., Ph.D.
Regional Adviser/Nutrition
SEARO (South East Asia Regional Office)
World Health House
Indraprastha Estate, Mahatma Gandhi Road
New Delhi 110002 INDIA
Consultants

KRAISID TONTISIRIN, M.D., Ph.D.
Director
Institute of Nutrition
Mahidol University
Salaya, Phutthamonthon 4
Nakhon Panthmo 73170 THAILAND

RICHARD DAWSON
Consultant
Food and Agriculture Organization of the United Nations
ESN Division
Viale Delle Terme Di Caracalla
00100 Rome ITALY