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*\*Journal titles abbreviated according to the NLM standard*

# **Biomarkers that can be Collected by Category of Condition**

Condition	Biomarker(s) Examined	Substance Source	Notes	Source
<b>Chronic Diseases</b>				
<a href="#">return to ToC</a>				
<i>(Diseases of Aging)</i>				
Alzheimer's disease Arthritis Cardiovascular disease Certain cancers Heart attack Osteoporosis Stroke Type 2 diabetes	IL-6	blood	<p>The association of IL-6 with cardiovascular disease is related to the central role this cytokine plays in promoting the production of C-reactive protein (CRP), an important risk factor for myocardial infarction.</p> <p>Blood level of IL-6 is known to rise with advancing age in humans, and the dysregulation of IL-6 may be a contributing factor to many of the diseases of aging.</p>	<p>Network on Measurement of Biological Risk. Biomarkers. [Internet]. Los Angeles, CA: UCLA. [cited 2008 Apr 25]. Available from: <a href="http://www.usc.edu/dept/gero/CBPH/biomarker/biomarkers-IL6.htm">http://www.usc.edu/dept/gero/CBPH/biomarker/biomarkers-IL6.htm</a></p>
Angina pectoris Diabetes Myocardial infarction Stroke	waist	girth	<p>Visceral (intra-abdominal) adipose tissue shows the strongest link to risk factor for CVD and Type 2 diabetes...</p>	<p>CARDIA. 2000. Year 15 (2000-2001) Protocol. [Internet]. Birmingham, AL: Cardia Coordinating Center, UAB. [cited 2008 Apr 25]. Available from: <a href="http://www.cardia.dopm.uab.edu/pdf/EXERCISE.pdf">http://www.cardia.dopm.uab.edu/pdf/EXERCISE.pdf</a></p>
Atherosclerosis Cancer Diabetes Hypertension Stroke Heart disease	body mass index (BMI) waist-to-hip ratio (WHR)	calculated in kilograms of weight, and height in meters, as the ratio of weight to height-squared (kg/m2).	<p>...higher values of BMI, wait and hip circumferences, and WHR tend to be at higher risks for hypertension, adult-onset diabetes mellitus, heart disease, stroke, various forms of cancer, atherosclerosis... osteoarthritis... increased inactivity, resulting in lower aerobic capacity and less muscle strength..., and disability...High WHR was also found to be related to some somatic and psychological health problems... those with a central distribution of fat (android or apple body shape) tend to experience higher rates of atherosclerotic heart disease, stroke, hypertension, hyperlipidemia and diabetes than those with a peripheral distribution of fat (gynoid or pear body shape).</p>	<p>Network on Measurement of Biological Risk. c2005. Weight,Body Mass Index (BMI), Waist / Hip Size [Internet]. Los Angeles, CA: NIA Demography of Aging Centers; [cited 2008 Apr 25]. Available from: <a href="http://www.usc.edu/dept/gero/CBPH/biomarker/biomarkers-weightbmihip.htm">http://www.usc.edu/dept/gero/CBPH/biomarker/biomarkers-weightbmihip.htm</a></p>

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Condition	Biomarker(s) Examined	Substance Source	Notes	Source
<b>Chronic Diseases</b>				
<a href="#">return to ToC</a>				
Hypertension	blood pressure		Two measurements of systolic and diastolic blood pressure...were made with an interval of at least 10 minutes between measurements.	Uzbekistan Health Examination Survey 2002 . [Internet]. Calverton, MD: ORC, Macro. [cited 2008 Apr 25]. Available from: <a href="http://www.measuredhs.com/pubs/pdf/FR143/14Chapter14.pdf">http://www.measuredhs.com/pubs/pdf/FR143/14Chapter14.pdf</a> .
Cardiovascular disease	blood pressure		...an index of cardiovascular activity... Elevated systolic pressure and elevated diastolic pressure predict increased risks of cardiovascular death.	Network on Measurement of Biological Risk. Biomarkers. Los Angeles, CA: UCLA. [cited 25 Apr 2008]. Available from: <a href="http://www.usc.edu/dept/gero/CBPH/biomarker/biomarkers-blood%20pressure.htm">http://www.usc.edu/dept/gero/CBPH/biomarker/biomarkers-blood%20pressure.htm</a>
Cardiovascular disease (coronary atherosclerosis)	cholesterol	blood	Most of the circulating cholesterol is found in 3 major lipoprotein fractions: very low density lipoproteins (VLDL), LDL, and HDL.	NHANES 2003–2004 Data Documentation Laboratory Assessment: Lab 13AM – Triglycerides and LDL-Cholesterol. 2007. [Internet]. Hyattsville, MD: National Center for Health Statistics. [cited 2008 Apr 21]. Available from: <a href="http://www.cdc.gov/nchs/data/nhanes/nhanes_03_04/113am_c.pdf">http://www.cdc.gov/nchs/data/nhanes/nhanes_03_04/113am_c.pdf</a>
Cardiovascular dise	fibrinogen	blood	Fibrinogen has been shown to be strongly predictive of both mortality... and the onset of cardiovascular disease...Fibrinogen is also as important as low levels of HDL cholesterol in predicting cardiovascular disease...  ...as important as low levels of HDL cholesterol in predicting cardiovascular disease...	Network on Measurement of Biological Risk. Biomarkers. Los Angeles, CA: UCLA. [cited 2008 Apr 25]. Available from: <a href="http://www.usc.edu/dept/gero/CBPH/biomarker/biomarkers-Fibrinogen.htm">http://www.usc.edu/dept/gero/CBPH/biomarker/biomarkers-Fibrinogen.htm</a>
Cardiovascular disease	homocysteine	blood	...related to a higher risk of coronary heart disease, stroke and peripheral vascular disease may have an effect on atherosclerosis by damaging the inner lining of arteries and promoting blood clots.  An >8-hour fast prior to sample collection is recommended.	Network on Measurement of Biological Risk. Biomarkers. [Internet]. Los Angeles, CA: UCLA. [cited 25 Apr 2008]. Available from: <a href="http://www.usc.edu/dept/gero/CBPH/biomarker/biomarkers-homocysteine.htm">http://www.usc.edu/dept/gero/CBPH/biomarker/biomarkers-homocysteine.htm</a>

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<b>Chronic Diseases</b>				
<a href="#">return to ToC</a>				
Chronic diseases		breastmilk	...easily accessible and has many known components, but it is probably not relevant to many of the chronic diseases studied with epidemiologic designs.	Potischman N. 2003 Mar. Biologic and methodologic issues for nutritional biomarkers. J Nutr [Internet]. [cited 2008 May 27];133 Suppl 3:875S-880S. Available from: <a href="http://jn.nutrition.org/cgi/content/full/133/3/875S">http://jn.nutrition.org/cgi/content/full/133/3/875S</a>
Coronary heart disease (CHD) peripheral atherosclerosis	triglycerides	blood	High levels...help determine the risk for coronary heart disease (CHD) and peripheral atherosclerosis	NHANES 2001–2002 Data Release Laboratory Assessment: Lab 13AM – Triglycerides and LDL-Cholesterol. Available from: <a href="http://www.cdc.gov/NCHS/data/nhanes/nhanes_01_02/13am_b_doc.pdf">http://www.cdc.gov/NCHS/data/nhanes/nhanes_01_02/13am_b_doc.pdf</a>
Coronary heart dise Nicotene		toenails	...toenails have an advantage over other existing biomarkers of smoking, because they have the longest half-life and window of exposure. The levels represent nicotine taken up from blood by nails during growth.	Al-Delaimy WK, Stampfer MJ, Manson JE, Willett WC. 2008 Apr. Toenail Nicotine Levels as Predictors of Coronary Heart Disease among Women. Am J Epidemiol. 167(11):1342-348. Available from: <a href="http://aje.oxfordjournals.org/cgi/content/abstract/167/11/1342">http://aje.oxfordjournals.org/cgi/content/abstract/167/11/1342</a>
Diabetes	blood	glycosylated hemoglobin (HbA1c)	Because red blood cells live in the bloodstream for approximately four months, the HbA1c test shows the average blood sugar for the past 2 to 3 months and is an indicator of glucose metabolism over that time.	Network on Measurement of Biological Risk. c2005. Glycosolated Hemoglobin [Internet]. Los Angeles, CA: NIA Demography of Aging Centers; [cited 2008 Apr 25]. Available from: <a href="http://www.usc.edu/dept/gero/CBPH/biomarker/biomarkers-glycosylated.htm">http://www.usc.edu/dept/gero/CBPH/biomarker/biomarkers-glycosylated.htm</a> .
Diabetes Hypertension Coronary heart disease	body fat	height weight	Body mass index...a more reproducible measure than...other measures of body fat, such as skinfold thickness...more strongly associated with blood pressure and serum cholesterol in some populations	CARDIA. 2000. Year 15 (2000-2001) Protocol. [Internet]. Birmingham, AL: Cardia Coordinating Center, UAB. [cited 2008 Apr 25]. Available from: <a href="http://www.cardia.dopm.uab.edu/pdf/CARDIAY20Protocol.pdf">www.cardia.dopm.uab.edu/pdf/CARDIAY20Protocol.pdf</a>
Heart attack Stroke	albumin	blood	Low levels of albumin have been related to heart attack, stroke, functioning loss, and death among older persons	Network on Measurement of Biological Risk. Biomarkers. Los Angeles, CA: UCLA. [cited 25 Apr 2008]. Available from: <a href="http://www.usc.edu/dept/gero/CBPH/biomarker/biomarkers-Albumin.htm">http://www.usc.edu/dept/gero/CBPH/biomarker/biomarkers-Albumin.htm</a>

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Condition	Biomarker(s) Examined	Substance Source	Notes	Source
<b>Chronic Diseases</b>				
<a href="#">return to ToC</a>				
Hypertension	blood pressure		<p>a. In addition to anthropometric measurements (height and weight) and household salt testing for iodine content, the following biomarkers are tested in DHS surveys:  Armenia 2005 DHS   Anemia, Blood Pressure  Azerbaijan 2006 DHS *   Anemia, Blood Pressure  Turkmenistan 2000 DHS   Anemia, Blood Pressure  Uzbekistan 2002 DHS   Anemia, Blood Pressure, Chlamydia (in Tashkent), Diabetes, Hepatitis B (in Tashkent), Lead (in Tashkent), Lipids (in Tashkent), Vitamin A (in Ferghana)</p> <p>b. Three measurements of systolic and diastolic blood pressure (measured in millimeters of mercury, mmHg) were made, with an interval of at least five minutes between measurements.</p>	<p>a. Measure DHS. Biomarkers Inventory. Calverton, MD: Measure DHS. [cited 25 Apr 2008]. Available from:  <a href="http://www.measuredhs.com/topics/biomarkers/surveys.cfm">http://www.measuredhs.com/topics/biomarkers/surveys.cfm</a></p> <p>b. Measure DHS. Armenia: Standard DHS, 2005. Calverton, MD: Measure DHS. [cited 2008 Apr 25]. Available from:  <a href="http://www.measuredhs.com/pubs/pub_details.cfm?ID=634&amp;ctry_id=81&amp;SrchTp=ctry">http://www.measuredhs.com/pubs/pub_details.cfm?ID=634&amp;ctry_id=81&amp;SrchTp=ctry</a></p>
Hypertension Kidney disease	creatinine	blood	...reflects kidney function...an important predictor and result of hypertension.	CARDIA Exam materials. [Internet]. Available from: <a href="http://www.cardia.dopm.uab.edu/pdf/PHLEB.PDF">http://www.cardia.dopm.uab.edu/pdf/PHLEB.PDF</a>
Hyperglycemia Hypoglycemia Diabetes (pre-diabetes)	glucose	blood urine	Also known as: Blood sugar, Fasting blood sugar, FBS, blood glucose, Oral Glucose Tolerance Test (OGTT or GTT), Urine glucose	Lab Tests Online. Glucose. [Internet]. Washington, DC: AACC. [cited 2008 Apr 25]. Available from: <a href="http://www.labtestsonline.org/understanding/analytes/glucose/sample.html">http://www.labtestsonline.org/understanding/analytes/glucose/sample.html</a>
Kidney disease	albumin	urine	Urinary albumin excretion...proposed as a sensitive and reasonably specific test to identify impaired renal function prior to gross creatinine elevations.	CARDIA. 2000. Year 15 (2000-2001) Microalbuminuria. [Internet]. Birmingham, AL: Cardia Coordinating Center, UAB. [cited 2008 Apr 25]. Available from: <a href="http://www.cardia.dopm.uab.edu/pdf/MICROAL.pdf">http://www.cardia.dopm.uab.edu/pdf/MICROAL.pdf</a>

***Biomarkers that can be Collected by Category of Condition***

Condition	Biomarker(s) Examined	Substance Source	Notes	Source
<b>Chronic Diseases</b>				
<a href="#">return to ToC</a>				
Liver disease Kidney disease	albumin	blood	<p>Decreased blood albumin may result from liver disease or kidney disease</p> <p>Low levels of albumin have been related to heart attack, stroke, functioning loss, and death among older persons...Data from the MacArthur study have related low levels of albumin to functional decline, death... and cognitive impairment...</p> <p>Concomitant low blood cholesterol and albumin levels may identify high functioning older persons who are at increased risk of subsequent mortality and functional decline...</p>	<p>Network on Measurement of Biological Risk. Biomarkers. [Internet]. Los Angeles, CA: UCLA. [cited 2008 Apr 25]. Available from:  <a href="http://www.usc.edu/dept/gero/CBPH/biomarker/biomarkers-Albumin.htm">http://www.usc.edu/dept/gero/CBPH/biomarker/biomarkers-Albumin.htm</a></p>

**Biomarkers that can be Collected by Category of Condition**

Condition	Biomarker(s) Examined	Substance Source	Notes	Source
<b>Drugs, Alcohol, Tobacco</b>				
<a href="#">return to ToC</a>				
Alcohol biomarkers	Gamma Glutamyl Transferase (GGT)	blood	Most commonly used traditional biomarker. Primarily reflects liver damage that is often related to alcohol consumption. Performs best in adults ages 30 to 60.	Center for Substance Abuse Treatment. 2006. The Role of Biomarkers in the Treatment of Alcohol Use Disorders. [Internet]. Rockville, MD: SAMSHA. [cited 2008 Apr 25]. Available from: <a href="http://kap.samhsa.gov/products/manuals/advisory/text/0609_biomarkers.htm">http://kap.samhsa.gov/products/manuals/advisory/text/0609_biomarkers.htm</a>
	Carbohydrate- Deficient Transferrin (CDT)		Equal to, or possibly slightly better than, GGT but much more specific. Very good biomarker of relapse to drinking following a period of abstinence. Likely less sensitive for women and younger people.  Alcohol biomarkers are not a substitute for self-report measures or information that would otherwise be gathered from a comprehensive patient history and physical by an appropriately trained health professional.	
Prenatal alcohol exposure	fatty acid ethyl esters (FAEEs)	meconium	...deposition of drugs into meconium begins at approximately the 12th to 16th week of gestational age when fetal swallowing commences, elevated FAEEs in meconium confirms exposure in the final two trimesters of pregnancy. The FAEEs detected in meconium is a marker for direct fetal exposure since maternal FAEEs are extensively metabolized by the placenta and thus do not cross to the fetus.  Maternal self-reports have so far been the gold standard for screening or confirming prenatal alcohol exposure; thus the FAEE level appears to be more sensitive and may identify infants who may otherwise be overlooked.	Koren G, Hutson J, Gareri J. Novel methods for the detection of drug and alcohol exposure during pregnancy: implications for maternal and child health. Clin Pharmacol Ther. 2008 Apr;83(4):631-4. Available from: <a href="http://www.nature.com/clpt/journal/v83/n4/full/6100506a.html">http://www.nature.com/clpt/journal/v83/n4/full/6100506a.html</a>

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Condition	Biomarker(s) Examined	Substance Source	Notes	Source
<b>Drugs, Alcohol, Tobacco</b>				
<a href="#">return to ToC</a>				
Environmental Tobacco Smoke (ETS)	cotinine	urine saliva hair	<p>Biomarkers...for ETS exposure...avoid many sources of bias and may provide greater sensitivity than questionnaires.</p> <p>Urine cotinine levels have been suggested as the gold standard for ETS exposure measurement...but it is affected by inter-individual variability in cotinine excretion levels for similar exposures and a relatively short half life of 20 hours.</p> <p>Cotinine in saliva is subject to similar disadvantages in addition to the artificially high estimates of cotinine in saliva compared with serum levels because of the ability of the salivary glands to concentrate this metabolite.</p> <p>The more recently developed method of nicotine assay in hair is less affected by the daily fluctuation of ETS exposure (because of the slow growth rate of hair), and it provides a long term exposure history because each 1 cm of hair represents approximately one month's exposure. However, chemicals applied to the hair (bleaching) and inter-individual differences in the rate of hair growth may affect nicotine levels.</p>	<p>Al-Delaimy WK, Crane J, Woodward A. Is the hair nicotine level a more accurate biomarker of environmental tobacco smoke exposure than urine cotinine? J Epidemiol Community Health. 2002 Jan;56(1):66-71. Available from: <a href="http://www.pubmedcentral.nih.gov/libproxy.lib.unc.edu/picrender.fcgi?artid=1732006&amp;blobtype=pdf">http://www.pubmedcentral.nih.gov/libproxy.lib.unc.edu/picrender.fcgi?artid=1732006&amp;blobtype=pdf</a>.</p>
Illicit drugs	Cocaine Methamphetamine Opioids Cannabinoids Benzodiazepines Nicotine  fatty acid ethyl esters (FAEEs)	hair urine	<p>The hair babies are born with grows during the last trimester of pregnancy, this neonatal hair test detects drug exposure in late pregnancy, long after the mother is aware that she has conceived.</p> <p>...adult hair typically grows at an average rate of 1 cm/mo, sectioning of maternal (or paternal) hair is useful in detecting patterns of drug use, identifying periods of drug use vs. periods of abstinence. In such analysis, the first 1 cm closest to the skull represents the most recent month.</p>	<p>Koren G, Hutson J, Gareri J. Novel methods for the detection of drug and alcohol exposure during pregnancy: implications for maternal and child health. Clin Pharmacol Ther. 2008 Apr;83(4):631-4. Available from: <a href="http://www.nature.com/clpt/journal/v83/n4/full/6100506a.html">http://www.nature.com/clpt/journal/v83/n4/full/6100506a.html</a></p>



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Condition	Biomarker(s) Examined	Substance Source	Notes	Source
<b>Drugs, Alcohol, Tobacco</b>				
<a href="#">return to ToC</a>				
Maternal alcohol consumption		hair	...were able to define with high specificity and sensitivity, using 6 cm of hair (representing 6 months of hair growth), teetotalers, social drinkers and those drinking excessively	Koren G, Hutson J, Gareri J. Novel methods for the detection of drug and alcohol exposure during pregnancy: implications for maternal and child health. Clin Pharmacol Ther. 2008 Apr;83(4):631-4. Available from: <a href="http://www.nature.com/clpt/journal/v83/n4/full/6100506a.html">http://www.nature.com/clpt/journal/v83/n4/full/6100506a.html</a>
		hair	Hair nicotine provides better information on long term ETS exposure than biomarker measures in urine, saliva, or serum because of the shorter half life of the latter biomarkers.  An advantage of nicotine in hair over cotinine in urine is its increased ability to differentiate exposure status because of less variability.	Al-Delaimy WK. 2002. Hair as a biomarker for exposure to tobacco smoke. Tob Control. [Internet]. Sep;11(3):176-82. Available from PubMed Central: <a href="http://www.pubmedcentral.nih.gov/libproxy.lib.unc.edu/picrender.fcgi?artid=1759008&amp;blobtype=pdf">http://www.pubmedcentral.nih.gov/libproxy.lib.unc.edu/picrender.fcgi?artid=1759008&amp;blobtype=pdf</a> .
Tobacco smoke exposure	Nicotene	toenails	...no "gold standard" method for measurement of the overall exposure to tobacco smoke.  ...earlier biomarkers, such as carbon monoxide in breath, serum cotinine and nicotine levels, and salivary cotinine, provide short-term measurement of tobacco exposure but fail to overcome the problem of daily variability.  Because of the slow growth rate of toenails, the cut toenail clippings represent exposure in the last few months. This has the main advantage of representing longer duration of exposure and therefore less variation than short-term biomarkers of salivary, serum, or urine nicotine and cotinine.	Al-Delaimy WK, Willett WC. Measurement of tobacco smoke exposure: comparison of toenail nicotine biomarkers and self-reports. Cancer Epidemiol Biomarkers Prev. [Internet] 2008 May;17(5):1255-61. Available from: <a href="http://cebp.aacrjournals.org/cgi/content/full/17/5/1255">http://cebp.aacrjournals.org/cgi/content/full/17/5/1255</a>

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Condition	Biomarker(s) Examined	Substance Source	Notes	Source
<b>Genetics</b>				
<a href="#">return to ToC</a>				
Breast cancer	BRCA-1 BRCA-2	blood	Genetic markers, if present, suggest an 80% likelihood of breast cancer occurrence.	American Association for Clinical Chemistry. Lab Tests Online. [Internet]. Washington, DC: AACC. [cited 2008 Apr 25]. Available from: <a href="http://labtestsonline.org/understanding/conditions/breast-3.html">http://labtestsonline.org/understanding/conditions/breast-3.html</a>
Colon cancer	Presence of blood	stool sample	...avoid certain medications and follow certain dietary restrictions for several days before collecting the FOBT samples.	American Association for Clinical Chemistry. 2008. Lab Tests Online. Fecal Occult Blood Test. [Internet]. Washington, DC: AACC. [cited 2008 Apr 25]. Available from: <a href="http://labtestsonline.org/understanding/analytes/fecal_occult_blood/glance.html">http://labtestsonline.org/understanding/analytes/fecal_occult_blood/glance.html</a>
Cystic fibrosis	Chloride conductance	sweat	measures the amount of sodium and chloride in sweat  Dysfunctional or absent CFTR causes the cells to be impermeable to chloride conductance and results in increased sodium and chloride concentrations in sweat.	American Association for Clinical Chemistry. Lab Tests Online. Washington, DC: AACC. [cited 2008 Apr 25]. Available from: <a href="http://labtestsonline.org/understanding/analytes/sweat_chloride/sample.html">http://labtestsonline.org/understanding/analytes/sweat_chloride/sample.html</a>
Gout	Uric acid	blood	Uric acid is normally carried through the blood and eliminated in the urine.	American Association for Clinical Chemistry. Gout: Lab Tests Online. Washington, DC: AACC. [cited 2008 May 16]. Available from: <a href="http://labtestsonline.org/understanding/conditions/gout.html">http://labtestsonline.org/understanding/conditions/gout.html</a>
Lupus	Antinuclear Antibody	blood	The presence of ANA is a marker of an autoimmune process and is associated with several autoimmune disorders but is most commonly seen in the autoimmune disorder systemic lupus erythematosus (SLE).	American Association for Clinical Chemistry. Systemic Lupus Erythematosus. Lab Tests Online. Washington, DC: AACC. [cited 2008 Apr 25]. Available from: <a href="http://labtestsonline.org/understanding/conditions/lupus.html">http://labtestsonline.org/understanding/conditions/lupus.html</a>
Neural tube defects (spina bifida anencephaly)	Alpha-fetoprotein (AFP)	blood		American Association for Clinical Chemistry. Lab Tests Online. Washington, DC: AACC. [cited 2008 Apr 25]. Available from: <a href="http://labtestsonline.org/understanding/analytes/afp_tumor/glance.html">http://labtestsonline.org/understanding/analytes/afp_tumor/glance.html</a>
Prostate cancer	Prostate Specific Antigen (PSA)	blood	...help[s] screen for and monitor prostate cancer. PSA is a good, but not perfect tool.	American Association for Clinical Chemistry. Lab Tests Online. Washington, DC: AACC. [cited 2008 Apr 25]. Available from: <a href="http://labtestsonline.org/understanding/conditions/prostate.html">http://labtestsonline.org/understanding/conditions/prostate.html</a>

## Biomarkers that can be Collected by Category of Condition

Condition	Biomarker(s) Examined	Substance Source	Notes	Source
Hormones				
<a href="#">return to ToC</a>				
About using hormonal biomarkers			Minimum aliquot requirements...differ according to the hormone of interest	
			Potential advantages of urine collection include the ability to measure hormones in their free form...ability to measure integrated hormone secretion in hormones affected by diurnal variation, and...ability to perform collection as outpatients	Derr RL, Cameron SJ, Golden SH. Pre-analytic considerations for the proper assessment of hormones of the hypothalamic-pituitary axis in epidemiological research. Eur J Epidemiol. 2006. 21(3):217-26. Available from: <a href="http://libproxy.lib.unc.edu/login?url=http://dx.doi.org/10.1007/s10654-006-0011-0">http://libproxy.lib.unc.edu/login?url=http://dx.doi.org/10.1007/s10654-006-0011-0</a> .
			...limitations include incomplete compliance with overnight or 24-h collections, poor stability of some hormones in urine, insensitivity of certain assays to low levels of hormones in urine, and interference by comorbidities such as renal	
About endocrine diseases				American Association for Clinical Chemistry. Lab Tests Online. Washington, DC: AACC. [cited 25 Apr 2008]. Available from: <a href="http://www.labtestsonline.org/understanding/conditions2/endocrine_table.html">http://www.labtestsonline.org/understanding/conditions2/endocrine_table.html</a>
Alzheimer's disease	Apolipoprotein (APOE)	blood	Studies have shown high risks of late-onset Alzheimer's disease among those with the APOE4 gene...The APOE4 gene is also known to be associated with cardiovascular diseases such as heart attack, stroke, and coronary artery disease...The presence of apolipoprotein e2 genotype has been related to familial hyperlipidemia...	Network on Measurement of Biological Risk. Biomarkers. Los Angeles, CA: UCLA. [cited 25 Apr 2008]. Available from: <a href="http://www.usc.edu/dept/gero/CBPH/biomarker/biomarkers-APOE.htm">http://www.usc.edu/dept/gero/CBPH/biomarker/biomarkers-APOE.htm</a> .
Cryptorchidism (Testicular disease)	FSH	blood	...serum concentration of LH was used only for calculation of the LH:testosterone ratio. This ratio was considered to be a more reliable marker of testicular function in the boys than the serum LH concentration because the postnatal peak of serum concentrations of LH and testosterone is relatively brief...and the timing of blood sampling varied between 2.33 and 5.43 months of age.	Andersen HR, Schmidt IM, Grandjean P, Jensen TK, Budtz-Jørgensen E, Kjærstad MB, Bælum J, Nielsen JB, Skakkebak NE, Main KM. Impaired reproductive development in sons of women occupationally exposed to pesticides during pregnancy. Environ Health Perspect. 2008. Apr;116(4):566-72. Available from: <a href="http://www.ehponline.org/members/2008/10790/10790.html">http://www.ehponline.org/members/2008/10790/10790.html</a> .
	Inhibin B Luteinizing hormone (LH) SHBG Testosterone		...results suggest an adverse effect of maternal occupational pesticide exposure on reproductive development in the sons, despite the exposures occurring within highly controlled greenhouse operations and special measures to protect pregnant women.	

**Biomarkers that can be Collected by Category of Condition**

Condition	Biomarker(s) Examined	Substance Source	Notes	Source
<b>Hormones</b>				
<a href="#">return to ToC</a>				
Cushing's Syndrome	ACTH	blood	<p>...ACTH, and cortisol exhibits significant diurnal variation, making the timing of their collection critical to the interpretation of the results...</p> <p>[caused by] excess ACTH</p>	<p>Derr RL, Cameron SJ, Golden SH. 2006. Pre-analytic considerations for the proper assessment of hormones of the hypothalamic-pituitary axis in epidemiological research. Eur J Epidemiol. 21(3):217-26. Available from: <a href="http://libproxy.lib.unc.edu/login?url=http://dx.doi.org/10.1007/s10654-006-0011-0">http://libproxy.lib.unc.edu/login?url=http://dx.doi.org/10.1007/s10654-006-0011-0</a></p> <p>American Association for Clinical Chemistry. Endocrine System and Syndromes. Lab Tests Online. Washington, DC: AACC. [cited 2008 Apr 25]. Available from: <a href="http://www.labtestsonline.org/understanding/conditions2/endocrine_table.html">http://www.labtestsonline.org/understanding/conditions2/endocrine_table.html</a></p>
Diabetes	glucose	blood	<p>...widely recognized as one of the leading causes of death and disability in the United States...likely to be underreported as the underlying cause of death on death certificates. About 65 percent of deaths among those with diabetes are attributed to heart disease and stroke.</p>	<p>National Diabetes Information Clearinghouse. 2006. Diabetes overview. [Internet]. Bethesda, MD: NDIC. [cited 2008 Jun 19]. Available from: <a href="http://diabetes.niddk.nih.gov/dm/pubs/overview/">http://diabetes.niddk.nih.gov/dm/pubs/overview/</a>.</p>
Hypogonadism	Testosterone	blood	<p>...a steroid hormone</p>	<p>American Association for Clinical Chemistry. Testosterone. Lab Tests Online. Washington, DC: AACC. [cited 2008 Apr 25]. Available from: <a href="http://www.labtestsonline.org/understanding/conditions2/endocrine_table.html">http://www.labtestsonline.org/understanding/conditions2/endocrine_table.html</a>.</p>

**Biomarkers that can be Collected by Category of Condition**

Condition	Biomarker(s) Examined	Substance Source	Notes	Source
<b>Hormones</b>				
<a href="#">return to ToC</a>				
Mental stress	BDNF		...serum BDNF levels and plasma MHPG levels might be biological markers reflective of psychological job stress...	Mitoma M, Yoshimura R, Sugita A, Umene W, Hori H, Nakano H, Ueda N, Nakamura J. Stress at work alters serum brain-derived neurotrophic factor (BDNF) levels and plasma 3-methoxy-4-hydroxyphenylglycol (MHPG) levels in healthy volunteers: BDNF and MHPG as possible biological markers of mental stress? Prog Neuropsychopharmacol Biol Psychiatry. 2008 Apr 1;32(3):679-85. Available from: <a href="http://libproxy.lib.unc.edu/login?url=http://dx.doi.org/10.1016/j.pnpbp.2007.11.011">http://libproxy.lib.unc.edu/login?url=http://dx.doi.org/10.1016/j.pnpbp.2007.11.011</a> .
	MHPG (Methoxyhydroxy-phenylglycol)	blood	...a major metabolite of noradrenaline, and homovanillic acid (HVA), a major metabolite of dopamine, are reported to reflect noradrenergic and dopaminergic neuronal tone, respectively in humans...	
Pineal	Melatonin	blood	Helps control sleep patterns, affects reproduction	American Association for Clinical Chemistry. Endocrine System and Syndromes. Lab Tests Online. Washington, DC: AACC. [cited 25 Apr 2008]. Available from: <a href="http://www.labtestsonline.org/understanding/conditions2/endocrine_table.html">http://www.labtestsonline.org/understanding/conditions2/endocrine_table.html</a>
Polycystic ovary syndrome (PCOS)	Estrogen			American Association for Clinical Chemistry. Estrogen. Lab Tests Online. Washington, DC: AACC. [cited 25 Apr 2008]. Available from: <a href="http://www.labtestsonline.org/understanding/analytes/estrogen/glance.html">http://www.labtestsonline.org/understanding/analytes/estrogen/glance.html</a>
	Progesterone	blood, saliva	...saliva testing is less common.	American Association for Clinical Chemistry. Progesterone. Lab Tests Online. Washington, DC: AACC. [cited 25 Apr 2008]. Available from: <a href="http://www.labtestsonline.org/understanding/analytes/progesterone/glance.html">http://www.labtestsonline.org/understanding/analytes/progesterone/glance.html</a>

**Biomarkers that can be Collected by Category of Condition**

Condition	Biomarker(s) Examined	Substance Source	Notes	Source
<b>Hormones</b> <a href="#">return to ToC</a>				
			Serum is the preferred matrix for analysis of thyroid hormones, growth hormone, IGF-1, and cortisol.	Derr RL, Cameron SJ, Golden SH. Pre-analytic considerations for the proper assessment of hormones of the hypothalamic-pituitary axis in epidemiological research. Eur J Epidemiol. 2006. 21(3):217-26. Available from: <a href="http://libproxy.lib.unc.edu/login?url=http://dx.doi.org/10.1007/s10654-006-0011-0">http://libproxy.lib.unc.edu/login?url=http://dx.doi.org/10.1007/s10654-006-0011-0</a> .
Stress	Cortisol	blood saliva	<p>...the time course for cortisol responses is in minutes, and as sampling is intermittent, this means that sampling must be conducted with sufficient frequency, and over a sufficient time, so as to capture responses being generated at different rates.</p> <p>...saliva samples were collected using cotton dental rolls...reported that cotton dental rolls artificially inflated levels of some biomarkers (testosterone, DHEA, progesterone, and estradiol) while deflating sIgA levels, but also found that cortisol, DHEA-S, and cotinine levels were unaffected.</p>	<p>b. Roy MP. Patterns of cortisol reactivity to laboratory stress. Horm Behav. 2004. Dec;46(5):618-27. Available from: <a href="http://libproxy.lib.unc.edu/login?url=10.1016/j.yhbeh.2004.06.015">http://libproxy.lib.unc.edu/login?url=10.1016/j.yhbeh.2004.06.015</a></p>
Thyroid diseases	Hypothalamus	blood	Communicates with both nervous and endocrine systems	<p>American Association for Clinical Chemistry. Endocrine System and Syndromes. Lab Tests Online. Washington, DC: AACC. [cited 25 Apr 2008]. Available from: <a href="http://www.labtestsonline.org/understanding/conditions2/endocrine_table.html">http://www.labtestsonline.org/understanding/conditions2/endocrine_table.html</a></p>

# *Biomarkers that can be Collected by Category of Condition*

Condition	Biomarker(s) Examined	Substance Source	Notes	Source
<b>Infections &amp; Markers of Inflammation</b>				
<a href="#">return to ToC</a>				
Atherosclerosis	C-Reactive Protein (CRP) Serum Amyloid A	blood	Two sensitive markers of inflammation...	CARDIA. Year 15 (2000-2001) Protocol. Birmingham, AL: Cardia Coordinating Center, UAB. Available from: <a href="http://www.cardia.dopm.uab.edu/pdf/PHLEB.PDF">http://www.cardia.dopm.uab.edu/pdf/PHLEB.PDF</a>
CVD	Isoprostanes	blood	Most of the associations have been found between oxidative damage and advanced cardiovascular disease...on the basis of F2-isoprostane measurements	CARDIA. <a href="#">Year 15 (2000-2001) Protocol</a> . Birmingham, AL: Cardia Coordinating Center, UAB. Available from: <a href="http://www.cardia.dopm.uab.edu/pdf/PHLEB.PDF">http://www.cardia.dopm.uab.edu/pdf/PHLEB.PDF</a>
Epstein-Barr Virus Antibodies (mononucleosis)	EBV antibodies	blood	According to the National Center for Infectious Diseases (NCID), as many as 95% of people in the United States will have been infected by EBV by the time they are 40 years old.	American Association for Clinical Chemistry. Epstein-Barr Virus Antibodies. Lab Tests Online. Washington, DC: AACC. [cited 25 Apr 2008]. Available from: <a href="http://labtestsonline.org/understanding/analytes/ebv/glance.html">http://labtestsonline.org/understanding/analytes/ebv/glance.html</a>
Group B streptococcus (GBS)	rectal specimen vaginal specimen	cells	...rayon swabs were used to obtain specimens from the anterior one-third of the vagina (without speculum placement) and rectum of all participants.	Fitzroy A. Orrett (2003) Colonization with Group B streptococci in pregnancy and outcome of infected neonates in Trinidad. Pediatrics International 45(3), 319–23.
Hepatitis B, C, D	HBsAg	blood	In the 2002 UHES, prevalence rates of hepatitis B were obtained by testing blood serum for the hepatitis B surface antigen (HBsAg). HBsAg is detectable when a person is infected with HBV and indicates that a person is infectious.	NHANES 2003–2004 Documentation, Codebook, and Frequencies. Laboratory Component. 2007. [Internet]. Hyattsville, MD: National Center for Health Statistics. [cited 2008 Apr 21]. Available from: <a href="http://www.cdc.gov/nchs/data/nhanes/nhanes_03_04/l02_c.pdf">http://www.cdc.gov/nchs/data/nhanes/nhanes_03_04/l02_c.pdf</a>  Uzbekistan Health Examination Survey 2002 . [Internet]. Calverton, MD: ORC, Macro. [cited 2008 Apr 25]. Available from: <a href="http://www.measuredhs.com/pubs/pdf/FR143/14Chapter14.pdf">http://www.measuredhs.com/pubs/pdf/FR143/14Chapter14.pdf</a>

# **Biomarkers that can be Collected by Category of Condition**

Condition	Biomarker(s) Examined	Substance Source	Notes	Source
<b>Infections &amp; Markers of Inflammation</b>				
<a href="#">return to ToC</a>				
Inflammation	Erythrocyte sedimentation rate (ESR)	blood	a. Measurement of rate of settling of erythrocytes in anticoagulated blood. Also called Blood Sedimentation	Uzbekistan Health Examination Survey 2002 . [Internet]. Calverton, MD: ORC, Macro. [cited 2008 Apr 25]. Available from: <a href="http://www.measuredhs.com/pubs/pdf/FR143/14Chapter14.pdf">http://www.measuredhs.com/pubs/pdf/FR143/14Chapter14.pdf</a> .
			b. Generally, ESR does not change as rapidly as does CRP, either at the start of inflammation or as it goes away. CRP is not affected by as many other factors as is ESR, making it a better marker of inflammation. However, because ESR is an easily performed test, many doctors still use ESR as an initial test when they think a patient has inflammation.	Lab Tests Online. c2001-2008. How reliable is laboratory testing? [Internet]. Washington (DC): American Association for Clinical Chemistry. Available from: <a href="http://www.labtestsonline.org/understanding/analytes/esr/test.html">http://www.labtestsonline.org/understanding/analytes/esr/test.html</a>
	C-Reactive Protein (CRP)	blood	c. rheumatoid arthritis, rheumatic fever, tuberculosis, pneumonia, and lupus	c. Network on Measurement of Biological Risk. Biomarkers. C-Reactive Protein. Los Angeles, CA: UCLA. [cited 2008 Apr 25]. Available from: <a href="http://www.usc.edu/dept/gero/CBPH/biomarker/biomarkers-C-reactive.htm">http://www.usc.edu/dept/gero/CBPH/biomarker/biomarkers-C-reactive.htm</a>
			d. "C-reactive protein is considered one of the best measures of the acute phase response to an infectious disease or other cause of tissue damage and inflammation."	d. NHANES 1999-2000 Public Data Release File (June 2002) Laboratory 11 - C-reactive protein (CRP), Fibrinogen, Helicobacter pylori, Bone alkaline phosphatase, and Urinary N-telopeptides (Ntx). 2002. [Internet]. Hyattsville, MD: National Center for Health Statistics. [cited 2008 Apr 21]. Available from: <a href="http://www.cdc.gov/nchs/data/nhanes/frequency/lab11doc.pdf">http://www.cdc.gov/nchs/data/nhanes/frequency/lab11doc.pdf</a>
Rubella	IgG antibodies IgM antibodies	blood	A blood sample is drawn from a vein in the arm of an adult or from a heelprick or the umbilical cord of a newborn.	Lab Tests Online. Rubella. [Internet]. Washington, DC: AACC. [cited 2008 Apr 25]. Available from: <a href="http://labtestsonline.org/understanding/analytes/rubella/glance.html">http://labtestsonline.org/understanding/analytes/rubella/glance.html</a>
Second hand smoke homocysteine		serum	continine The main limitation is that serum cotinine measurements may not reflect cumulative, long-term exposure to tobacco smoke. Cotinine has a half-life of approximately 16–18 hr and serum concentrations reflect tobacco smoke exposure only over the previous 24–48 hr.	Clark JD 3rd, Wilkinson JD, Leblanc WG, Dietz NA, Arheart KL, Fleming LE, Lee DJ. Inflammatory markers and secondhand tobacco smoke exposure among U.S. workers. Am J Ind Med. 2008 May 14. Available from: <a href="http://libproxy.lib.unc.edu/login?url=http://dx.doi.org/10.1002/ajim.20591">http://libproxy.lib.unc.edu/login?url=http://dx.doi.org/10.1002/ajim.20591</a> .



**Biomarkers that can be Collected by Category of Condition**

Condition	Biomarker(s) Examined	Notes	Source
<b>Metals &amp; Organic Compounds</b>			
<a href="#">return to ToC</a>			
Arsenic	fingernails hair	Hair and nail samples are good indicators for certain toxic elements to which subjects have been exposed during the previous 2–18 months. The main problem of using hair and nails is the external contamination.	Samanta G, Sharma R, Roychowdhury T, Chakraborti D. Arsenic and other elements in hair, nails, and skin-scales of arsenic victims in West Bengal, India. Sci Total Environ. 2004 Jun 29;326(1-3):33-47. Available from: <a href="http://libproxy.lib.unc.edu/login?url=http://dx.doi.org/10.1016/j.scitotenv.2003.12.006">http://libproxy.lib.unc.edu/login?url=http://dx.doi.org/10.1016/j.scitotenv.2003.12.006</a>
		Hair samples were obtained from people who did not have colored or treated hair.	
		House dust and hair samples collected in the CS were available for measuring total As levels. The samples had been stored in polypropylene bags at -2 C until analysis in 2000.	
Cadmium	fingernails	The levels of heavy metal in the nail tissues were found to be significantly influenced by both environmental and nutritional factors.	Hussein Were F, Njue W, Murungi J, Wanjau R. 2008. Use of human nails as bio-indicators of heavy metals environmental exposure among school age children in Kenya. Sci Total Environ. Apr 15;393(2-3):376-84. Available from: <a href="http://libproxy.lib.unc.edu/login?url=http://dx.doi.org/10.1016/j.scitotenv.2007">http://libproxy.lib.unc.edu/login?url=http://dx.doi.org/10.1016/j.scitotenv.2007</a> .
		...clipped every two weeks for seven months...	
Calcium	fingernails	The levels of heavy metal in the nail tissues were found to be significantly influenced by both environmental and nutritional factors.	Hussein Were F, Njue W, Murungi J, Wanjau R. Use of human nails as bio-indicators of heavy metals environmental exposure among school age children in Kenya. Available from: <a href="http://libproxy.lib.unc.edu/login?url=http://dx.doi.org/10.1016/j.scitotenv.2007">http://libproxy.lib.unc.edu/login?url=http://dx.doi.org/10.1016/j.scitotenv.2007</a> .
		...clipped every two weeks for seven months...	
Inorganic mercury	blood urine	"...if the sample is collected within 24 to 48 hours of exposure or in the case of continuing exposure...the half-life of inorganic mercury in blood is only ~3 days, blood ceases to be a valuable biomarker a few days after exposure is terminated in most cases..."	Risher JF, De Rosa CT. Inorganic: the other mercury. J Environ Health. 2007 Nov;70(4):9-16; discussion 40. Available from: <a href="http://www.neha.org/JEH/2007_abstracts.htm#Inorganic:%20The%20Other%20Mercury">http://www.neha.org/JEH/2007_abstracts.htm#Inorganic:%20The%20Other%20Mercury</a>
		"...urine is typically the most appropriate bodily fluid for examination"	

### Biomarkers that can be Collected by Category of Condition

Condition	Biomarker(s) Examined	Notes	Source
<b>Metals &amp; Organic Compounds</b>			
<a href="#">return to ToC</a>			
Lead		...affects cognitive functioning	
	blood	LeadCare Analyzer, a US Food and Drug Administration (FDA)-approved device that has been used successfully in other studies in remote areas of developing nations	Solon O, Riddell TJ, Quimbo SA, Butrick E, Aylward GP, Lou Bacate M, Peabody JW. Associations between cognitive function, blood lead concentration, and nutrition among children in the central Philippines. J Pediatr. 2008 Feb;152(2):237-43. Available from: <a href="http://libproxy.lib.unc.edu/login?url=http://dx.doi.org/10.1016/j.jpeds.2007.09.008">http://libproxy.lib.unc.edu/login?url=http://dx.doi.org/10.1016/j.jpeds.2007.09.008</a>
		The recommended method of detecting lead poisoning involves the measurement of lead levels in blood in terms of micrograms per deciliter.	Uzbekistan Health Examination Survey 2002 . [Internet]. Calverton, MD: ORC, Macro. [cited 2008 Apr 25]. Available from: <a href="http://www.measuredhs.com/pubs/pdf/FR143/14Chapter14.pdf">http://www.measuredhs.com/pubs/pdf/FR143/14Chapter14.pdf</a> .
	fingernails	The levels of heavy metal in the nail tissues were found to be significantly influenced by both environmental and nutritional factors.  ...clipped every two weeks for seven months...	Hussein WF, Njue W, Murungi J, Wanjau R. 2008. Use of human nails as bio-indicators of heavy metals environmental exposure among school age children in Kenya. Sci Total Environ. Apr 15;393(2-3):376-84. Available from: <a href="http://libproxy.lib.unc.edu/login?url=http://dx.doi.org/10.1016/j.scitotenv.2007">http://libproxy.lib.unc.edu/login?url=http://dx.doi.org/10.1016/j.scitotenv.2007</a> .
Methylmercury	blood hair cord	fish consumption	Risher JF, De Rosa CT. Inorganic: the other mercury.J Environ Health. 2007 Nov;70(4):9-16; discussion 40. Available from: <a href="http://www.neha.org/JEH/2007_abstracts.htm#Inorganic:%20The%20Other%20Mercury">http://www.neha.org/JEH/2007_abstracts.htm#Inorganic:%20The%20Other%20Mercury</a>
	umbilical cord	The present study was carried out to determine the usefulness of the cord mercury concentration as an exposure biomarker in comparison with more commonly used biomarkers of prenatal methylmercury exposure from maternal seafood consumption.	Grandjean P, Budtz-Jørgensen E, Jørgensen PJ, Weihe P. Umbilical cord mercury concentration as biomarker of prenatal exposure to methylmercury. Environ Health Perspect. 2005 Jul;113(7):905-8. Available from: <a href="http://www.pubmedcentral.nih.gov/articlerender.fcgi?tool=pubmed">http://www.pubmedcentral.nih.gov/articlerender.fcgi?tool=pubmed</a>

**Biomarkers that can be Collected by Category of Condition**

Condition	Biomarker(s) Examined	Notes	Source
<b>Metals &amp; Organic Compounds</b>			
<a href="#">return to ToC</a>			
Uranium	urine	<p>Overnight urine samples (accumulation of 10–12 h) were collected in the morning in plastic bottles... Hair was collected by cutting about 100 mg from an area near the ear and close to the scalp (proximal). The entire length of the hair was used for the analysis. Toenails clippings from about two months of clippings, weighing around 100 mg per person, were provided by the subjects.</p> <p>Hair bio-concentrates and integrates the uranium content in the body over a period of time and samples can be measured to estimate the body burden in weeks or months. Furthermore, these samples can be stored in simple polyethylene bags or vials for long periods and do not require special storage facilities, such as refrigerators or any type of conservation with chemicals.</p>	<p>Hussein WF, Njue W, Murungi J, Wanjau R. 2008. Use of human nails as bio-indicators of heavy metals environmental exposure among school age children in Kenya. Sci Total Environ. Apr 15;393(2-3):376-84. Available from: <a href="http://libproxy.lib.unc.edu/login?url=http://dx.doi.org/10.1016/j.scitotenv.2007">http://libproxy.lib.unc.edu/login?url=http://dx.doi.org/10.1016/j.scitotenv.2007</a>.</p>
Zinc	fingernails	<p>The levels of heavy metal in the nail tissues were found to be significantly influenced by both environmental and nutritional factors.</p> <p>...clipped every two weeks for seven months...</p>	<p>Hussein Were F, Njue W, Murungi J, Wanjau R. Use of human nails as bio-indicators of heavy metals environmental exposure among school age children in Kenya. Available from: <a href="http://libproxy.lib.unc.edu/login?url=http://dx.doi.org/10.1016/j.scitotenv.2007">http://libproxy.lib.unc.edu/login?url=http://dx.doi.org/10.1016/j.scitotenv.2007</a>.</p>

**Biomarkers that can be Collected by Category of Condition**

Condition	Biomarker(s) Examined	Substance Source	Notes	Source
<b>Nutrients</b>				
<a href="#">return to ToC</a>				
			<p>...biochemical markers of nutrient status have less error than dietary assessment...</p> <p>...dietary data are inadequate because of limitations in food-composition data, whereas biomarkers of nutritional status related to these nutrients are available.</p> <p>Because excretion is a point of control, urinary markers of nutrients are often not useful.</p> <p>When observing a nutritional biomarker in the serum...what is being viewed is a snapshot in time, similar to a 24-h recall.</p>	<p>Potischman N. 2003 Mar. Biologic and methodologic issues for nutritional biomarkers. J Nutr. [Internet]. [cited 2008 May 27];133 Suppl 3:875S-880S. Available from: <a href="http://jn.nutrition.org/cgi/content/full/133/3/875S">http://jn.nutrition.org/cgi/content/full/133/3/875S</a></p>
<i>in general</i>	<p>α-tocopherol betacarotene retinol Vitamin B12 Vitamin C</p>		<p>.. higher consumption of plant foods over animal foods, olive oil use as well as the rest of the elements of the MDP, may be associated with higher levels of these vitamin biomarkers as well as a more healthful lipid profile.</p>	<p>Bach-Faig A, Geleva D, Carrasco JL, Ribas-Barba L, Serra-Majem L. 2006. Evaluating associations between Mediterranean diet adherence indexes and biomarkers of diet and disease. Public Health Nutr. Dec;9(8A):1110-7. Available from: <a href="http://libproxy.lib.unc.edu/login?url=http://dx.doi.org/10.1017/S1368980007668499">http://libproxy.lib.unc.edu/login?url=http://dx.doi.org/10.1017/S1368980007668499</a>.</p>
All-cause mortality	Vitamin C	blood	<p>...20 μmol/L rise in plasma ascorbic acid concentration, equivalent to about 50 g per day increase in fruit and vegetable intake, was associated with about a 20% reduction in risk of all-cause mortality...independent of age, systolic blood pressure, blood cholesterol, cigarette smoking habit, diabetes, and supplement use.</p> <p>...plasma ascorbic acid is strongly related to dietary ascorbic acid intake.</p>	<p>Khaw KT, Bingham S, Welch A, Luben R, Wareham N, Oakes S, Day N. 2001. Relation between plasma ascorbic acid and mortality in men and women in EPIC-Norfolk prospective study: a prospective population study. European Prospective Investigation into Cancer and Nutrition. Lancet. Mar 3;357(9257):657-63. Available from: <a href="http://libproxy.lib.unc.edu/login?url=http://dx.doi.org/10.1016/S0140-6736(00)04128-3">http://libproxy.lib.unc.edu/login?url=http://dx.doi.org/10.1016/S0140-6736(00)04128-3</a>.</p>

**Biomarkers that can be Collected by Category of Condition**

Condition	Biomarker(s) Examined	Substance Source	Notes	Source
<b>Nutrients</b> <a href="#">return to ToC</a>				
Anemia	iron	blood	"Anemia testing in MEASURE DHS surveys provides a cost-effective opportunity to estimate the prevalence and differentials in levels of anemia within the populations surveyed."	Measure DHS. Anemia. Calverton, MD: Measure DHS. [cited 25 Apr 2008]. Available from: <a href="http://www.measuredhs.com/topics/anemia/start.cfm">http://www.measuredhs.com/topics/anemia/start.cfm</a>
Hydrogen breath test			lactose intolerance	Potischman N. 2003 Mar. Biologic and methodologic issues for nutritional biomarkers. J Nutr. [Internet]. [cited 2008 May 27];133 Suppl 3:875S-880S. Available from: <a href="http://jn.nutrition.org/cgi/content/full/133/3/875S">http://jn.nutrition.org/cgi/content/full/133/3/875S</a>
Iodine		urine	Urine iodine is the standard method for assessing iodine status and intake worldwide	Hambidge M. 2003. Biomarkers of trace mineral intake and status. J Nutr. Mar;133 Suppl 3:948S-955S. Available from: <a href="http://jn.nutrition.org/cgi/reprint/133/3/948S">http://jn.nutrition.org/cgi/reprint/133/3/948S</a> .

**Biomarkers that can be Collected by Category of Condition**

Condition	Biomarker(s) Examined	Substance Source	Notes	Source
<b>Nutrients</b> <a href="#">return to ToC</a>				
Iron		blood	<p>Iron status is evaluated by several tests that are not always run together.</p> <p>There are more sensitive biomarkers of iron status, and for other trace minerals, plasma/serum assays are of limited value.</p> <p>Plasma/serum ferritin is the most sensitive indicator of iron stores.</p> <p>Reliable surrogate biomarkers of the total quantity of dietary iron are unavailable because of the wide variation in bioavailability and especially owing to the large difference in absorption of heme iron versus inorganic iron. In contrast, a range of biomarkers is available that in combination allows for reliable assessment of iron status and, therefore, of the adequacy of iron intake, especially in noninfected, nonstressed individuals.</p> <p>...evaluating diet is a cumbersome task that depends on, among other factors, the choice of the dietary assessment tool, dedication, consistency and honesty of the study participants, the accuracy of the data collection and entry as well as the completeness of the dietary database used for analysis.</p>	<p>Lab Tests Online. Iron Tests. [Internet]. Washington, DC: AACC. [cited 2008 Apr 25]. Available from: <a href="http://www.labtestsonline.org/understanding/analytes/iron/glance.html">http://www.labtestsonline.org/understanding/analytes/iron/glance.html</a></p> <p>Hambidge M. 2003. Biomarkers of trace mineral intake and status. J Nutr. Mar;133 Suppl 3:948S-955S. Available from: <a href="http://jn.nutrition.org/cgi/reprint/133/3/948S">http://jn.nutrition.org/cgi/reprint/133/3/948S</a>.</p>
		diet	<p>...the use of biomarkers has several drawbacks...their concentrations depend on food intake, as in the case of tocopherol and lipid intake. Measurement errors, such as misclassification and bias, a high cost and the need to use invasive techniques for collection, may provide additional challenges for the use of biomarkers.</p>	<p>Bach-Faig A, Geleva D, Carrasco JL, Ribas-Barba L, Serra-Majem L. 2006. Evaluating associations between Mediterranean diet adherence indexes and biomarkers of diet and disease. Public Health Nutr. Dec;9(8A):1110-7. Available from: <a href="http://libproxy.lib.unc.edu/login?url=http://dx.doi.org/10.1017/S1368980007668499">http://libproxy.lib.unc.edu/login?url=http://dx.doi.org/10.1017/S1368980007668499</a>.</p>

**Biomarkers that can be Collected by Category of Condition**

Condition	Biomarker(s) Examined	Substance Source	Notes	Source
<b>Nutrients</b> <a href="#">return to ToC</a>				
Low micronutrient levels	alpha-carotene beta-carotene beta-cryptoxanthin folate lutein/zeaxanthin lycopene selenium vitamins A, B12, C, D, E	blood	Overweight and obese adults had higher odds of low levels for a number of nutrients compared with normal-weight adults. Odds of being low in multiple micronutrients was most common among overweight and obese premenopausal women.	Kimmons JE, Blanck HM, Tohill BC, Zhang J, Khan LK. 2006. Associations between body mass index and the prevalence of low micronutrient levels among US adults. MedGenMed. Dec 19;8(4):59. Available from: <a href="http://www.pubmedcentral.nih.gov/libproxy.lib.unc.edu/articlerender.fcgi?tool=pubmed&amp;pubmedid=17415336">http://www.pubmedcentral.nih.gov/libproxy.lib.unc.edu/articlerender.fcgi?tool=pubmed&amp;pubmedid=17415336</a>
Micronutrient levels in blood		blood	Venipuncture blood samples are the biologic specimen of choice for most large-scale studies that involve hundreds, thousands and hundreds of thousands of individuals.	Hussein WF, Njue W, Murungi J, Wanjau R. 2008. Use of human nails as bio-indicators of heavy metals environmental exposure among school age children in Kenya. Sci Total Environ. Apr 15;393(2-3):376-84. Available from: <a href="http://libproxy.lib.unc.edu/login?url=http://dx.doi.org/10.1016/j.scitotenv.2007.">http://libproxy.lib.unc.edu/login?url=http://dx.doi.org/10.1016/j.scitotenv.2007.</a>
			Blood samples are accessible, present minimal subject burden and are logistically feasible on a large scale.	Potischman N. 2003 Mar. Biologic and methodologic issues for nutritional biomarkers. J Nutr. [Internet]. [cited 2008 May 27];133 Suppl 3:875S-880S. Available from: <a href="http://jn.nutrition.org/cgi/content/full/133/3/875S">http://jn.nutrition.org/cgi/content/full/133/3/875S</a>
Nutritional factors		buccal	...these cells tend to have limited utility for nutritional factors, because the specimens are often contaminated with food.	Potischman N. 2003 Mar. Biologic and methodologic issues for nutritional biomarkers. J Nutr. [Internet]. [cited 2008 May 27];133 Suppl 3:875S-880S. Available from: <a href="http://jn.nutrition.org/cgi/content/full/133/3/875S">http://jn.nutrition.org/cgi/content/full/133/3/875S</a>
Selenium		plasma	"only selenium assays in plasma/serum are a primary choice of biomarker"	Hambidge M. 2003. Biomarkers of trace mineral intake and status. J Nutr. Mar;133 Suppl 3:948S-955S. Available from: <a href="http://jn.nutrition.org/cgi/reprint/133/3/948S">http://jn.nutrition.org/cgi/reprint/133/3/948S</a> .

**Biomarkers that can be Collected by Category of Condition**

Condition	Biomarker(s) Examined	Substance Source	Notes	Source
<b>Nutrients</b> <a href="#">return to ToC</a>				
Water-soluble nutrients		urine	...may only be relevant for nutrients with a consistent intake.	Potischman N. 2003 Mar. Biologic and methodologic issues for nutritional biomarkers. J Nutr. [Internet]. [cited 2008 May 27];133 Suppl 3:875S-880S. Available from: <a href="http://jn.nutrition.org/cgi/content/full/133/3/875S">http://jn.nutrition.org/cgi/content/full/133/3/875S</a>
Zinc		plasma	Plasma zinc is currently the most widely used and accepted biomarker of zinc status despite poor sensitivity and imperfect specificity.	Hambidge M. 2003. Biomarkers of trace mineral intake and status. J Nutr. Mar;133 Suppl 3:948S-955S. Available from: <a href="http://jn.nutrition.org/cgi/reprint/133/3/948S">http://jn.nutrition.org/cgi/reprint/133/3/948S</a> .



### Biomarkers that can be Collected by Category of Condition

Condition	Biomarker(s) Examined	Substance Source	Notes	Source
<b>Parasites</b>				
<a href="#">return to ToC</a>				
Amebiasis	Entamoeba histolytica	stool sample	Diagnosis of amebiasis can be very difficult. One problem is that other parasites and cells can look very similar to <i>E. histolytica</i> when seen under a microscope.	CDC. 2004. Parasitic disease information fact sheet: Amebiasis. [Internet]. Atlanta, GA: Centers for Disease Control. [cited 2008 May 16]. Available from: <a href="http://www.cdc.gov/ncidod/dpd/parasites/amebiasis/factsht_amebiasis.htm">http://www.cdc.gov/ncidod/dpd/parasites/amebiasis/factsht_amebiasis.htm</a>
Cryptosporidiosis	Cryptosporidium	stool sample	Most often, stool specimens are examined microscopically using different techniques (e.g., acid-fast staining, direct fluorescent antibody [DFA] , and/or enzyme immunoassays for detection of Cryptosporidium sp. antigens).	CDC. 2008. "Crypto" - Cryptosporidiosis. [Internet]. Atlanta, GA: Centers for Disease Control and Prevention. [cited 2008 May 16]. Available from: <a href="http://www.cdc.gov/crypto/">http://www.cdc.gov/crypto/</a>
Giardia	Giardia lamblia	stool sample	When multiple samples are ordered, they should be collected at different times on different days because parasites are shed intermittently and may not be in the stool at all times.  During the past two decades, <i>Giardia</i> has become recognized as one of the most common causes of waterborne illness (drinking water and recreational water) in the United States. The germ is found in every part of the United States and the world.	Lab Tests Online. 2008. O&P. [cited 2008 May 16]. Washington, DC: LTO. Available from: <a href="http://labtestsonline.org/understanding/analytes/op/glance.html">http://labtestsonline.org/understanding/analytes/op/glance.html</a>  Centers for Disease Control. 2007. Giardia. [Internet]. Atlanta, GA: CDC. [cited 2008 May 15]. Available from: <a href="http://www.cdc.gov/healthyswimming/giardiafacts.htm">http://www.cdc.gov/healthyswimming/giardiafacts.htm</a>
Schistosomiasis (aka Bilharzia, Katayama fever, Swimmer's itch, Blood fluke)	schistosome eggs	stool sample		Medlineplus. 2007. Stool ova and parasites exam. [Internet]. Bethesda, MD: NLM. [cited 16 May 2008]. Available from: <a href="http://www.nlm.nih.gov/medlineplus/ency/article/003756.htm">http://www.nlm.nih.gov/medlineplus/ency/article/003756.htm</a>
Shigellosis	<i>Shigella</i>	stool sample	Infective dose -- As few as 10 cells depending on age and condition of host. The <i>Shigella spp.</i> are highly infectious agents that are transmitted by the fecal-oral route.	FDA/Center for Food Safety & Applied Nutrition. The bad bug book: Shigella. [Internet]. Rockville, MD: FDA. [cited 2008 May 16]. Available from: <a href="http://www.cfsan.fda.gov/%7Emow/intro.html">http://www.cfsan.fda.gov/%7Emow/intro.html</a> .
Toxoplasmosis	IgG antibodies IgM antibodies	blood	Because these antibody tests can be difficult to interpret, the Centers for Disease Control and Prevention (CDC) recommends that all positive results be confirmed by a laboratory that specializes in diagnosing toxoplasmosis.	MedlinePlus. 2008. Toxoplasmosis. [cited 2008 May 16]. Bethesda, MD: NLM. [Internet]. Available from: <a href="http://www.nlm.nih.gov/medlineplus/toxoplasmosis.html">http://www.nlm.nih.gov/medlineplus/toxoplasmosis.html</a>

***Biomarkers that can be Collected by Category of Condition***

Condition	Biomarker(s) Examined	Substance Source	Notes	Source
<b>Parasites</b>				
<a href="#">return to ToC</a>				
Trichomonas	Trichomonas vaginalis	vaginal secretions urethral secretions		Lab Tests Online. 2006. Trichomonas. [cited 29 Apr 2008]. Washington, DC: LTO. [Internet]. Available from: <a href="http://labtestsonline.org/understanding/analytes/trichomonas/glance.html">http://labtestsonline.org/understanding/analytes/trichomonas/glance.html</a>

**Biomarkers that can be Collected by Category of Condition**

Condition	Biomarker(s) Examined	Substance Source	Notes	Source
<b>Sexually Transmitted Diseases</b>				
<a href="#">return to ToC</a>				
Bacterial vaginosis (BV)	BV	vaginal swab	Women in the highest quartile of stress measures...had the highest risk of BV.	Harville EW, Savitz DA, Dole N, Thorp JM Jr, Herring AH. 2007. Psychological and biological markers of stress and bacterial vaginosis in pregnant women. BJOG. Feb;114(2):216-23. Available from: <a href="http://libproxy.lib.unc.edu/login?url=http://dx.doi.org/10.1">http://libproxy.lib.unc.edu/login?url=http://dx.doi.org/10.1</a>
Chlamydia	Chlamydia trachomatis (bacteria)	cervical swab specimen	...sample...from the infected area, such as the cervix, urethra, penis, anus, or throat.	Uzbekistan Health Examination Survey 2002 . [Internet]. Calverton, MD: ORC, Macro. [cited 2008 Apr 25]. Available from: <a href="http://www.measuredhs.com/pubs/pdf/FR143/14Chapter14.pdf">http://www.measuredhs.com/pubs/pdf/FR143/14Chapter14.pdf</a> .
		urine	Urine specimens are acceptable if the particular lab where the sample is sent uses a molecular method...	American Association for Clinical Chemistry. 2004. Estrogen. Lab Tests Online. [Internet]. Washington, DC: AACC. [cited 2008 Apr 25]. Available from: <a href="http://www.labtestsonline.org/understanding/conditions/chlamydia.html">http://www.labtestsonline.org/understanding/conditions/chlamydia.html</a>
Gonorrhea	Neisseria gonorrhoeae (bacteria)	swab sample: discharge secretions urine	...sample...from the infected area such as the cervix, urethra, penis, anus, or throat. A urine sample is used in some tests.	American Association for Clinical Chemistry. 2006. Gonorrhea. Lab Tests Online. [Internet]. Washington, DC: AACC. [cited 2008 Apr 25]. Available from: <a href="http://labtestsonline.org/understanding/analytes/gonorrhea/glance.html">http://labtestsonline.org/understanding/analytes/gonorrhea/glance.html</a>
Herpes simplex virus 1 (HSV-1)		blood		NHANES 2003–2004 Data, Codebook, and Frequencies: MEC Laboratory Component: Herpes I and Herpes II. 2006. [Internet]. Hyattsville, MD: National Center for Health Statistics. [cited 2008 Apr 21]. Available from: <a href="http://www.cdc.gov/nchs/data/nhanes/nhanes_03_04/109_c.pdf">http://www.cdc.gov/nchs/data/nhanes/nhanes_03_04/109_c.pdf</a> .

***Biomarkers that can be Collected by Category of Condition***

Condition	Biomarker(s) Examined	Substance Source	Notes	Source
<b>Sexually Transmitted Diseases</b>				
<a href="#">return to ToC</a>				
Herpes simplex virus 2 (HSV-2)		blood	HSV-2 best marker of sexual behavior risk leading to STDs	NHANES 2003–2004 Data, Codebook, and Frequencies: MEC Laboratory Component: Herpes I and Herpes II. 2006. [Internet]. Hyattsville, MD: National Center for Health Statistics. [cited 2008 Apr 21]. Available from: <a href="http://www.cdc.gov/nchs/data/nhanes/nhanes_03_04/09_c.pdf">http://www.cdc.gov/nchs/data/nhanes/nhanes_03_04/09_c.pdf</a> .

**Biomarkers that can be Collected by Category of Condition**

Condition	Biomarker(s) Examined	Substance Source	Notes	Source
Sexually Transmitted Diseases				
<a href="#">return to ToC</a>				
HIV	Human immunodeficiency virus	a. semen	a. Efforts to understand male to female sexual transmission of HIV must include semen analysis.	a. Price MA, Cohen MS, Hoffman IF, Chilongozi D, Martinson FE, Tembo T. Collecting the essence of man: semen collection for HIV transmission studies in sub-Saharan Africa. Sex Transm Infect. 2005 Apr;81(2):185-6. Available from: <a href="http://sti.bmj.com/cgi/content/extract/81/2/185-a">http://sti.bmj.com/cgi/content/extract/81/2/185-a</a>
		b. blood	b. Blood is tested using an enzyme-linked immunoassay (ELISA) to detect antibody to HIV with a western blot confirmation of positive ELISA tests.	b. NHANES. Health professionals. [Internet]. Hyattsville, MD: National Center for Health Statistics. [cited 2008 Apr 21]. Available from: <a href="http://www.cdc.gov/nchs/about/major/nhanes/hlthprofess.htm">http://www.cdc.gov/nchs/about/major/nhanes/hlthprofess.htm</a>
		c. saliva	c. ...the availability of round-the-clock rapid HIV testing resulted in successful documentation of HIV serostatus...	c. Pai NP, Barick R, Tulskey JP, Shivkumar PV, Cohan D, Kalantri S, Pai M, Klein MB, Chhabra S. Impact of round-the-clock, rapid oral fluid HIV testing of women in labor in rural India. PLoS Med. 2008 May 6;5(5):e92. Available from: <a href="http://libproxy.lib.unc.edu/login?url=http://dx.doi.org/10.1371/journal.pmed.0050092">http://libproxy.lib.unc.edu/login?url=http://dx.doi.org/10.1371/journal.pmed.0050092</a>
		d. urine	Antibodies...detected by a screening test called an ELISA...method is very sensitive but requires another test, a Western Blot, to confirm the results because false positives can occur.	d. Lab Tests Online. 2005. Human Immunodeficiency Virus (HIV) [Internet]. Washington (DC): American Association for Clinical Chemistry; [cited 2008 Apr 25]. Available from: <a href="http://www.labtestsonline.org/understanding/conditions/hiv.html">http://www.labtestsonline.org/understanding/conditions/hiv.html</a>
Human Papillomavirus (HPV)	DNA	vaginal cells	...human papillomavirus (HPV) DNA-based tests are more accurate than Pap smears in detecting precancerous lesions.	Sellers JW, Karwalajtys TL, Kaczorowski J, Mahony JB, Lytwyn A, Chong S, Sparrow J, Lorincz A; Survey of HPV in Ontario Women Group. Incidence, clearance and predictors of human papillomavirus infection in women. CMAJ. 2003 Feb 18;168(4):421-5. Available from: <a href="http://www.cmaj.ca/cgi/content/full/168/4/421">http://www.cmaj.ca/cgi/content/full/168/4/421</a>
			DNA-Based HPV Tests More Accurate Than Pap Smears	NHANES. Health professionals. [Internet]. Hyattsville, MD: National Center for Health Statistics. [cited 2008 Apr 21]. Available from: <a href="http://www.cdc.gov/nchs/about/major/nhanes/hlthprofess.htm">http://www.cdc.gov/nchs/about/major/nhanes/hlthprofess.htm</a>

**Biomarkers that can be Collected by Category of Condition**

Condition	Biomarker(s) Examined	Substance Source	Notes	Source
<b>Sexually Transmitted Diseases</b>				
<a href="#">return to ToC</a>				
		Smears		Ronco G, Giorgi-Rossi P, Carozzi F, Confortini M, Dalla Palma P, Del Mistro A, Gillio-Tos A, Minucci D, Naldoni C, Rizzolo R, Schincaglia P, Volante R, Zappa M, Zorzi M, Cuzick J, Segnan N; New Technologies for Cervical Cancer Screening Working Group. Results at recruitment from a randomized controlled trial comparing human papillomavirus testing alone with conventional cytology as the primary cervical cancer screening test. J Natl Cancer Inst. 2008 Apr 2;100(7):492-501. Available from: <a href="http://jnci.oxfordjournals.org/cgi/content/full/100/7/492">http://jnci.oxfordjournals.org/cgi/content/full/100/7/492</a>
Lymphogranuloma venereum (LGV)	<i>Chlamydia trachomatis</i> (serovars L1, L2, or L3)	rectal swabs	...rarely occurs in the United States and other industrialized countries.  In states that lack laboratory capacity to perform LGV diagnostic testing, specimens may be submitted to CDC's Chlamydia Laboratory for testing.	CDC. 2006 Lymphogranuloma Venereum (LGV) Project. [cited 2008 Apr18]. Atlanta, GA: CDC. [Internet]. Available from: <a href="http://www.cdc.gov/std/lgv/default.htm">http://www.cdc.gov/std/lgv/default.htm</a> .
Syphilis	Treponema pallidum (bacteria)	blood chancre scraping		Lab Tests Online. 2006. Syphilis [Internet]. Washington (DC): American Association for Clinical Chemistry; [cited 2008 Apr 25]. Available from: <a href="http://www.labtestsonline.org/understanding/analytes/syphilis/glance.html">http://www.labtestsonline.org/understanding/analytes/syphilis/glance.html</a> .
Trichomonas (see <a href="#">Parasites</a> )				