Because the good will of those we serve is the foundation of our success, it's a real pleasure at this holiday season to say, “Thank You” as we wish you a full year of happiness and health.

CAMLT Board of Directors 2012-13

Alicia Santos Named CLS of the Year!

Alicia has been a very active, no, make that an extremely active member of CAMLT since she joined in 1992. In 1999 Alicia won the CAMLT Membership Drive, recruiting more than 5 members that year. (We don’t remember the exact number, probably close to 20, but all she needed was 5 or more to be entered in the drawing.) At the chapter level Alicia has served as Eastland Chapter President and Delegate many times. In fact, she would probably be President still if she had not stepped up to be District IV Consultant in 2006. She served as District IV Consultant for two terms, 2006-2008 and 2008-2010. In addition, she has served on the 2004, 2008 and 2012 Convention Committees. Every year she is an integral part of the Eastland and Foothill Chapters’ Spring Symposium, recruiting speakers, mailing and hand delivering fliers, and working diligently at the event itself.

Alicia earned a BSMT from the University of Santo Thomas in the Philippines and trained at Saint Joseph’s Hospital School of Medical Technology in Syracuse, New York. She worked at St. Joseph’s Hospital for 5 years before moving to California in 1976 where she accepted a position at Cedars-Sinai Medical Center. In 1979, Alicia earned a Master’s Degree in Clinical Science from CSU, Dominguez Hills. Alicia is married and has two daughters and five grandchildren.
As I begin my second year as your President, I realize that we need to focus on strengthening our organization. We must find better ways to explain to our colleagues the importance of belonging to CAMLT and encourage them to remain members. As a first step, we must better inform all members of our profession of our activities and significance via newsletters, website postings, social media, and face to face interactions at educational events. Thanks to Helery Romero, West Side Chapter, one can follow our activities on Facebook. This year we plan to keep you informed with regular publications of Newsline, up to date postings on the CAMLT website and Facebook and announcements at our Statewide Seminars and Annual Meeting. Make an effort to stay informed about the issues that concern you and be part of the commitment to make CAMLT stronger.

If it wasn’t for the efforts of CAMLT’s Legislative Committee and Public Policy Advocates this year, pharmacists and optometrists would have been permitted to perform a wide range of clinical laboratory tests without oversight. In addition, others wanted to dilute CLS training standards to allow a college or university holding a NAACLS accreditation to send CLS students to any CLIA certified laboratory for clinical rotations without CDPH oversight and approval. Because of CAMLT this year, two bills were successfully amended to impose some accountability on pharmacists and optometrists and the third bill clarified requirements for CLS training without compromising existing standards.

My hope is that we continue to grow in numbers and in influence. There was a motion in the House of Delegates meeting that charged each chapter to set a goal to increase their membership. It was also encouraging that many of our newer members vowed to step up to the plate and get involved on various committees, chapter activities and state wide offices. We all came home from our annual meeting filled with so many good ideas for professional growth, enhancing the strength of our organization or for getting involved. Now that more than a month has passed since our annual meeting, the reality of life sets in and we go back to the routine. Instead, let’s make this year and every year to follow different. I vowed to continue as your president for a second term with the understanding that more of you will participate; I cannot do this alone. CAMLT needs each and every one of you to get involved.

We will continue our collaborative efforts with other organizations to make our voices and influence stronger. We will continue to focus on patient safety, education and work force development. To each of you who are currently holding a CAMLT office or those of you I will meet or work with in the coming year, I thank you for your support. We cannot be successful without each other; there is strength in numbers. Let’s transform our ideas into reality and make our actions meaningful to all.

Sincerely,

Dora Goto
President, CAMLT
TECH TONIC SHAKES UP THE
PASADENA HILTON

The 2012 CAMLT Annual Meeting truly was a “Seismic Event”. Indian summer sunshine greeted delegates and seminar attendees to Pasadena September 21 through 23. The 2012 Convention Committee, headed by Co-chairs Kathleen Doty and Rebecca Rosser, greeted 200 registered attendees, 100 CLS and MLT students with their Program Directors and Education Coordinators, exhibitors and the Board of Directors and CAMLT Staff.

Eighteen seminars on a broad variety of topics were led by experts in all fields of laboratory science. Topics included “Immune System 101: It’s a Jungle in There”, “Crystal Ball Gazing – What Will the Hematology Lab Look Like in 2025”, “Fearless Fluids”, “Fatty Acid Oxidation and Bile Acids Biosynthesis Disorders” and “What’s Up with CLIA?”. Comments on the quality and utility of the presentations were uniformly positive.

Student Day included sixteen poster or powerpoint presentations on everything from ABO discrepancies to thalassemia. The judges declared a three-way tie for winning presentation:
**Rachel Steinberger and Joshua Akin of UC San Diego CLS Program for their presentation on “Enhancement of Autoverification through Observation”;**
**Amanda Avila and Sarah Harris from Children’s Hospital, Central California in Madera for their presentation on “Antibiotic Usage in RSV Bronchiolitis Patients”; and**
**Dioscelina Bloom and Amanjoth Sandhu for their poster on “Everything You Wanted to Know about MTG”.** The winners were presented with certificates for a one-year active membership in CAMLT.

The social events were a highlight of the weekend. Fun Nite attendees entered a cocktail lounge atmosphere, where they enjoyed tasty hors d’oeuvres and complimentary drinks. A photo booth provided an opportunity to create souvenirs of the evening. Then a fast round of Speed Mentoring began: students and newly licensed CLS were encouraged to talk one-on-one with an experienced mentor to ask questions and seek advice. The bell rang every five minutes, and the conversations were lively and productive.

The Annual LabPac Luncheon speaker was Raul Bocanegra, candidate for State Assembly from the 39th District. Mr. Bocanegra ran against another Democratic candidate in a race made possible by the new state open primary law. Luncheon guests had a chance to pose questions to the candidate and also to Kathy Rees and Russ Noack of Public Policy Advocates. (By the way, Mr. Bocanegra won.)

The Installation Banquet closed the weekend with the installation of new officers and remarks from Dora Goto, who will continue as President for the 2012-2013 year. Ann Tonini served as Installing Officer for Rhoda Mae Ocubillo, Secretary, and Melissa Parry, District II Consultant. Aylmer Dy, who was elected District IV Consultant, was unable to attend.

The highlight of the evening was the announcement of the CLS of the Year Award, given to Alicia Santos for her dedicated support of CAMLT for many years.

Congratulations to the 2012 Award winning chapters!

Berenice Stevens Award – San Luis Obispo Chapter
Newsletter Award – Sacramento Chapter “Your Analysis”

Valerie Trenev receives Berenice Stevens Award from Chris Darmanian on behalf of San Luis Obispo Chapter.

Shareen Slater receives Newsletter Award from Chris Darmanian on behalf of Sacramento Chapter.
Support Your Local E&R
CAMLT’s Education and Research Foundation

The Education and Research Foundation of CAMLT is a non-profit foundation whose purpose is to provide resources and opportunities in the Clinical Laboratory field for advancing education and research. Using funds donated by chapters and individuals, various awards and scholarships are given each year. Each award carries its own criteria, but both members and non-members benefit. Most are selected by drawing, as the process of giving means-based or merit-based scholarships would require a cumbersome administrative process.

The Foundation Trustees administer the awards, and constantly seek to craft new ways of funding the awards and tailoring them to changing needs. There are twelve Trustees, six nominated by the CAMLT Board of Directors, and six nominated by the Chair of E&R with input from the Trustees. The Chair-Appointed Trustees usually come from the clinical laboratory industry and allow the Foundation to benefit from the support and advice of our industry partners.

Individual donations to the Education and Research Foundation are always welcome. This is an excellent way for members and non-members to directly support continuing advancement of the members of our profession and the students who are our future.

The E&R Foundation Awards:

Membership and Eleanor Kelley Awards are given to participants in CAMLT State Seminars throughout the year, and consist of a full day CE coupon for a CAMLT State Seminar. Funds come from E&R and from a generous donation in memory of Eleanor Kelley, a deceased member.

The Ruth Baldwin Memorial Award provides a one-year CAMLT membership. Funds were donated by friends of Ruth Baldwin.

The Clinical Laboratory Science Clinical Internship Awards are given to three students working in an approved clinical internship program in California, chosen by random drawing from names submitted by Program Directors throughout the state.

E&R Student Stipend Awards go to five students registered for the Annual Meeting.

Two awards administered by the Trustees of E&R require an application process.

The Ronnie Peterson Research and Scholarship Award provides funding for members wishing to implement projects or pursue personal educational opportunities which further the profession of Clinical Laboratory Science.

Mini-Grants for Review Seminars may be applied for by participants in the Review Seminars to cover their costs of attending the reviews. An application form is available on the CAMLT web site.

SB 1481 (Negrete McLeod)
Clinical laboratories: community pharmacies.

Sponsored by the California Pharmacists Association (CPhA) and others, SB 1481 aims to expand Pharmacists’ scope of practice into laboratory testing without a laboratory director as defined in California Laboratory Law. CAMLT directed our legislative advocate, Public Policy Advocates to work extensively with the Committee Consultant analyzing the bill that raised many substantive questions. As a result, the bill passed out of committee with the following amendments:

1) Exempt pharmacists from the application of Section 1206.5 where the customer requests the pharmacist to do one of three specified tests the bill has been limited to, namely, OTC, FDA approved test kits for glucose, A1c, and cholesterol for sale to the public so long as the pharmacist obtains a valid CLIA certificate of waiver and complies with all of the requirements for the performance of waived clinical laboratory tests under applicable federal regulations. 2) The pharmacist obtains a registration from the Department of Public Health and complies with the Chapter. 3) The tests are only performed by a licensed pharmacist in the course of performing routine assessment procedures in compliance with section 4052.4.

The bill was signed by the Governor on September 30 despite efforts to have this bill vetoed. The good news is that this is a far narrower bill than the pharmacists had hoped for. In addition, it does impose some accountability on them for the purposes of the three tests that the bill authorizes them to do.

Make it a priority to meet with your Legislators between now and January. Remember, these interactions are integral components of our grassroots program. For tips, please refer to the CAMLT Grassroots Guide on the website. Note that it is particularly crucial to meet with Legislators who participate on the Assembly and Senate committees through which CAMLT bills most frequently pass so they are better prepared to tackle complex clinical laboratory issues that arise in committee: 1) Assembly Business, Professions and Consumer Protection Committee, 2) Assembly Health Committee, 3) Senate Business, Professions and Economic Development Committee and 4) Senate Health Committee.


CAMLT LAB-PAC

Consider a donation to LAB-PAC. Through LAB-PAC you can help support candidates for state legislature who are in tune with the issues facing clinical laboratory science. A contribution to LAB-PAC insures that your voice is heard. Your voluntary contribution, when added to the contributions of others, makes a real difference.

The annual CAMLT LAB-PAC “Share the Wealth” Fundraiser and Drawing takes place during the CAMLT Annual Meeting. Tickets are available all year round at State Seminar Events and at some Chapter Seminar Events. 50% of all ticket sale proceeds go toward prizes:

First Prize: 30% of total proceeds
(up to a maximum of $3,000)

Second Prize: 15% of total proceeds
(up to a maximum of $1,500)

Third Prize: 5% of total proceeds
(up to a maximum of $500)

The 2012 LAB-PAC “Share the Wealth” Drawing winners are:

First place: Patricia Fawkes
Second place: Nick Hidek
Third place: Carol Beatty

Congratulations to the winners!

California CLS/MLT Licensure Examination Review Seminars 2013**

This program was initially held in 2004 and repeated in 2005-12. Evaluation of the California CLS and MLT exam results show that participants in our review classes passed the exam at significantly higher rates than historical passing rates. Therefore, CAMLT will be presenting review sessions in 2013. These seminars are directed toward persons preparing for the California CLS or MLT licensing and/or certifying examinations and licensed individuals in need of a comprehensive review.

This review seminar is not eligible for continuing education credit for current licensees.

<table>
<thead>
<tr>
<th>Dates (tentative)</th>
<th>Presentation Location</th>
<th>Time</th>
<th>Cost</th>
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</thead>
<tbody>
<tr>
<td>January 26, 27 &amp;</td>
<td>John Muir Medical Center (Concord) 2540 East Street Concord, CA</td>
<td>8:30am - 6pm all days</td>
<td>$80 per day or $395 for all 6 days</td>
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<tr>
<td>February 9, 10, 16, 17 Sat &amp; Sun</td>
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<tr>
<td>February 2 &amp; 3 Sat &amp; Sun</td>
<td>UC Irvine Medical Center 101 The City Drive Orange, CA</td>
<td>8:30am - 6pm both days</td>
<td>$295</td>
</tr>
<tr>
<td>August 17, 18, 24, 25 &amp; September 7, 8 Sat &amp; Sun</td>
<td>John Muir Medical Center (Concord) 2540 East Street Concord, CA</td>
<td>8:30am - 6pm all days</td>
<td>$80 per day or $395 for all 6 days</td>
</tr>
<tr>
<td>September 14 &amp; 15 Sat &amp; Sun</td>
<td>UC Irvine Medical Center 101 The City Drive Orange, CA</td>
<td>8:30am – 6pm all days</td>
<td>$295</td>
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Additional information, exact locations of seminars, seminar abstract, registration forms, and related educational/course material for purchase are updated regularly at www.camlt.org and click on the Professions and Examination Review Seminars course link.

**Sponsored in part by:** John Muir Health Bay Valley Medical Group

November/December, 2012 CAMLT/Newsline 5
RONNY PETERSON RESEARCH AND SCHOLARSHIP AWARD

SUBMISSIONS INVITED FOR 2013 AWARD

This award was established in memory of Ronny Peterson, a past President of the California Association for Medical Laboratory Technology (CAMLT). Ronny, a dedicated member of CAMLT, was an active supporter of the advancement of the profession. The scholarship provides funding for persons wishing to implement projects or pursue personal educational opportunities which further the profession of Clinical Laboratory Science.

Applications are accepted throughout the year. Chosen recipients will be announced at the Annual Meeting of CAMLT, held in the fall each year.

Amount funded: Maximum of $1000
Submission deadline: August 1, 2013 for 2013 Award

Criteria:
1. Applicant must be a member of CAMLT
2. Applicant will submit a one-page justification for fund usage that includes:
   a. Proposed use of funds
   b. Description of how use of funds will further the profession
3. Examples of appropriate fund usage are:
   a. Pursuit of a related degree beyond that required for CLS licensing
   b. Attendance at professional workshops that provide the attendee with new or advanced work skills (not required continuing education)
   c. Development of materials for use in student recruitment
   d. Development of materials for membership recruitment

Judging:
Justification document and materials will be evaluated by the Board of Trustees, Education and Research Foundation, CAMLT, or appropriate designees. All criteria must be met. The award will be given to the member whose request, in the opinion of the judges, best furthers the profession.

Submit information to:
   Education and Research Foundation
   CAMLT Executive Office
   1895 Mowry Avenue, Suite 112
   Fremont, CA 94538-1766

The award recipient will be announced at the CAMLT Annual Meeting, to be held September 27-29, 2013 in Santa Clara.
CAMLT’s Got a Little List, We’ve Got a Little List…

WHEN YOU WISH UPON A STAR, as they say, dreams can come true. But what if the Star has the wishes? We know you think CAMLT is a stellar organization for laboratory folks. Maybe you feel you have benefited personally from CAMLT’s programs – met some great people, attended seminars that helped you grow in your profession, learned about the legislative process and how each of us can become involved. Maybe you would like to return the favor by helping to fund one of CAMLT’s excellent programs. Or maybe you would like to fill an immediate, concrete need for the organization. Well, we have just the thing for you…our CAMLT Wish List!

Wish List Donors

We extend our sincere thanks to the individuals and chapters that have contributed to CAMLT’s Wish List from December 1, 2011 to November 30, 2012.

**VEGA $2500 - $4999**
Foothill Chapter

**SPICA $100 - $499**
Christine Darmanian
Dora Goto
Adrienne Lieu
Valerie Shipilov-Chataignier
Mary Jeanne Stavish
Alice Takeda

**CASTOR $20 - $99**
Normadene Carpenter
Lisa Glaser
Virginia Vorous

If you are feeling generous, please contact the CAMLT Executive Office at office@camlt.org or complete the information below and fax to (510) 792-3045 or return to:

CAMLT
1895 Mowry Avenue, Suite 112
Fremont, CA  94538

Name:_________________________________
Address: _______________________________
______________________________________
City/State/Zip:__________________________
Phone:________________________________
Email:________________________________

$               toward 1 LCD Projector
$               toward refurbishing projects at the Executive Office
$               cash donation

◊ My check is enclosed, payable to CAMLT.
◊ You may charge my donation to my credit card.
◊ Visa
◊ Master Card
Card #_____________________________  Exp. _______
Signature__________________________  Date _______

For those of you who have given in the past, thank you. Your kindness is appreciated and valued by all!

Please Note - “Contributions or gifts to California Association for Medical Laboratory Technology are NOT tax deductible as charitable contributions for income tax purposes. However, they may be tax deductible as ordinary and necessary business expenses subject to restrictions imposed as a result of association lobbying activities. CAMLT estimates that the non-deductible portion of your contributions - the portion which is allocable to lobbying - is 33%.”
CONVENTION 2012 MEMORIES
Thank you to all the supporters of the 73rd Annual Meeting and Exhibits!

Convention Sponsors

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Bay Valley Medical Group
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Janet Vogel

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Aerotek
Children’s Hospital Los Angeles
City of Hope
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Immunodiagnostic Systems Inc.
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South Bay Chapter
Bay Valley Medical Group
East Bay Chapter
San Luis Obispo Chapter
Fresno Chapter
Janet Vogel

ABSTRACTS
VITAMIN D
Course # DL-999
2.0 CE/Contact Hours
Level of Difficulty: Intermediate
Les Revier, BS, MBA, CLS, C(ASCP),
Senior Manager, UCSD Medical Center Laboratory, Retired
Program Director, San Diego Miramar College Medical
Laboratory Technician Program

OBJECTIVES:
Upon completion of this course the participant will be able to:

- Outline the role of vitamin D in calcium homeostasis and its effects in the body.
- Discuss the finding that the role of vitamin D insufficiency is much more widespread than previously thought.
- Discuss the factors that affect activation of vitamin D in the skin by sunlight.
- Outline the diseases vitamin D has been found to ameliorate.
- List the current dosing recommendation for vitamin D.
- Discuss the status of measuring vitamin D level.
- List several dietary sources of vitamin D.

ABSTRACT:
Over the last decade, interest in vitamin D has exploded. This vitamin, previously known primarily for its importance in preventing the bone conditions of rickets in children and osteomalacia, the softening of the bones, in adults, has recently been recognized as having a substantially greater role in health. Vitamin D is now known to affect a variety of physiologic systems and increased intake has been linked to a number of favorable health outcomes and even to a reduction in overall mortality.

25-hydroxyvitamin D (25-OHD), vitamin D, determination is of diagnostic importance for the investigation of vitamin D deficiency and much more rarely, intoxication. Despite the name, vitamin D is a pre-hormone, being endogenously synthesized provided there is adequate sunlight. Its biological function, exerted through the active form 1,25 dihydroxyvitamin D$_3$ (1,25-(OH)$_2$D) is to maintain calcium and phosphate levels in the blood. In addition, vitamin D has important roles in immune regulation. This presentation will examine the role of vitamin D in calcium homeostasis, discuss recently proposed effects on other diseases and conditions, provide insight into current dosing, discuss vitamin D insufficiency, and describe the measuring of vitamin D.

VITAMIN D
Vitamin D is a fat-soluble compound that is required for normal calcium metabolism. While vitamin D is essential for human health, it is not obtained primarily from the diet and therefore, is not technically a vitamin. In actuality vitamin D is a hormone. Further, its biologic actions occur after it is metabolized to 1,25-dihydroxyvitamin D. This active form of vitamin D is a steroid hormone structurally related to estradiol, cortisol, and aldosterone. (1)

The major form of vitamin D circulating in the body is 25-hydroxyvitamin D [25-(OH)D]. It has a half-life of about 2 weeks, which makes its serum concentration a good biomarker of vitamin D status. The recommended minimum level of 25-(OH)D is under debate, but experts have proposed that levels of 30 ng/mL (75 nmol/L) or higher may be optimal. (Table I) This level is linked with a decreased risk for bone fractures.

Vitamin D deficiency appears to affect all age and demographic groups in the U.S. In a recent national survey, the average 25-(OH)D level for both men and women of various ages was similar at 24 ng/mL. In the U.S., about 36% of healthy young adults have levels that are less than sufficient. However, vitamin D deficiency does vary with age, ethnicity (skin color), and geographic location. (2) Among almost 700 men residing in Boston, most (83%) had insufficient vitamin D levels and one third were deficient; virtually all Indian born and Chinese-born men had low vitamin D levels. (3) Among young women in Texas, white women had levels near sufficient, while Hispanic and black women had deficient levels. The lowest levels were in black women. In a group of older adults (> 55 years) living in Missouri, African Americans had levels lower than whites but the levels for both races were insufficient. (4) Arab-American women in Michigan had deficient levels, with the lowest in those who wore veils and did not take vitamin D supplements. (5)

HISTORY OF RICKETS AND VITAMIN D
Rickets has been known since ancient times. Writings from the first and second centuries by Soranus, a Roman physician, and Galen, a Greek physician, described conditions with bony deformities in infants. Although these descriptions can be interpreted as evidence for rickets, it was not until the 17th century that the first clear descriptions were made by Dr. Daniel Whisler in 1645 and then by Professor Francis Glisson in 1650. In the late 1700s, rickets became widespread in Europe as people stayed indoors and lived in polluted cities with reduced sunlight. In 1865, Trousseau recommended cod liver oil for treating rickets. He also noted the importance of sunlight.

Vitamin D became classified as a vitamin through a historical accident: In 1921 Sir Edward Mellanby, after experiments with dogs raised indoors and given a restricted diet, wrote, “The action of fats in rickets is due to a vitamin or accessory food factor which they contain, probably identical with the fat-soluble vitamin.” He established that cod liver oil was an antirachitic agent.

In 1923, Goldblatt and Soames established that when a precursor to vitamin D in the skin was exposed to sunlight, a substance equivalent to the fat-soluble vitamin was produced. Laboratories in Germany and England elucidated the chemi-
ical structure of the D vitamins in the early 1930s. Vitamin D$_3$ was not characterized until 1936 when it was shown to result from the ultraviolet irradiation of 7-dehydrocholesterol in the skin. About the same time the antirachitic substance in cod liver oil was shown to be identical to vitamin D3.

In the 1930s the Public Health's recommendation of fortifying milk with vitamin D and giving cod liver oil as a nutritional supplement led to near eradication of rickets in the United States and other industrialized nations. Now rickets has made a comeback and also remains common in less well developed countries. (6)

**ACTIVATION OF VITAMIN D**

The formation of vitamin D in the body starts with the conversion, by ultraviolet light (UVB), of 7-dehydrocholesterol, which is present in the skin, to vitamin D$_3$ (cholecalciferol). This is followed by hydroxylation in the liver to create 25-hydroxyvitamin D$_3$ (25-(OH)$_2$D$_3$) and then a second hydroxylation, primarily by the kidneys, to form 1,25 dihydroxyvitamin D$_3$ (1,25-(OH)$_2$D$_3$), also known as calcitriol, which is the physiologically active form of vitamin D$_3$.

There are two main forms of vitamin D: vitamin D$_2$ (ergocalciferol) and vitamin D$_3$ (cholecalciferol). Vitamin D$_2$ is obtained by consumption of plant foods and yeasts, while D$_3$ is produced in the skin by UVB radiation or obtained from animal foods such as fatty fish. (Table 2) The 25-(OH)D serum concentration reflects vitamin D produced in the skin as well as that obtained from food and supplements; both 25-(OH)$_2$D$_2$ and 25-(OH)$_2$D$_3$ are measured as part of the 25-(OH)D serum concentration. Hydroxylated vitamin D (25-(OH)D) is stored in body fat until needed. Similar to D$_3$, D$_2$ is hydroxylated in the liver to form 25-(OH)D$_2$ and then in the kidneys to form active 1,25-(OH)$_2$D$_2$.

Since adequate amounts of vitamin D cannot be obtained from the diet, throughout the history of the species, humans have had to get vitamin D from UVB's activation of 7-deoxycholesterol in the skin. The earliest members of Homo sapiens evolved in Africa and had darkly pigmented skin adapted to the conditions of UV radiation that existed near the equator. As humans migrated north out of the tropics they encountered environments in which they got less UV radiation during the year, especially during winter-time. The dark pigmentation was detrimental to the production of adequate amounts of vitamin D. Dark skin contains so much melanin, which acts like a natural sun-screen, that very little UV radiation, and specifically very little of the shorter-wavelength UVB radiation, can penetrate the skin. The solution, over evolutionary time, has been for migrants to northern latitudes to lose skin pigmentation.

Another effect of UVB is to destroy the nutrient folate. Anthropologist Dr. Nina Jablonski (7) states, “Throughout the world, human skin color has evolved to be dark enough to prevent sunlight from destroying folate but light enough to foster the production of vitamin D. Recent epidemiological and physiological evidence suggests that the worldwide pattern of human skin color is the product of natural selection acting to regulate the effects of the sun’s ultraviolet radiation on key nutrients crucial to reproduction.” In farther northern latitudes most UVB is absorbed by the atmosphere for most of the year, only reaching the earth during summer. Thus, rickets was prevalent in the northern populations until the problem was recognized and dietary supplementation, such as codfish oil became available. Now pills can supply adequate amounts of vitamin D.

**MECHANISM OF ACTION OF VITAMIN D**

Most of the actions of vitamin D are mediated through a nuclear transcription factor, vitamin D receptor (VDR). When 1,25-dihydroxyvitamin D enters the nucleus of a cell, it associates with the VDR and then complexes with retinoic acid X receptor (RXR). The entire complex starts molecular interactions that modulate the transcription of specific genes. More than fifty genes in tissues in the body are known to be regulated by 1,25-dihydroxyvitamin D.

In small intestinal epithelial cells 1,25-(OH)$_2$D upregulates expression of a number of genes that stimulate transepithelial calcium transport from the intestinal lumen into the blood. In the bone 1,25-(OH)$_2$D stimulates terminal differentiation of osteoclast precursors to osteoblasts. 1,25-(OH)$_2$D also stimulates osteoblasts to influence osteoclasts to mobilize bone calcium. 1,25-(OH)$_2$D plays an important role in mineralization of bone, since abnormal bone results when vitamin D is deficient or its metabolism is defective.

The conversion of 25-(OH)D to active 1,25-(OH)$_2$D is tightly regulated by the body, primarily by the conversion step in the kidneys. The parathyroid hormone (PTH) and serum calcium and phosphorus levels are the major regulators of 1,25-(OH)$_2$D production in the kidneys. The parathyroid glands sense serum calcium levels and secrete PTH if calcium levels drop too low. This increases production of 1,25-dihydroxyvitamin D, which results in:

- Increasing intestinal absorption of dietary calcium
- Increasing the reabsorption of calcium filtered by the kidneys
- Mobilizing calcium from bone when serum calcium level is below normal

Elevated PTH is a marker for vitamin D deficiency. Overproduction of 1,25-(OH)$_2$D is inhibited by a negative feedback loop: 1,25-(OH)$_2$D inhibits PTH release and the CYP (cytochrome) 27B1 enzyme that forms 1,25(OH)$_2$D, in addition to activating the CYP enzyme that metabolizes it.

Natural vitamin D levels in humans exposed daily to hours of intense sunlight (e.g., lifeguards) are 50-125 ng/mL. Continued UVB exposure does not result in excessive vitamin D formation. Vitamin D is sensitive to UV radiation and heat; sustained UVB exposure causes its photodegradation in the skin to an inactive product. No cases have ever been reported of vitamin D intoxication from sun exposure.
VITAMIN D REQUIREMENTS (see Table III)

The recommended adequate intake (AI) of vitamin D as established by the Food and Nutrition Board (FNB) of the Institute of Medicine in 1997 was 200 IU for newborn to age 50. This dose is a daily intake, obtained from food and/or supplements, that is minimally sufficient to maintain bone health and normal calcium metabolism in healthy people. Since that time, a considerable amount of new information on vitamin D has become available. In 2008, the FNB established an expert panel to review current information and to revise the AI for vitamin D. The Institute of Medicine issued new recommendations in September 2010. (See Table III)

Many clinicians and researchers consider the current vitamin D normal range too low for optimal health due to the focus only on vitamin D’s action on calcium and bone. In 2008 both the National Osteoporosis Foundation (NOF) and the American Academy of Pediatrics recommended intakes for vitamin D that are greater than the current AIs. (8,9)

The NOF recommends that adults under 50 years of age consume 400-800 IU/day (Table III). Other clinicians believe that daily doses will need to be even higher (in the absence of sun exposure) to achieve the desired vitamin D levels linked with health benefits beyond bone health. It has been suggested that to achieve sufficiency levels for 97% of U.S. residents who are at risk for bone loss, the required minimum daily intake of vitamin D, would be 2600 IU/day (in the absence of significant sun exposure) or intake from diet and supplements of about 1000 IU/day for every 33 lb (15 kg) of body weight. The presence of obesity, increased vitamin D destruction, or serious illness such as cancer, heart disease, or diabetes may increase the required intake. Further, these are the doses needed for maintenance of adequate serum concentrations. For individuals with vitamin D deficiency or insufficiency (Table I), a “loading dose” to correct the serum concentration is the first step. The typical loading dose is 50,000 IU of oral vitamin D given weekly for 8 weeks or twice weekly for 5 weeks. It has been suggested that all individuals at risk of vitamin D deficiency have a serum 25-(OH)D level measured twice yearly to guide vitamin D dosing. Prescription vitamin D analogues and active vitamin D (calcitriol) are available for people with fat malabsorption or an inability to produce active vitamin D in the kidney (chronic renal failure).

Vitamin D3 and D2 have been regarded as equally effective based on their ability to prevent rickets. However, new evidence shows they are metabolized differently and that D2 may be more effective at increasing and maintaining vitamin D serum levels, as well as binding to the vitamin D receptor (VDR). Most vitamin manufacturers have replaced ergocalciferol (D2) with cholecalciferol (D3) in their products.

VITAMIN D DEFICIENCY

Risk Factors for Deficiency (1)

- “Exclusively breast-fed infants: Infants who are exclusively breast-fed and do not receive vitamin D supplementation are at high risk of deficiency, particularly if they have dark skin and/or receive little sun exposure. Human milk generally provides 25 IU of vitamin D per liter, which is not enough for an infant if it is the sole source.
- Dark skin: People with dark-colored skin synthesize less vitamin D on exposure to sunlight than those with light-colored skin, particularly if they live far from the equator.
- Aging: The elderly have reduced capacity to synthesize vitamin D in skin when exposed to UVB, and the elderly are more likely to stay indoors or use sunscreen. Institutionalized adults who are not supplemented are at extremely high risk of deficiency.
- Covering all exposed skin or using sunscreen whenever outside: Osteomalacia has been documented in women who cover all of their skin whenever they are outside for religious or cultural reasons. The application of sunscreen with an SPF greater than 8 reduces production of vitamin D by 95%.
- Fat malabsorption syndromes: Cystic fibrosis and cholestatic liver disease impair the absorption of dietary vitamin D.
- Inflammatory bowel disease: People with inflammatory bowel disease like Crohn’s disease appear to be at increased risk of deficiency, especially those who have had small bowel resections.
- Obesity: Obesity increases the risk of deficiency—once vitamin D is synthesized in the skin or ingested, it is deposited in body fat stores, making it less bioavailable to people with large stores of body fat.”

Severe deficiency

Rickets: In infants and children severe deficiency results in the failure of bone to mineralize. In the absence of adequate mineralization, weight-bearing arms and legs become bowed. In infants there may be delayed closure of the fontanels in the skull. The rib cage may be deformed due to the pulling action of the diaphragm. Severe hypocalcemia may cause seizures. Since UVB activates 7-dehydrocholesterol in the skin to vitamin D3, when UVB is decreased in the higher latitudes, inadequate amounts of vitamin D3 are produced, resulting in inadequate mineralization of bones. Now fortification of foods and taking of vitamin D pills has led to significant reduction in rickets. However, complacency about vitamin D deficiency has led to continued nutritional rickets in cities throughout the world.

Osteomalacia (soft bones) in adults: Although bones are no longer growing in adults, there is a constant state of turnover. In adults with severe vitamin D deficiency bone mineral is progressively lost, resulting in bone pain and osteomalacia.

Symptoms of Deficiency

The symptoms of vitamin D deficiency in adults are bone discomfort (in the low back and lower extremities), myalgia (muscle aches), and weakness. These symptoms may be misdiagnosed as arthritis, fibromyalgia, or chronic fatigue syndrome. Due to muscle weakness, there is an increased risk of falls. Vitamin D deficiency can also exacerbate or
cause osteoporosis. Myalgia is also a common adverse effect experienced by individuals taking statin medications to lower cholesterol. Some evidence suggests that individuals with low vitamin D levels may be more likely to experience myalgia, and that increasing vitamin D levels may resolve statin induced myalgia in a large percentage of patients.

Toxicity

Vitamin D toxicity is rare. Too much sun exposure does not cause toxicity because the body regulates the amount of vitamin D produced; even fortified foods do not contain large amounts. Short-term use of even very large doses of vitamin D (e.g., 50,000 IU/week for 8 weeks) does not cause toxicity. Toxicity is unlikely in adults unless more than 10,000 IU/day is taken for many months or years. Vitamin D toxicity results in hypercalcemia. Increased serum calcium levels can cause nausea and vomiting, constipation, mental status changes, and heart arrhythmias; deposition of calcium in the kidneys and soft tissues may also occur. A 25-(OH)D level consistently above 200 ng/mL (> 500 nmol/L) is considered potentially toxic.

Effects of Vitamin D in the Body

A growing volume of research shows that vitamin D has diverse effects throughout the body. As mentioned previously, researchers have discovered that the vitamin D receptor (VDR) is found in numerous tissues. Once activated, this receptor can work on DNA to produce a wide variety of effects. A summary of some of the most intriguing findings about the emerging roles for vitamin D follows.

Bone Fracture

Osteoporosis-related fractures are a major health risk for the elderly, particularly older women, and vitamin D may reduce this risk. A recent analysis of 9 clinical trials found that vitamin D, in doses greater than 400 IU daily, reduced the risk of nonvertebral and hip fractures by 20% and 18%, respectively, in adults aged 65 or older. These results were independent of calcium supplementation. Lower doses did not appear to provide the same benefit. An earlier analysis of 13 trials found that overall vitamin D in doses of 300-800 IU/day did not significantly reduce fractures. However, high-dose vitamin D (700-800 IU/day) reduced the risk of both nonvertebral and hip fractures, particularly in institutionalized elders, who may have greater compliance with daily vitamin D intake. Not surprisingly, a substantial body of evidence indicates that the combination of vitamin D and calcium may provide a greater benefit in reducing bone fractures than vitamin D (400-800 IU daily) alone. Overall, the current body of evidence suggests the combination of vitamin D, in doses greater than 400 IU daily, with calcium (at least 1000 mg daily) is a reasonable regimen for elders interested in reducing the risk of fractures.

Muscle Strength and Falls

With the aging population of the U.S., the impact of falls and injuries including bone fracture on health care utilization is becoming increasingly important. Each year, about one-third of people who are 65 or older experience one or more falls. About 10% of these lead to emergency room visits and more than 5% are linked with at least one fracture. Vitamin D is an emerging therapy for fall prevention. The positive effect of vitamin D on muscle strength appears to be mediated by the vitamin D receptor (VDR) present in skeletal muscle tissue. Vitamin D supplementation has been noted to improve muscle strength, function, and balance.

A number of clinical trials have shown that vitamin D supplementation reduces the risk of falls in older adults, while others have found no benefit. Differences in study design may have contributed to the inconsistent results. For example, the definition of a fall was not consistent across studies, and some studies may not have recorded all falls. In addition, the dose of vitamin D appears to be an important variable. The strongest evidence supporting vitamin D supplementation for fall prevention comes from studies using at least 700 IU per day. A recent meta-analysis of 8 randomized, controlled trials showed about a 20% reduction in the risk of fall with doses of 700 to 1000 IU daily; little or no effect was seen with daily doses of 400 IU or less. The analysis suggested that supplementation must result in 25-(OH)D levels of at least 24 ng/ml to prevent falls. In addition, vitamin D3 appeared to provide a greater benefit than vitamin D2. The dosing regimen also appears to have an important effect on falls. In a recent study using once yearly administration of a very high vitamin D dose (500,000 IU), an increase in risk of falls was observed in the first 3 months after administration. Daily, weekly or monthly dosing regimens may be more likely to be beneficial. Preliminary evidence suggests the benefit of vitamin D supplementation for fall prevention may be more pronounced in older, than in healthier individuals. For example, one study in ambulatory elders who were younger and healthier, on average, than the population in previous studies did not find a significant reduction in fall risk with a dose of 800 IU of vitamin D.

Although further study is needed, the evidence to date suggests that higher vitamin D doses reduce the risk of falls in elders. Cholecalciferol (vitamin D3), in doses of at least 700 IU daily, is a reasonable recommendation for older individuals interested in taking a vitamin D supplement to help prevent falls.

Cancer

The association between cancer and sunlight exposure has been investigated by medical researchers for almost 75 years. Early investigators noted that patients with skin cancers attributed to sun exposure had a reduced incidence of non-skin cancers. Studies have looked at the relationship between latitude, a surrogate measure for sun exposure and vitamin D levels, and the risk of cancers. The strongest data to date come from epidemiological and observational studies. While these studies cannot establish a causal relationship between low vitamin D levels and cancers, they have identi-
fied an association. Several approaches have been taken to look at vitamin D status, including the evaluation of dietary intake, sun exposure, and serum levels of both 25-(OH)D and 1,25-(OH)2D. Colorectal cancer and breast cancer are the most well-studied. Although the evidence to date is mixed, there is sufficient positive evidence linking higher 25-(OH)D levels to lower cancer risk to warrant further investigation. (11)

**Colorectal Cancer**

Over 30 observational studies of colon cancer or pre-cancerous polyps and vitamin D have been published. The majority found a statistically significant link between increasing vitamin D status and reduction in cancer risk. A recent meta-analysis of studies looking at colorectal cancer risk and 25-(OH)D levels over time (rather than single measurements) also supports an inverse relationship. One large clinical trial, the Women’s Health Initiative, did not show any correlation between taking a vitamin D supplement and the incidence of colon cancer. However, the dose of vitamin D used in this study was only 400 IU, which is now generally believed to be inadequate to produce a protective effect.

**Breast Cancer**

Numerous studies have shown a link between higher levels of sun exposure and a lower incidence of breast cancer. In contrast, 6 observational studies did not find a link between breast cancer risk and vitamin D intake from food and supplements. Some evidence suggests the preventive effects of vitamin D may be limited to specific groups (e.g., premenopausal women) or tumor types (e.g., estrogen receptor positive), although further study is needed. The results of studies evaluating vitamin D blood levels have been inconsistent. Thus, while some evidence suggests higher vitamin D status is linked with lower breast cancer risk, the relationship remains unclear.

**Prostate Cancer**

Observational studies identified a correlation between higher sunlight levels and lower prostate cancer (PC) mortality, leading to the hypothesis that vitamin D affects the risk of developing this cancer. However, analysis of 4 studies evaluating sunlight exposure and PC risk found no relationship. Similarly, the analysis of 10 studies of serum vitamin D levels and PC incidence found no decrease in incidence with increased 25-(OH)D levels. The strongest evidence to date does not support a link between vitamin D and reduced PC risk.

**Other Cancers**

Associations between increased vitamin D and decreased risk for some other cancers including pancreatic, other GI tract cancers, and some hematologic cancers have also been reported.

**Potential Mechanisms**

How might vitamin D affect cancer growth? The bottom line is that there is no clear consensus, and the effects may vary by tumor type. Several potential mechanisms have been identified. Most of the tissues of the body contain the vitamin D receptor (VDR), and vitamin D affects cell growth and proliferation by activation of this receptor.

Vitamin D promotes cell differentiation, modulates cell growth, and induces apoptosis (programmed death) in cancer cells. Vitamin D also has an increasingly recognized role in immune modulation, which can impact the body’s ability to respond to cancer. Its role in hormonal and cellular signaling is also beginning to be recognized. Vitamin D has an anti-angiogenic effect on tumors, blocking the growth of new blood vessels needed to supply growing tumors. Many types of tumor cells express the VDR, including melanoma and breast cancers. Many healthy tissues, including colon, breast and prostate tissue, contain an enzyme that activates circulating pre-vitamin D, which allows local tissue levels of active vitamin D to be higher than circulating levels.

**Cardiovascular Disease**

The body of evidence supporting the role of vitamin D in cardiovascular risk reduction is also increasing. Most studies to date have been epidemiological and observational, but unlike the evidence for cancer, a number of clinical trials have also been published. While the observational evidence has not been uniformly positive, overall it suggests an inverse relationship between vitamin D status and the incidence of cardiovascular disease (CVD). For example, an analysis of 3 studies evaluating 25-(OH)D levels and hypertension incidence found a statistically significant association between low levels and new onset hypertension after 7 to 8 years. Nine observational studies have investigated the relationship between 25-(OH)D levels and new onset CVD (e.g., heart attack, cardiovascular-related death, stroke). Five of these studies, or slightly more than half, found an inverse relationship between the two.

**Type 2 Diabetes**

Pancreatic β cells have vitamin D receptors, and pancreatic tissue contains the enzyme needed to convert 25-(OH)D to 1,25-(OH)2D. Vitamin D has been theorized to play a role in insulin secretion, insulin sensitivity, and inflammation. All these effects potentially influence the development and control of type 2 diabetes mellitus (DM).

The observational evidence for a link between low vitamin D status and the risk of type 2 DM is mixed. Among men, 2 of 4 longitudinal observational studies identified a link between higher vitamin D levels and lower risk of new-onset type 2 DM. Among women, only 1 of 4 studies found a similar link. The randomized clinical trials (RCTs) to date have shown some interesting results. Three trials showed no effect of vitamin D on fasting glucose levels among participants who had normal fasting glucose levels when the trials began. In 2 short-term trials of participants with type 2 DM, vitamin
D supplementation had no effect on measures of glucose control. A more recent trial in women with vitamin D deficiency and insulin resistance showed improvement in insulin resistance with supplementation. Although the evidence to date is intriguing, further study is needed to establish a role for vitamin D in type 2 DM.

**Autoimmune Diseases**

Vitamin D is known to play a role in both the innate and the acquired immune systems. Low vitamin D levels have been linked with an increased risk of autoimmune diseases such as type 1 diabetes, multiple sclerosis, and rheumatoid arthritis. Vitamin D receptors are present in cells involved in these diseases, including macrophages, chondrocytes, pancreatic β cells, and synoviocytes. In addition, the enzyme for converting 25-(OH)D to 1,25-(OH)₂D is present in macrophages and dendritic cells. The mechanisms underlying the link between vitamin D and reduced autoimmune disease risk are largely unknown, but may be due to vitamin D’s immunomodulatory effects.

**Type 1 Diabetes Mellitus**

Animal studies suggest that the immunomodulatory effects of Vitamin D decrease autoimmune destruction of pancreatic β-cells and increase insulin secretion and glucose tolerance. Studies investigating vitamin D supplements for the prevention of type 1 DM have been largely observational. In a recent meta-analysis of observational studies, vitamin D supplementation in children and infants was associated with a 29% reduction in the risk of type 1 DM. It appeared to be a dose dependent effect, with higher doses resulting in greater risk reduction. This preliminary evidence suggests an important role for vitamin D supplementation in type 1 DM; however, clinical trials are needed to establish a benefit.

**Multiple Sclerosis**

Some of the strongest evidence for a link between multiple sclerosis (MS) risk and serum 25-(OH)D levels comes from a large observational study of over 7 million U.S. military personnel. Cases of MS were identified along with 25-(OH)D levels. Compared with matched controls, white participants with higher vitamin D levels had a significantly lower risk of developing MS. This relationship was not significant in blacks and Hispanics. Based on the results, Ascherio, Munger, and Simon, authors of a recent review, estimated that 70% of MS cases in the U.S. and Europe could be prevented by increasing vitamin D serum levels in adolescents and young adults to a level greater than 40 ng/mL. Studies of the effect of vitamin D on preventing progression or prolonging remission in MS patients have been small and vary in quality. One study designed to examine the tolerability of oral calcitriol (target dose: 2.5 mcg/d) noted a reduction in the exacerbation rate during the 48 week supplementation period compared with the pre-treatment rate. Further study of vitamin D supplementation for both preventing and slowing the progression of MS are needed to clarify its role. (12)

**Rheumatoid Arthritis**

The evidence supporting a role for vitamin D in rheumatoid arthritis (RA) is developing, but remains relatively scarce. One observational study of older women suggested a link between higher vitamin D intake and a lower risk of developing RA. However, another observational study found no link between vitamin D levels and the onset of RA. In patients with established RA, the relationship between higher vitamin D serum levels and disease activity is also unclear. The impact of vitamin D in studies of RA is often confounded by other RA treatments that could affect disease activity, and by the overlap between RA and other conditions where vitamin D has known or likely effects (e.g., bone fractures and falls). Until a clear benefit for individuals with RA is established, the most reasonable recommendation is to correct vitamin D deficiency in individuals at high risk for RA, fractures or falls, such as postmenopausal women. (13)

**Infectious Diseases**

Early research showing an antimicrobial effect of vitamin D in cells infected with *M. tuberculosis* led to studies investigating of the role of vitamin D in various infectious diseases. Studies have largely been observational, but 2 recent RCTs are of interest. The first examined the effects of vitamin D supplementation in an African population with tuberculosis, and failed to show any benefit. However, the dosing regimen may not have been optimal. The other trial compared the incidence of influenza A among school-aged Japanese children taking vitamin D 1200 IU daily with those who were taking placebo. The results suggested that vitamin D₃ supplementation in winter may reduce the incidence of influenza A. (14) Additional clinical trials are needed to confirm a role for vitamin D supplementation in these or any other infections.

**Measuring Vitamin D status**

The serum concentration of 25-hydroxy-vitamin D is typically used to determine vitamin D status. It reflects vitamin D produced in the skin as well as that acquired from the diet, and has a fairly long circulating half-life of 15-21 days. It does not, however, reveal the amount of vitamin D stored in other body tissues. The level of serum 1,25-dihydroxy-vitamin D is not usually used to determine vitamin D status because it has a short half-life of 15 hours and is tightly regulated by parathyroid hormone, calcium, and phosphate, such that it does not decrease significantly until vitamin D deficiency is already well advanced. Although cholecalciferol and 1,25-(OH)₂D can be measured in the circulation, the best estimates of vitamin D status are provided by measurement of 25-(OH)D.

Definitive methods employ GC coupled with mass spectrometry detection. Recently a candidate reference method using LC-tandem mass spectrometry was published. While these reference methods are suitable for validating the recovery and accuracy of routine methods, their complexity and derivatisation requirements mitigate against regular use.
Vitamin D has also been measured by High Pressure Liquid Chromatography (HPLC); Immunoassay, both RIA and Chemiluminescent. These include the Diasorin RIA; the Nichols Advantage; the IDS Gamma B and the Diasorin Liaison.

Serum is the preferred specimen although plasma (EDTA and Li-heparin) samples are satisfactory. Vitamin D analytes have been shown to be stable for up to 2 weeks at 30°C and to be unaffected by up to 4 freeze-thaw cycles. Storage of frozen serum samples at −20°C for up to one year has also been reported to cause no loss in vitamin D metabolites. However, it seems that the measurement of 25-(OH)D by immunoassay will remain the method of choice for reasons of convenience, speed, turnaround and cost. Beginning in July 2009 a standard reference material became available which allowed laboratories to standardize their procedures.

**Dietary sources of Vitamin D**

Listed below are a few sources of vitamin D and the amounts of vitamin D contained

- **Fatty fish species**, such as:
  - Catfish, 85 g (3 oz) provides 425 IU (5 IU/g)
  - Salmon, cooked, 100 g (3.5 oz) provides 360 IU (3.6 IU/g)
  - Mackerel, cooked, 100 g (3.5 oz), 345 IU (3.45 IU/g)
  - Sardines, canned in oil, drained, 50 g (1.75 oz), 250 IU (5 IU/g)
  - Tuna, canned in oil, 100 g (3.5 oz), 235 IU (2.35 IU/g)
  - Eel, cooked, 100 g (3.5 oz), 200 IU (2.00 IU/g)

- A whole egg provides 20 IU if egg weighs 60 g (0.33 IU/g)

- **Beef liver**, cooked, 100 g (3.5 oz), provides 15 IU (0.15 IU/g)

- **Fish liver oils**, such as cod liver oil, 1 Tbs. (15 ml) provides 1360 IU (90.6 IU/ml)

- UV-irradiated mushrooms and UV-irradiated yeast are the only vegan sources of vitamin D from food stuffs. A 100g portion provides: (regular) 14 IU (0.14 IU/g), (exposed to UV) 500 IU (5 IU/g). Both yeast and mushroom materials, when irradiated with UV, produce vitamin D₂, but it is not known whether the D₂ is biologically fully equivalent to the D₃ vitamin in humans.

Nutrition Facts labels on food products in the U.S. are not required to list vitamin D content unless a food has been fortified with this nutrient.

**Conclusion**

Vitamin D is not a true vitamin but has been found to be a steroid hormone. It is obtained primarily by action of UVB on a precursor substance in the skin and lesser amounts from the diet. Vitamin D was formerly thought to be associated only with bone health (prevention of rickets and osteomalacia) but in recent years evidence has accumulated indicating that it is important for the immune system and for help in preventing cancers and other diseases.

Epidemiological studies suggest that achieving and maintaining a serum 25-(OH)D level of 34 ng/mL may be associated with a 50% reduction in the relative risk of colorectal cancer. Similarly, a level of 42ng/mL may be linked with a 40% reduction in breast cancer risk, and a level of 52ng/mL may be associated with a 50% drop in breast cancer risk. Supplementation may be a safe and effective way to achieve these levels, although daily consumption of 2,000-4,000 IU would be necessary to achieve the indicated levels in 90% or more of the population. These doses exceed the upper limit for a daily dose in current guidelines, but revisions to these guidelines are expected soon. Recommended intakes and the upper limit are anticipated to be adjusted upward.
**Table I. Vitamin D [25-(OH)D] Serum Levels**

<table>
<thead>
<tr>
<th>Deficiency</th>
<th>&lt; 20 ng/ml (&lt;50 nmol/L)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Insufficiency</td>
<td>21-29 ng/mL (51-74 nmol/L)</td>
</tr>
<tr>
<td>Sufficiency</td>
<td>&gt; 30 ng/mL</td>
</tr>
</tbody>
</table>

**Table II. Definition of Terms**

<table>
<thead>
<tr>
<th>Vitamin D Form</th>
<th>Physiologically Active?</th>
<th>Major Sources</th>
</tr>
</thead>
<tbody>
<tr>
<td>25-(OH)D₂ (ergocalciferol, vitamin D₂)</td>
<td>No</td>
<td>Plant foods</td>
</tr>
<tr>
<td>25-(OH)D₃ (cholecalciferol, D₃)</td>
<td>No</td>
<td>Animal foods, fortified foods produced in the skin with UVB</td>
</tr>
<tr>
<td>1,25-(OH)₂ D</td>
<td>Yes</td>
<td>Produced in the body from D₂ and D₃</td>
</tr>
</tbody>
</table>

**Table III. Daily Vitamin D Intake Recommendations**

*Institute of Medicine Food & Nutrition Board – Issued in 1997*

<table>
<thead>
<tr>
<th>Birth - 50 years</th>
<th>5 mcg (200 IU)</th>
</tr>
</thead>
<tbody>
<tr>
<td>51 – 70 years</td>
<td>10 mcg (400 IU)</td>
</tr>
<tr>
<td>71 + years</td>
<td>15 mcg (600 IU)</td>
</tr>
</tbody>
</table>

*Institute of Medicine Food & Nutrition Board – Issued in 2010*

<table>
<thead>
<tr>
<th>Infants-1 year</th>
<th>10 mcg (400 IU)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-70 years</td>
<td>15 mcg (600 IU)</td>
</tr>
<tr>
<td>71 + years</td>
<td>20 mcg (800 IU)</td>
</tr>
</tbody>
</table>

*American Academy of Pediatrics – Issued in 2008*

<table>
<thead>
<tr>
<th>2 months – adolescence</th>
<th>10 mcg (400 IU)</th>
</tr>
</thead>
</table>

*National Osteoporosis Foundation – Issued in 2008*

<table>
<thead>
<tr>
<th>Adolescents – 50 years</th>
<th>10 -20 mcg (400 – 800 IU)</th>
</tr>
</thead>
<tbody>
<tr>
<td>All adults &gt; 51 years</td>
<td>20 -25 mcg (800-1000 IU)</td>
</tr>
</tbody>
</table>
REFERENCES

1. Linus Pauling Institute at Oregon State University
   http://lpi.oregonstate.edu/infocenter/vitamins/vitaminD/

REVIEW QUESTIONS:
Course #DL-999
Choose the one best answer

1. The primary role of vitamin D is to regulate:
   a. calcium and phosphorous
   b. phosphorous and magnesium
   c. parathyroid hormone
   d. all of above

2. The half life of vitamin D is:
   a. 1 week
   b. 2 weeks
   c. 1 month
   d. 2 months

3. In the U.S. about _______% of healthy young adults have vitamin D levels that are less than sufficient.
   a. 24%
   b. 36%
   c. 50%
   d. 54%

4. Vitamin D is an essential molecule for human health. Vitamin D is technically a:
   a. mineralcorticoid
   b. glucocorticoid
   c. hormone
   d. hydroxyl vitamin

5. The main form(s) of vitamin D is/are:
   a. vitamin D$_4$
   b. vitamin D$_3$
   c. vitamin D$_2$ and D$_3$
   d. vitamin D$_1$

6. The National Osteoporosis Foundation recommends that adults who are under 50 years of age should consume:
   a. 100-200 IU/day
   b. 200-400 IU/day
   c. 400-800 IU/day
   d. >800 IU/day

7. Individuals with vitamin D deficiency or vitamin D insufficiency need a “loading dose of _____________ to correct the serum vitamin D concentration.
   a. 25,000 IU per week for 8 weeks
   b. 35,000 IU per week for 8 weeks
   c. 50,000 IU per week for 8 weeks
   d. 60,000 IU per week for 8 weeks
8. Which of the following is not a symptom of vitamin D deficiency in adults:
   a. bone discomfort
   b. myalgia
   c. weakness
   d. headaches

9. Vitamin D toxicity results from:
   a. long-range high dose vitamin D supplementation
   b. too much sun exposure
   c. eating a diet high in vitamin D-containing food
   d. increased activity of the hydroxylation step in the kidney

10. A deficiency of vitamin D is important in which of the following diseases?
    a. rickets
    b. intestinal absorption
    c. osteoporosis
    d. all of above

11. Some recent studies have suggested that there may be a reduction of falls in elderly patients who are receiving vitamin D doses of:
    a. <200 IU/day
    b. 300-400 IU/day
    c. 400 IU/day
    d. 700 IU/day

12. Which of the following is not a risk factor for vitamin D deficiency?
    a. exclusively breast fed infants without supplements
    b. dark skin at higher latitudes
    c. light skin near the equator
    d. elderly age

13. Low vitamin D levels have been linked with increased risks of all but which of the following autoimmune diseases:
    a. type I diabetes
    b. multiple sclerosis
    c. rheumatoid arthritis
    d. myasthenia gravis

14. The authors of a recent review estimated that 70% of multiple sclerosis cases in the U.S. and Europe could be prevented by increasing vitamin D serum levels in adolescent and young adults to levels greater than:
    a. 10 ng/ml
    b. 20 ng/ml
    c. 30 ng/ml
    d. 40 ng/ml

15. The preferred specimen for vitamin D analysis is?
    a. EDTA plasma
    b. serum
    c. sodium citrate plasma
    d. Li-heparin plasma

16. The current method of choice for vitamin D analysis for reasons of convenience, turn around time, and cost is?
    a. immunoassay
    b. High Pressure Liquid Chromatography (HPLC)
    c. atomic absorption
    d. mass spectrometry-gas chromatography (MS-GC)

17. Epidemiological studies suggest that a serum level of approximately 42ng/ml may be associated with a decrease in colorectal and breast cancers. Dietary supplementation to achieve this level should be approximately:
    a. 200-400 IU/day
    b. 800-1200 IU/day
    c. 2000-4000 IU/day
    d. 4000-6000 IU/day

18. Patients are considered to have a vitamin D deficiency when their serum levels are less than:
    a. 45 ng/ml
    b. 40 ng/ml
    c. 30 ng/ml
    d. 20 ng/ml

19. Of the following, which is the best source of dietary vitamin D?
    a. fish liver oils
    b. beef liver
    c. spinach
    d. whole eggs

20. Research studies have suggested that there is a relationship between vitamin D and cardiovascular disease. They suggest that the relationship is a/an
    a. direct relationship
    b. inverse relationship
    c. 2:1 relationship
    d. equal relationship
DISTANCE LEARNING  
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Course Registration Form &  
Answer Sheet

INSTRUCTIONS: Upon completion of one or more Distance Learning courses, answer the test questions using the answer sheet below. Copies of answer sheets are acceptable. Submit the following to CAMLT:

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2. Evaluation Form, and  
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   non-member: $15/CE unit )

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Course Title: ________________________________  
Course Number: _____-_____

SIGNATURE (REQUIRED FOR PROCESSING)
circle the one best answer

1. a  7. a  13. a  19. a  25. a  
b  b  b  b  b  
c  c  c  c  c  
d  d  d  d  d

2. a  8. a  14. a  20. a  26. a  
b  b  b  b  b  
c  c  c  c  c  
d  d  d  d  d

3. a  9. a  15. a  21. a  27. a  
b  b  b  b  b  
c  c  c  c  c  
d  d  d  d  d

4. a  10. a  16. a  22. a  28. a  
b  b  b  b  b  
c  c  c  c  c  
d  d  d  d  d

5. a  11. a  17. a  23. a  29. a  
b  b  b  b  b  
c  c  c  c  c  
d  d  d  d  d

6. a  12. a  18. a  24. a  30. a  
b  b  b  b  b  
c  c  c  c  c  
d  d  d  d  d

Please Print Clearly  
Name: ________________________________________

Home Address: ___________________________________

City: _____________________State: ___ Zip: __________

Home Tel: (_____) _____ -- _______ X _________  
Work Tel: (_____) _____ -- _______ X _________

Employed at: _____________________________________

CDPH License/Certificate #_______________________

METHOD OF PAYMENT:

( ) Member ( ) Non-member

( ) Check Payable to: CAMLT  
(Returned checks subject to a $20 fee)

( ) VISA or ( ) MasterCard (indicate card type)

Card #: _________________________ Exp. Date: _______

Signature: _____________________________________

Distance Learning Evaluation Form

This evaluation form MUST BE RETURNED TO CAMLT along with your review questions. Your comments help us to provide you with better continuing education materials in the home study format. We welcome and encourage any additional comments. Please respond to the following statements by circling the number that agrees with your assessment of the statement with “5” meaning you strongly agree, “4” meaning you agree, “3” meaning you have no opinion, “2” meaning you disagree and “1” meaning you strongly disagree.

1. Overall, I was satisfied with the quality of this course.  
   5  4  3  2  1

2. The objectives of this course were met.  
   5  4  3  2  1

3. Difficulty was consistent with the no. of CE hours.  
   5  4  3  2  1

4. I will use what I learned from this course.  
   5  4  3  2  1

5. It took me _____ hours to complete this course.

6. What did you like or dislike about this program?
### CAMLT DISTANCE LEARNING COURSES

CAMLT is approved as a provider of continuing education programs in the clinical laboratory sciences by the California Department of Public Health as a CA CLS Accrediting Agency (#0021) and by the ASCLS P.A.C.E® Program (#519).

Permission to reprint any part of these articles, other than for CAMLT credit, must be obtained in writing from the CAMLT Executive Office.

**Course #/Title (place a check next to each course ordered)**

<table>
<thead>
<tr>
<th>Course #</th>
<th>Title</th>
<th>CE Units</th>
<th>Level of Difficulty</th>
</tr>
</thead>
<tbody>
<tr>
<td>DL-905</td>
<td>The Bug Everyone Has - Epstein-Barr Virus: A Case Study</td>
<td>2.0</td>
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<tr>
<td>DL-906</td>
<td>Ergonomics – An Intermediate Self-Study Package for Safety</td>
<td>2.0</td>
<td>Intermediate</td>
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<td>DL-909</td>
<td>A Safety Plan for Laboratories</td>
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<td>DL-922</td>
<td>Hematology Case Study: A Hypochromic, Microcytic Anemia</td>
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<td>DL-950</td>
<td>Smallpox</td>
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<td>DL-954</td>
<td>Review of Blood Collection Equipment</td>
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<td>DL-956</td>
<td>Patty Pancreas</td>
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<td>DL-957</td>
<td>A Bacterial Carcinogen – <em>Helicobacter pylori</em></td>
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<td>DL-958</td>
<td>A Plague on US</td>
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<td>DL-963</td>
<td>Patient Identification</td>
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<td>Basic</td>
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<td>DL-965</td>
<td>Infectious Disease: A Gender Bias</td>
<td>1.0</td>
<td>Basic</td>
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<td>DL-966</td>
<td>Cystic Fibrosis and Microbial Infections</td>
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<td>Freneic Flora and Freezing Frank (Thyroid Hormones and Thyroid Diseases)</td>
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<td>Intermediate</td>
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<td>DL-968</td>
<td>An Introduction to HIV, HIV Infection, and AIDS</td>
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<td>DL-970</td>
<td>HIV/AIDS Part II – Life and Times of the Human Immunodeficiency Virus</td>
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<td>Hemoglobin A1c Testing of Patients with Hemoglobinopathies</td>
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<td>Anaerobic Bacteriology for the Clinical Laboratory</td>
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<td>Intermediate</td>
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<td>DL-975</td>
<td>Megaloblastic Anemia</td>
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<td>Intermediate</td>
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<td>DL-976</td>
<td>Update on West Nile Virus</td>
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<td>Intermediate</td>
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<td>DL-979</td>
<td>Papillomaviruses and Cervical Cancer</td>
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<td>DL-980</td>
<td>What You Always Wanted to Know About <em>E. coli</em> O157:H7 Infection</td>
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<td>DL-982</td>
<td>Chlamydiae and Their Role in Human Disease</td>
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<td>Intermediate</td>
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<td>DL-983</td>
<td>Prion Diseases</td>
<td>1.0</td>
<td>Intermediate</td>
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<tr>
<td>DL-984</td>
<td>Cost Effective Clinical Microbiology</td>
<td>3.0</td>
<td>Intermediate</td>
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<tr>
<td>DL-985</td>
<td>Hematology Case Studies: Platelets – available on website only</td>
<td>1.0</td>
<td>Intermediate</td>
</tr>
<tr>
<td>DL-986</td>
<td>Candida and its Role in Opportunistic Mycoses</td>
<td>2.0</td>
<td>Intermediate</td>
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<td>DL-987</td>
<td>An Update on Autoimmune Diseases</td>
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<td>Intermediate</td>
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<td>DL-988</td>
<td>The Great Imposter</td>
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<td>Intermediate</td>
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<tr>
<td>DL-989</td>
<td>Neutrophilia – available on website only</td>
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<td>DL-990</td>
<td>CLOSTRIDIUM DIFFICILE 027: The Recent Emergence of a New Strain</td>
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<td>Organ Specific Autoimmune Diseases</td>
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<td>Coccidioidomycosis (Valley Fever); A Reemerging Mycosis</td>
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<td>Campylobacter jejuni – Foodborne Gastroenteritis</td>
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<tr>
<td>DL-995</td>
<td>Hemolytic Disease of the Newborn</td>
<td>1.0</td>
<td>Basic</td>
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<tr>
<td>DL-996</td>
<td>Norovirus: Travelers’ Diarrhea and Much More</td>
<td>2.0</td>
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<td>DL-997</td>
<td>What’s Going on with Whooping Cough (Pertussis)?</td>
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<td>DL-998</td>
<td>Neonatal Alloimmune Thrombocytopenia</td>
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<td>Intermediate</td>
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<td>DL-999</td>
<td>Vitamin D</td>
<td>2.0</td>
<td>Intermediate</td>
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<td>DL-001</td>
<td>Hantavirus – A Special Pathogen</td>
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<td>DL-002</td>
<td>Potential Problems with the Diagnosis of Malaria in the United States; Lab ID of Malaria</td>
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<td>Intermediate</td>
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<tr>
<td>DL-003</td>
<td>Update on Salmonella Foodborne Gastroenteritis</td>
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<td>Intermediate</td>
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<tr>
<td>DL-004</td>
<td>Viral Hepatitis: Causes, Diagnosis, and Treatment</td>
<td>2.0</td>
<td>Intermediate</td>
</tr>
</tbody>
</table>

### DISTANCE LEARNING ORDER FORM

**CHECK ONE:** [ ] MEMBER ($12/UNIT) / [ ] NON-MEMBER ($15/UNIT)

**NAME:** (PLEASE PRINT) ____________________________________________________________

**ADDRESS:** _______________________________________________________________________

**CITY:** ____________________________ **STATE:** ______________ **ZIP:** _____________________

**TELEPHONE:** (HOME) ____________________________ (WORK) ____________________________

**EMAIL:** ____________________________________________________________ **CA DPH LICENSE/CERTIFICATE #:** ____________________________

**METHOD OF PAYMENT:** [ ] CHECK [ ] VISA [ ] MASTERCARD

**CARD #:** ____________________________________________________________ **EXPIRATION DATE:** ____________________________

**SIGNATURE:** (REQUIRED OF ALL REGISTRANTS) __________________________________________________________________

**NOTE:** INCLUDE THE MEMBERSHIP RENEWAL, ORDER FORM, AND PAYMENT IN ONE ENVELOPE
MEMBERSHIP APPLICATION

Personal Information
Name __________________________________
Address ________________________________
City ______________ State _____ Zip______
CDPH License/ Certificate # ______________
Home Phone ___________________________
E-mail ________________________________

Employment Information
Employer _____________________________
Address _______________________________
City _____________ State ______ Zip _____
Work Phone ___________________________
E-Mail ________________________________

CAMLT asks you to contribute to one or both of these two worthwhile entities

LAB-PAC
The CAMLT Political Action Committee helps your association advocate on behalf of you and your profession. Help support quality clinical laboratory medicine in the California legislative arena.

Contributions are NOT tax deductible
You must be a U.S. citizen to donate.

Education & Research Foundation
Your tax deductible contribution supports scholarship programs, outreach efforts and students pursuing careers in the clinical laboratory sciences. Please enclose a separate check when contributing to E & R Foundation.

Applicants are considered for membership in the class which meets his/her maximum qualifications.
I declare that in making application for membership, I have met the qualifications listed for the category to which I am applying.

Applicant Signature ______________________
Recruiter (if known) ______________________

Membership Categories

( ) Active - $120 annually
An individual who 1) Holds a license or certification in a clinical laboratory profession issued by the California Department of Public Health; or 2) Holds a baccalaureate degree from an accredited college or university and is eligible to sit for the CDPH license examination; or 3) Holds a Masters or Doctorate degree in science, education or administration and is actively employed in clinical laboratory science.

( ) Collaborative - $65 annually
An optional special non-voting, non office holding membership category open to licensed Medical Laboratory Technicians or Certified Phlebotomy Technicians, who desire to support the association. All other membership benefits are afforded. These members are also eligible to apply for active membership if they desire to vote and/or hold office in the association.

( ) Associate - $75 annually
An individual who has an interest in the field of clinical laboratory science and/or supporting the purposes or goals of CAMLT, but is not otherwise eligible for membership.

( ) Student - $10 annually
An individual who possesses a valid training license from Laboratory Field Services (CDPH) and is engaged as a trainee or a full time student at an accredited college or university in a program that leads to eligibility for the training license.

( ) Lifetime - $1250 one time fee
Meets Active member requirements and submits the one time application fee.

( ) 20/20 Option - $20 annually
An additional $20 payment at time of renewal entitles the member a 20% discount on CAMLT state sponsored C.E. fees for the year (not applicable to Distance Learning)

Membership Dues $ ________
20/20 Option $ ________
LAB-PAC Contribution $ ________
E & R Foundation Donation $ ________
(separate check - tax deductible)
Total Payment Amount $ ________

Checks payable to CAMLT and/or E & R as appropriate
OR

Credit Card Payment: ( ) VISA ( ) Master Card
Card #________________________________
Exp.______________________
Authorized Date _______ Signature ________________________________

Mail to: CAMLT, 1895 Mowry Ave. Suite 112, Fremont, CA 94538
Fax to: 510-792-3045 (Voice Phone 510-792-4441)
CONTINUING EDUCATION
CALENDAR
Save These Dates - Program Planning in Progress!

February 23-24, 2013  CAMLT Winter Seminar North
UC Davis Medical Center, Sacramento

March 2-3, 2013  Tulare/Kings Chapter Seminar
Visalia Convention Center

March 9-10, 2013  Fresno Chapter’s “Cheaper by the Dozen” Seminar

March 16, 2013  Eastland and Foothill Chapters’ Spring Symposium
City of Hope, Duarte

March 23-24, 2013  CAMLT Winter Seminar South
North Hollywood

April 20-21, 2013  CAMLT Spring Seminar South
San Diego

June 22-23, 2013  CAMLT Summer Seminar North
John Ascuaga's Nugget Hotel/Casino, Sparks, NV

September 27-29, 2013  CAMLT's 74th Annual Meeting, Exhibits and Workshops
Lucky 2013
Hyatt Regency Hotel, Santa Clara

Check CAMLT’s website for further details: http://www.camlt.org/edu_calendar.html

“Lucky 2013”
September 27-29, 2013
Santa Clara, California
Hyatt Regency Hotel

Watch For Convention Detail As The Date Approaches – www.camlt.org

Want More Information? Contact:
Tel: 510/792-4441
Fax: 510/792-3045
Website: www.camlt.org

CAMLT Executive Office
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Fremont, CA 94538-1766