Sun protection, sunscreens and Vitamin D

GP National Conference

Rotorua Energy Events Centre

June 2009

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Dermatologist

New Zealand Dermatological Society Incorporated

Melanoma

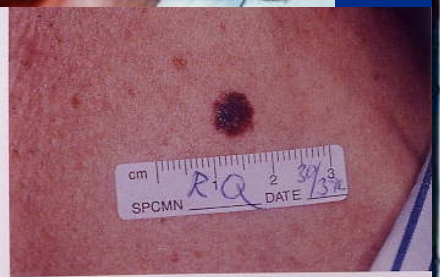
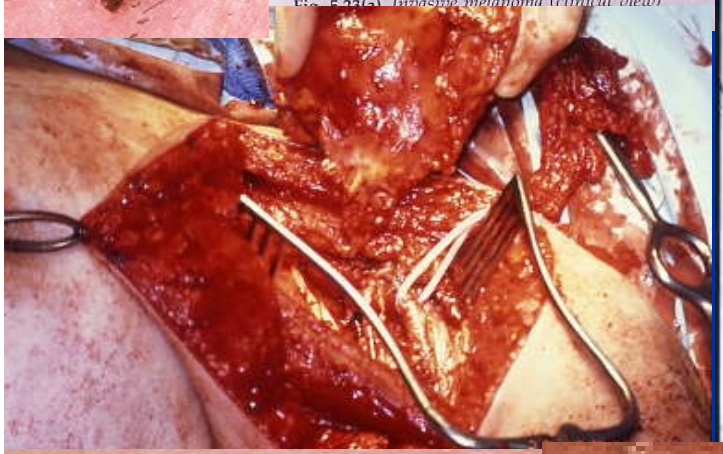


Fig. 5.23(a) *Invasive melanoma (clinical view)*



Skin cancer and sunlight

- Exposure to UVR causes > 90% of skin cancers
- Skin cancer is commonest cancer in NZ
  - >50,000 new cases per year
  - ~300 deaths per year
  - ~$33.4 NZ million per year

- International Agency for Research on Cancer. IARC Monographs on the evaluation of carcinogenic risks to humans. Solar ultraviolet radiation. Lyon: International Agency for Research on Cancer, 1992.
- Armstrong BK. How sun exposure causes skin cancer. In: Hill D, Elwood JM, English DR, Eds. Prevention of Skin Cancer. Dordrecht: Kluwer Academic Publishers, 2004.
- O'Dea D. The Costs of Skin Cancer to New Zealand. Wellington: Cancer Society of New Zealand, 2000.
- New Zealand Health Information Service. Cancer, New Registrations and Deaths. Wellington: New Zealand Health Information Service, 2004.

Melanoma

- 1842 new cases in 2002
- 328 directly attributable to severe sunburn
- (Sneyd and Cox 2006)
- Authors recommended, "***to reduce burden of melanoma in NZ, need to prevent excessive sun exposure and (facilitate) early diagnosis***"
- Whilst cancer overall is rare in adolescence, melanoma was commonest cancer

Melanoma

- NZ incidence and death rate among world highest
- 56.2/100,000 in European population of Auckland highest reported worldwide
- men >50yrs present with more advanced melanoma and have higher mortality rate
- ↓ incidence in <50yrs of age in NZ
- Projected stable or declining incidence and mortality rates

- Min of Health *Cancer in NZ:Trends and projections.* Public Health Intelligence Occasional Bulletin No 15, 2002

Most cumulative UV is from childhood

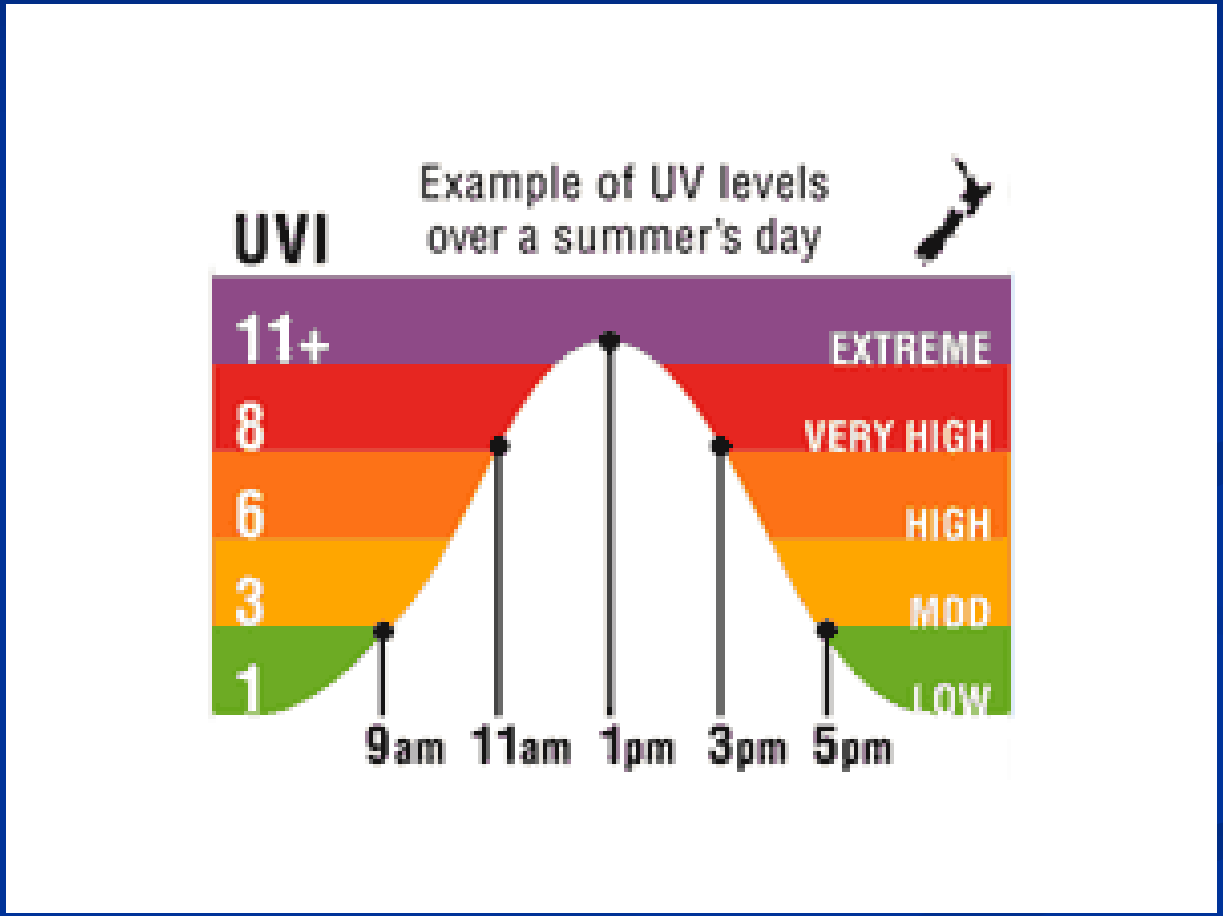
Sun protection

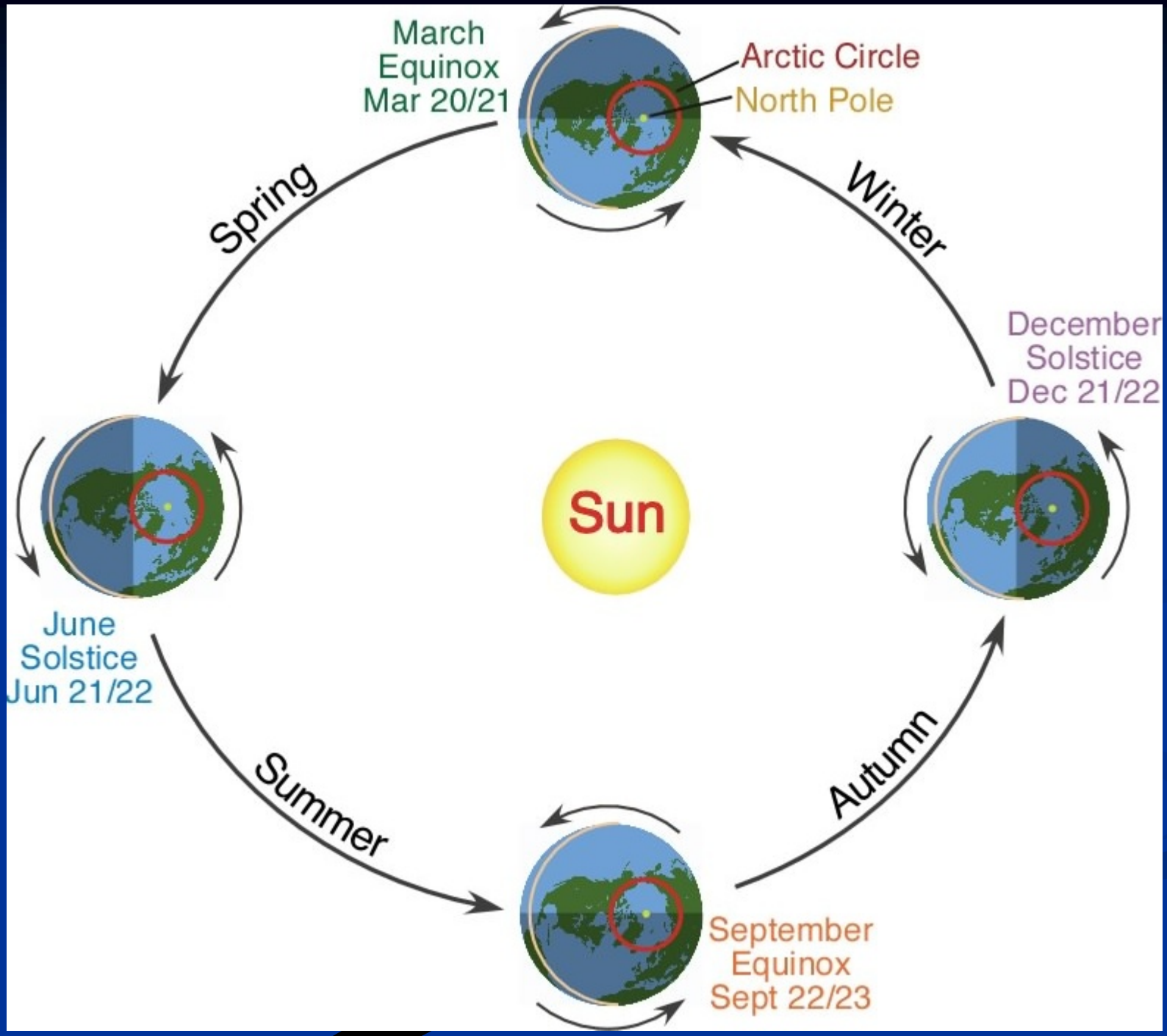
- Avoid sun
- Broad rim hat
- Wrap-round sunglasses
- Large area of skin covered
- Densely woven clothing
- Sunscreen

Avoid the sun?
When?

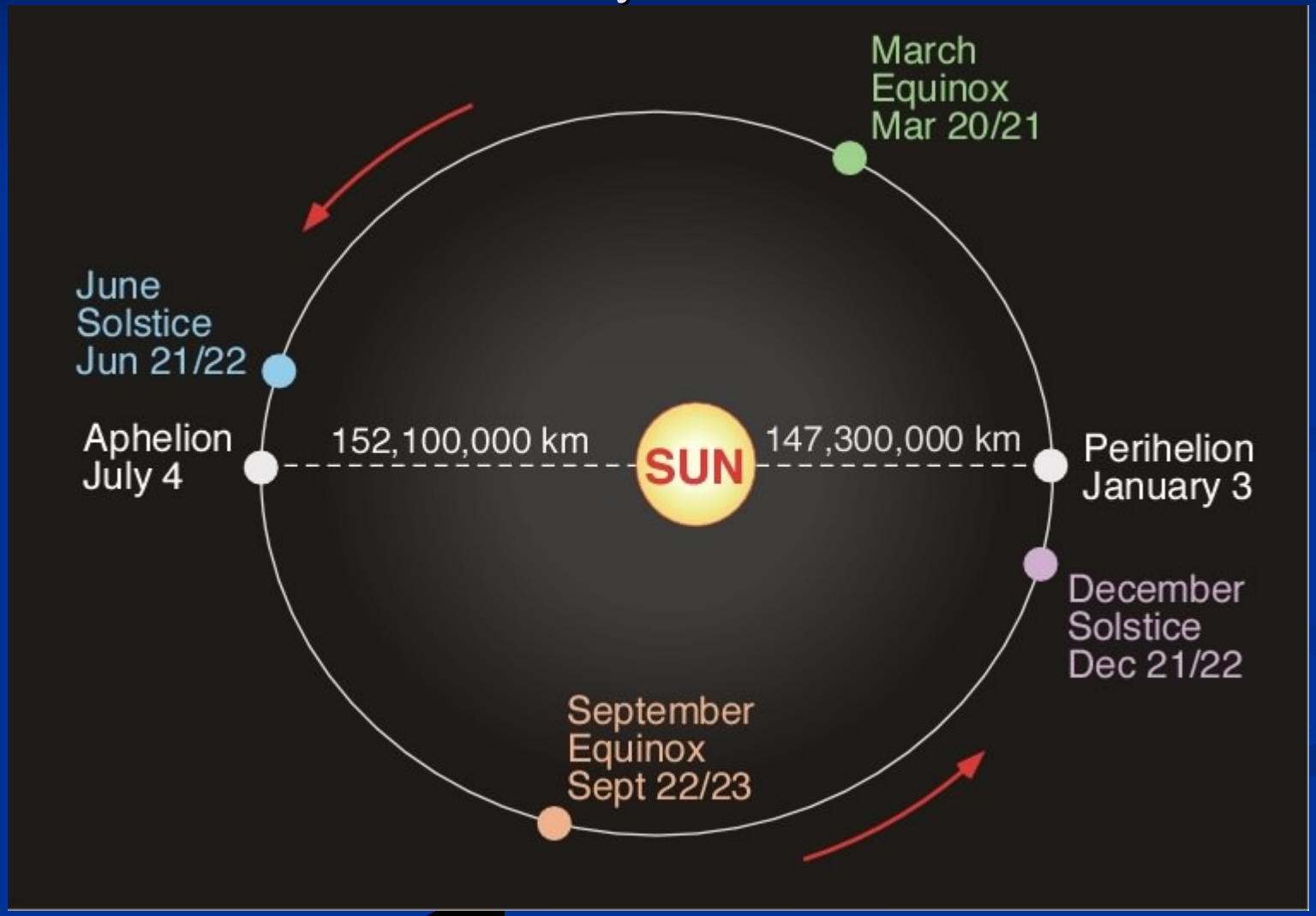
How Ultraviolet Radiation (UVR) Behaves During a Day

NZ Cancer Society



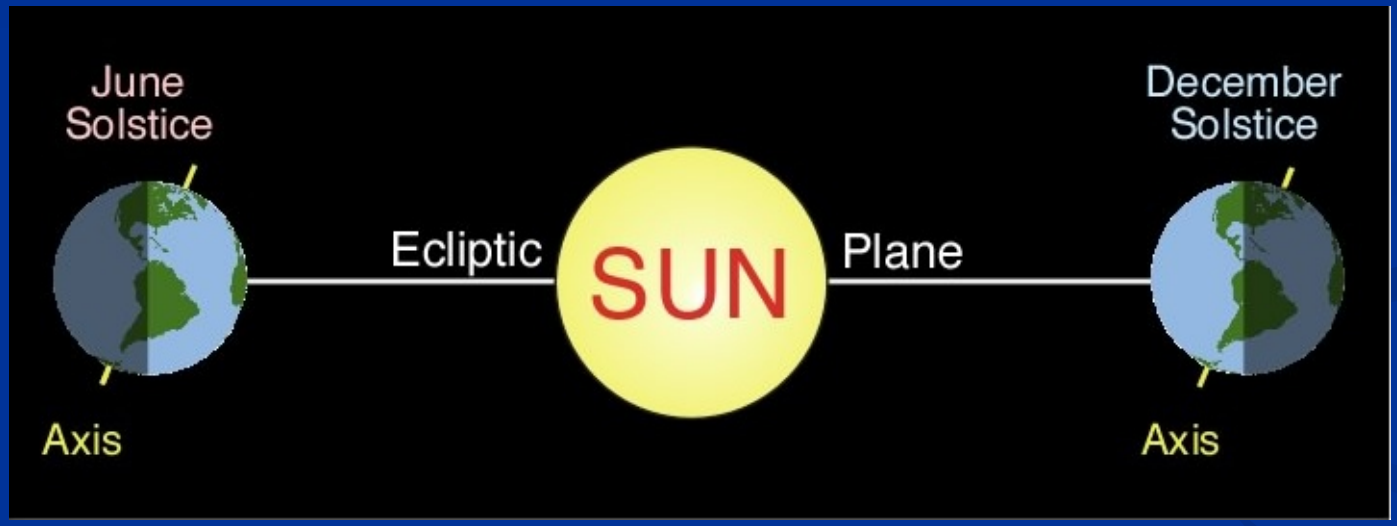

March
Equinox
Mar 20/21
Arctic Circle
North Pole
Spring
Winter
December
Solstice
Dec 21/22
Sun
June
Solstice
Jun 21/22
Summer
Autumn
September
Equinox
Sept 22/23

Earth's orbit around sun, elliptical not circular
Earth - sun distance varies through the year
Solar radiation received by earth varies

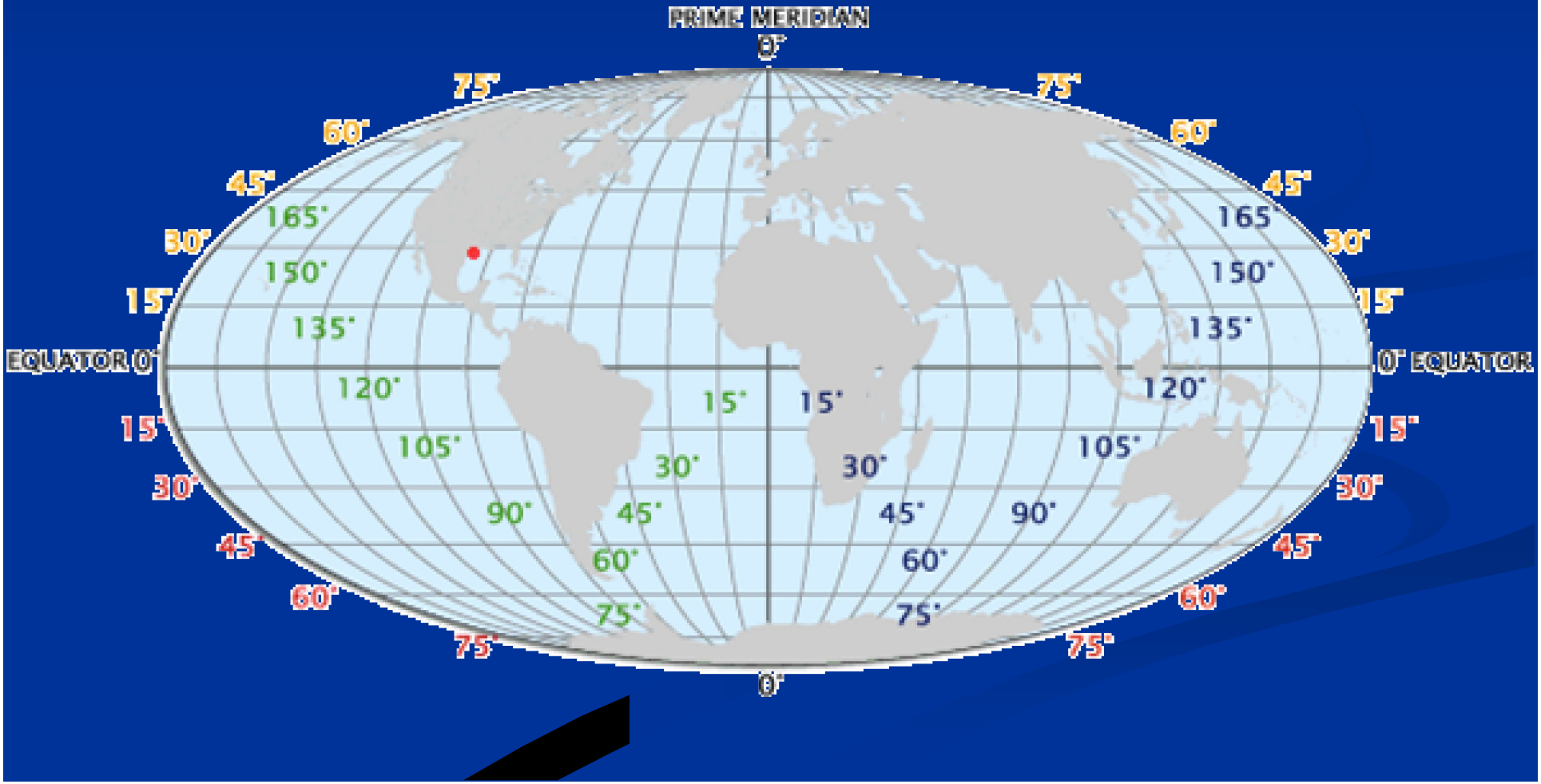


Additionally, the Earth's axis tilts.

(Seasons Northern Hemisphere Seasons shown).

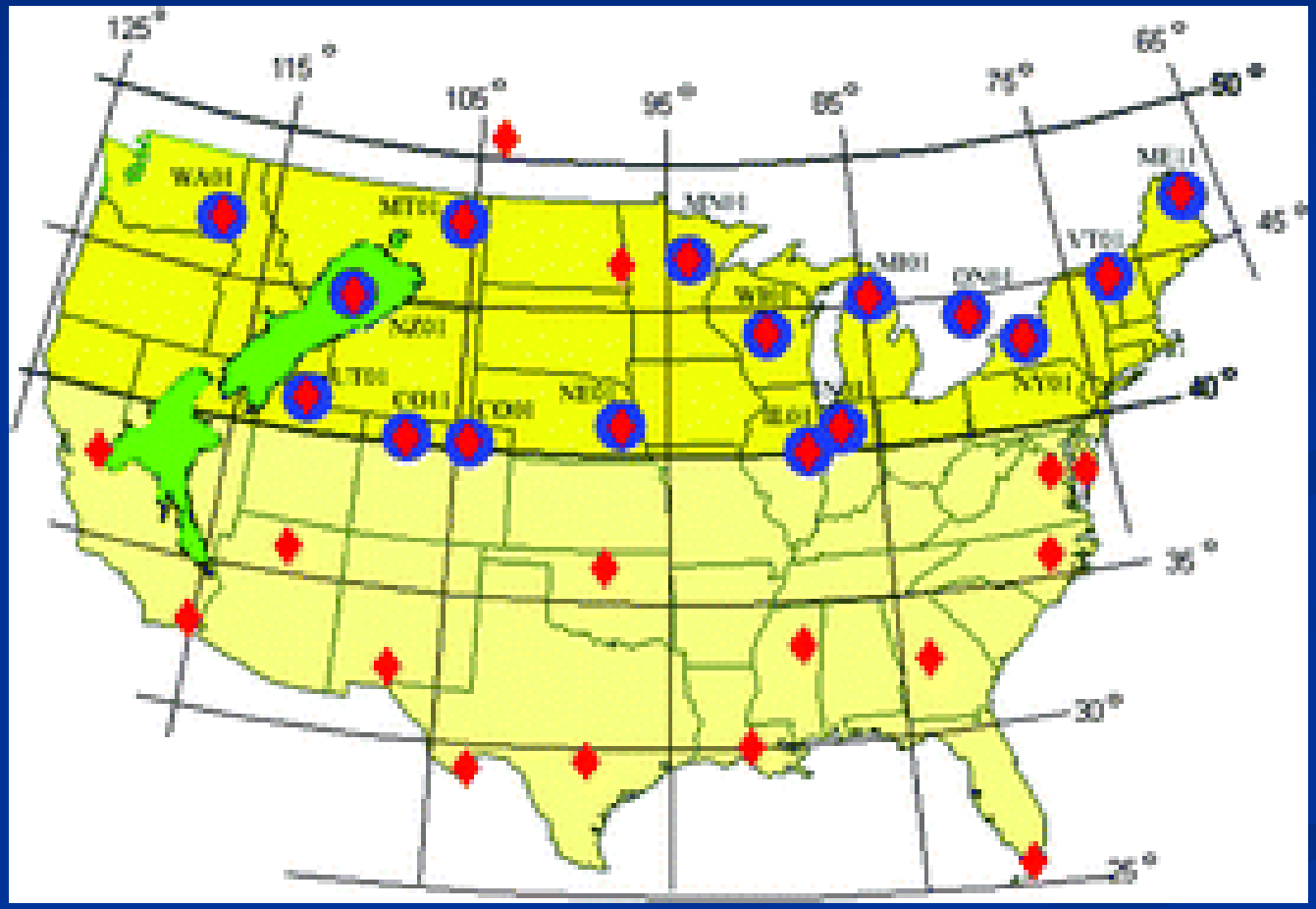


NZ latitude ~Southern hot Europe but without the heat!



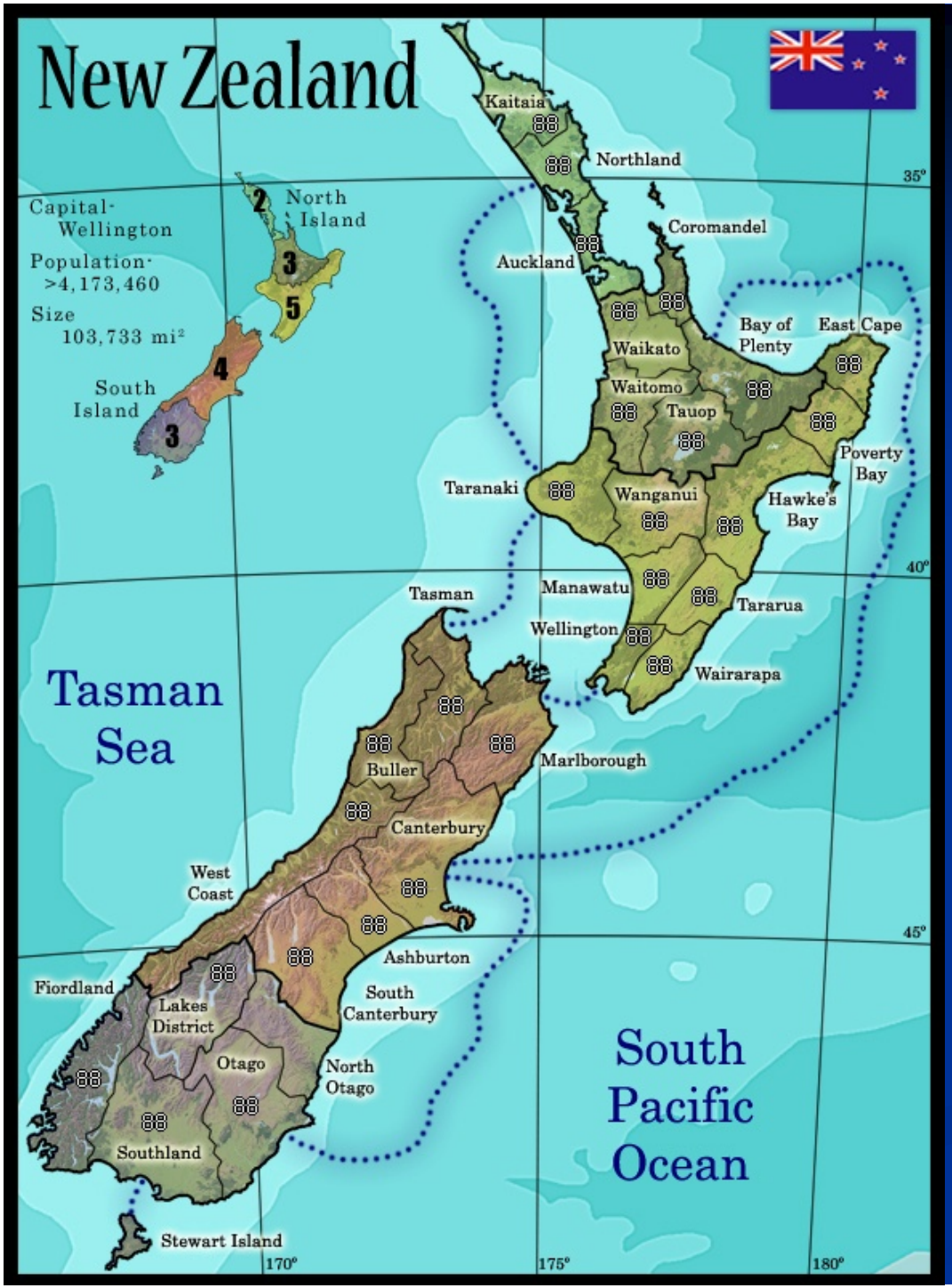
Geographical differences in erythemally-weighted UV measured at mid-latitude USDA sites

NIWA Richard McKenzie, Greg Bodeker, Gwen Scott, Jim Slusser and Kathleen Lantz



UV issues for NZ

- Peak UV intensities in NZ
  - exceed those at comparable latitudes and altitudes in Northern hemisphere by 41 ± 5%,
  - Comparable to 1 km higher, 5 degrees closer to the equator
  - Anomalously extreme high UVI values
- lower ozone amounts + the closer Earth–Sun separation in summer all contribute to the relatively high UV intensities at the NZ
- UVI in NZ winter lower
- large summer/winter contrast in NZ UVI, may be important from a health perspective.



north

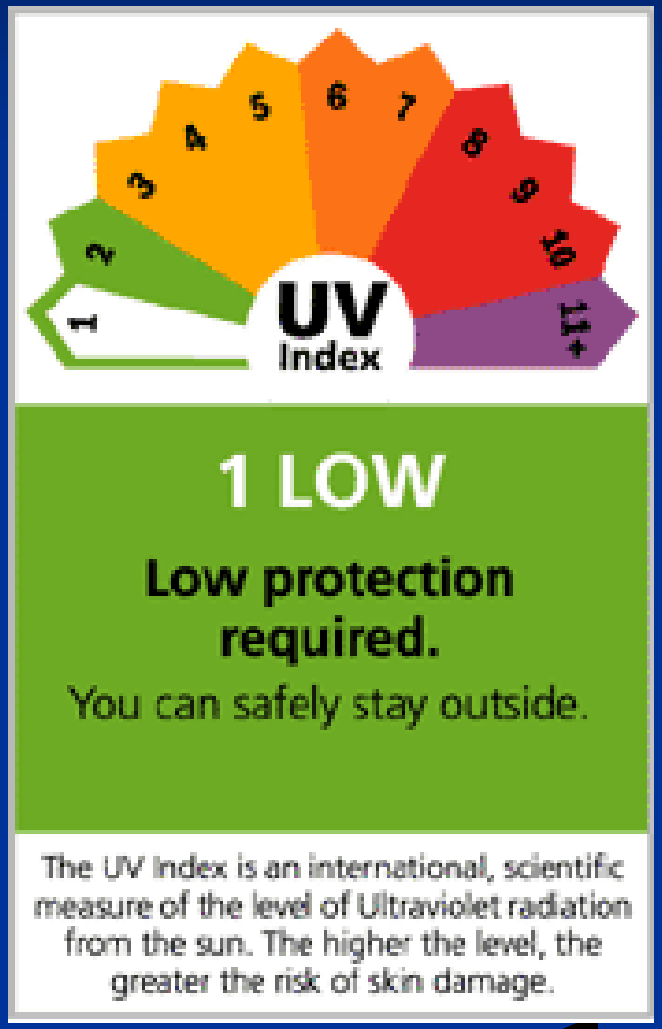
↓ UVI

south

UV index (UVI) NIWA

- standard measurement of erythemal (sun-burn causing) tendency
- more objective measure c.f. old "time to burn"
- Open-ended scale :UVI < 3 is low; UVI >10 is extreme
- depends on
  - sun elevation angle
  - ozone amount,
  - cloud cover,
  - sun-earth separation,
  - altitude,
  - pollution,
  - surface reflections (e.g., snow cover)
- In NZ winter UVI rarely > 3.
- **NIWA website provides Daily Predictions and Measurements**

Daily UVI predictions



- available on Cancer Society and NIWA websites
- Locate specific areas within NZ

UVI issues for NZ

- NZ UVI anomalously
  - High in summer
  - Low in winter
- Greater contrast too between Northland and Southland

Shade reduces UVR

Sun protection

- Avoid sun
- Broad rim hat
- Wrap-round sunglasses
- Large area of skin covered
- Densely woven clothing
- Sunscreen

Hats:

variable sun protection for the head, face and neck

- Depending on fabric, design, way they are worn,
- brim width
  - wide (>7.5cm) provide SPF 7 for nose, 3 for cheek, 5 for neck and 2 for chin.
  - Medium (2.5cm-7.5cm) provide SPF 3 for nose, 2 for cheek and neck and none for chin.
  - Narrow (<2.3cm) provide SPF 1.5 for nose and little or no protection for chin and neck

Variable protection from sunhats

Wrap-round sunglasses preferable

Sunglasses

- Cataracts and eye cancer arise from chronic sun exposure to the lens
- single or several additive exposures relevant
- ***sunglasses which absorb 99-100% of the full UV spectrum (up to 400nm) should be worn***
- Additional retinal protection can be provided by lenses that reduce violet/blue light transmission

UPF = UV protection factor from clothing

- transmission of UVA and UVB through fabrics measured by spectrophotometry
- UPF should be > 30
- clothing design should cover the upper and lower body
  - (base of neck down to hip and across shoulders down to ¾ of upper arm, and lower body coverage should be from waist to knee)

↑clothing UPF by

- tighter woven fabrics
- darker colours
- optical brighteners
- laundering with UV absorber Tinosorb FD
- distance of fabric from the skin i.e. not too tight
- hydration ↑viscose or silk UPF but↓ cotton UPF

- For adequate photoprotection, denier count needs to be> 40 but popular pantyhose 15 denier provides less than 2 UPF.

Sun protection

- Avoid sun
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Sunscreen

- SPF = sun protection factor
- Burn time with sunscreen compared to no sunscreen
- UVB protection factor
- No universally agreed measure of UVA protection

Sunscreens

- Physical /non-chemical / inorganic
- Organic / chemical

Inorganic sunscreen

- Titanium dioxide and zinc oxide
- photostable
- not absorbed systemically
- not been reported to sensitise (cause allergic skin reactions)
- reflect and diffuse UVR
- ↓ particle size to microionised form (10-50nm) c.f. 200-500nm of non-microionised form gives better cosmesis
  but shifts protection towards shorter wavelengths, unless particles coated with dimethicone or silica

Organic / chemical sunscreens

- absorb UVR energy converted to unnoticeable heat
- variable UVL spectrum cover
  - Classified as UVB or UVA filters
- Variable duration of effect
  - photostable : able to absorb UVR photons repetitively
  - photounstable: filter rapidly loses its absorption capacity and protective potency
  - photoreactive if absorbed UV photons create photoexcited molecules reacting with skin biomolecules, ambient O_2 or other sunscreen component

Examples of organic filters

- *UVA filters*
- titanium dioxide and zinc oxide
- benzophenones (oxybenzone, sulisobenzone, dioxybenzone),
- butyl methoydibenzoyl methane (avobenzone, Parsol 1789)
- menthyl anthranilate

- *UVB filters*
- para-aminobenzoic acid (PABA) derivatives (e.g. Octyl dimethyl para-aminobenzoic acid)
- Cinnamates (octyl methoxycinnamate,
- Parsol MCX, cinoxate)
- salicylates (octyl salicylate, homosalate, trolamine salicylate),
- Octocrylene
- phenylbenzimidazole sulfonic acid.

Broad spectrum sunscreens

high level of absorption in both the UVB and UVA ranges

Sunscreen stability variable, so...

- Sunscreens need frequent re-application
  - Prolonged UVA coverage so less frequent for Neutrogena Helioplex, Daylong
- keep sunscreens away from heat and sunlight when not in use
- discard sunscreens after best-before-date

Other aspects of sunscreen

- Sun sensitivity re SPF number (fair vs. pigmented skin)
- Sensitivity / intolerance
  - non-perfumed hypoallergenic / low irritant sunscreens e.g. *Ego Low Irritant Sunscreen.*
  - Microionised sunscreens cosmetically better tolerated
- Dryness
  - sunscreen with a moisturising base e.g. sunscreen creams or ointments. *E.g. Ego Ultra, Ego Daily Face Matt Formula, Neutrogena Age Shield.*
- oily / acne-prone / hairy skin
  - lighter base, e.g. lotion or gel. e.g. *Neutrogena Dry Touch. Ego Sports Milk, Ego Sports Gel.*
- Activity
  - wet / sweaty – choose water resistant, longer lasting or rub resistant sunscreen e.g. *Day Long SPF 30+, Ego Sports Milk or gel.*

Once daily sunscreen application

- SPF same *not safe* to be *in sun all day long*
- Extra thorough application to avoid missed areas
- More resistant to rub / sweat / water loss

Wide ranging sunscreens for varied skin types, water resistance etc.

Non-greasy sunscreens

Amount of sunscreen & SPF

- The declared sun protection factor (SPF) is based on the use of a sunscreen layer of 2 mg cm^2.
- Only around 25% (0.5 mg/ $cm^{2)}$ of this amount is applied by sunbathers.
- at the usual application rate of 0.5 mg/cm^2, the true SPF is a 4th root of the claimed SPF
- @ 2 mg/cm^2 →SPF 30;
- @ 1.0 mg/cm^2 → SPF 5.5;
- @ 0.5 mg/cm^2 → real SPF 2.3

Faurschou A, Wulf HC. The relation between sun protection factor and amount of suncreen applied in vivo. Br J Dermatol. 2007 Apr;156(4): 716-9.

Other aspects of sunscreens - how much to use? Average adult size

- 1/2 teaspoon
  - face
  - neck (front &back)
  - ears
- 1 teaspoon
  - each arm and leg,
  - on the back
  - and on the torso
- *Sunscreen should be reapplied frequently e.g. every two hours

Future sunscreen improvement

- More photostable
- Progressive UVA protection
- Research in immuno- protective / enhancing properties in sunscreens e.g. photo antioxidants

Do sunscreens make a difference?

Sunscreens

- Regular use of sunscreen SPF > 7.5 can ↓lifetime incidence of non-melanoma skin cancer by ~80%
  - Risk reduction for nonmelanoma skin cancer with childhood sunscreen use. Arch Dermatol 1986;122:537-45.

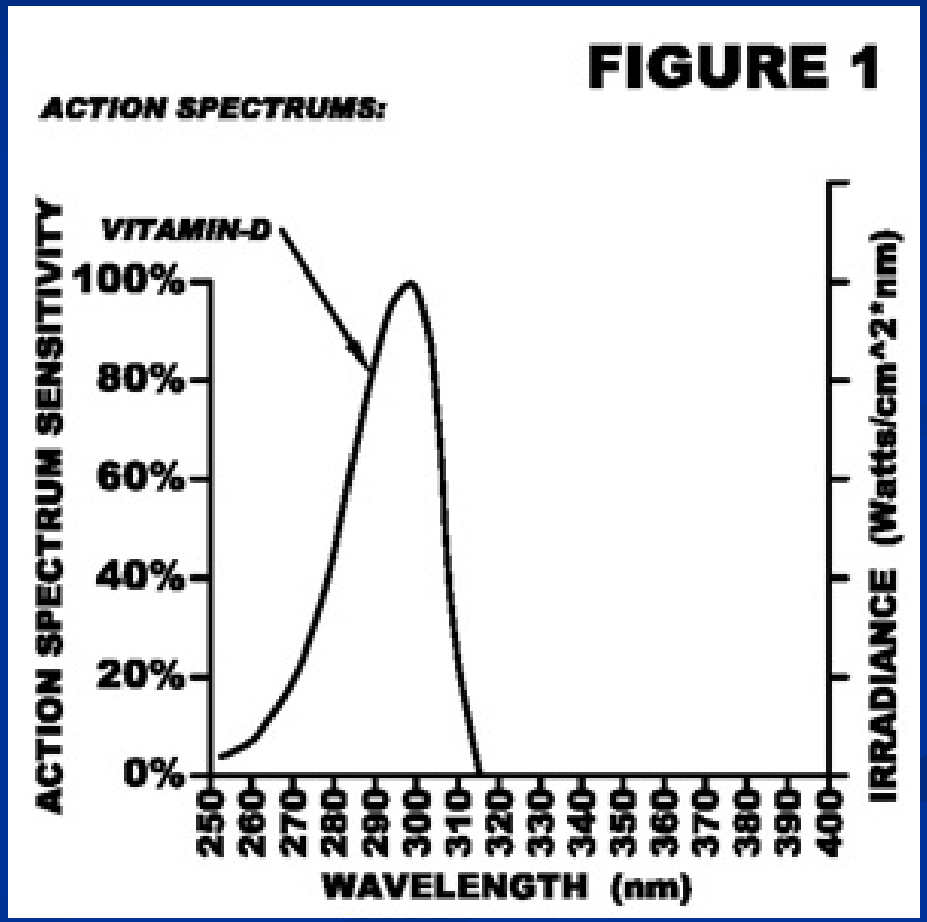
- Daily use of high SPF (>17) ↓ development of new solar keratoses (SCC precursor) and ↑ remission of existing lesions AJD 2007;48:67-76

Sunscreens

- Reduce UV-induced *p53* mutations
- Decrease immunosuppressive effects of sunlight
- Immune protective factor correlated with UVA protection factor of sunscreens (not SPF)
- SPF (sun protection factor) only internationally recognised end-point for the evaluation of sunscreen effectiveness

What about Vitamin D?

- Vit D production from UVB part of UV spectrum
- High SPF sunscreen better protection from UVB
- Regular sunscreen usage and sun protective behaviour does not impair Vit D levels (Marks,'95)



Vitamin D benefits

- helps bone, joint, muscle and neurological function, calcium regulation, TSH production, hair growth and development
- link between sunlight exposure, vitamin D levels and osteoporosis, well established.

- Working Group of the Australian and New Zealand Bone and Mineral Society, Endocrine Society of Australia, Osteoporosis Australia. Vitamin D and Adult Bone Health in Australia and New Zealand: a position statement. Med J Aust 2005;182(6):281-5.

Vitamin D

- may help prevent or improve the outcome of
  - breast, prostate and colorectal cancer, non-Hodgkin lymphoma,
  - cardiovascular disease,
  - diabetes and
  - autoimmune diseases (e.g. Multiple Sclerosis)

Vitamin D benefits

- mechanism been linked to the regulatory role of 25-hydroxyvitamin D on cellular growth both in normal and cancer cells.

7-dehydrocholesterol (abundant in skin)

▼ UVB (290-320nm)

Previtamin D

▼ skin temperature dependent conversion

Vitamin D3 (cholecalciferol)

▼ liver hydroxylation

Hydroxycholecalciferol

▼ kidney (& paracrine in other organs) hydroxylation

1,25-dihydroxycholecalciferol

Effect of MED on Vitamin D production

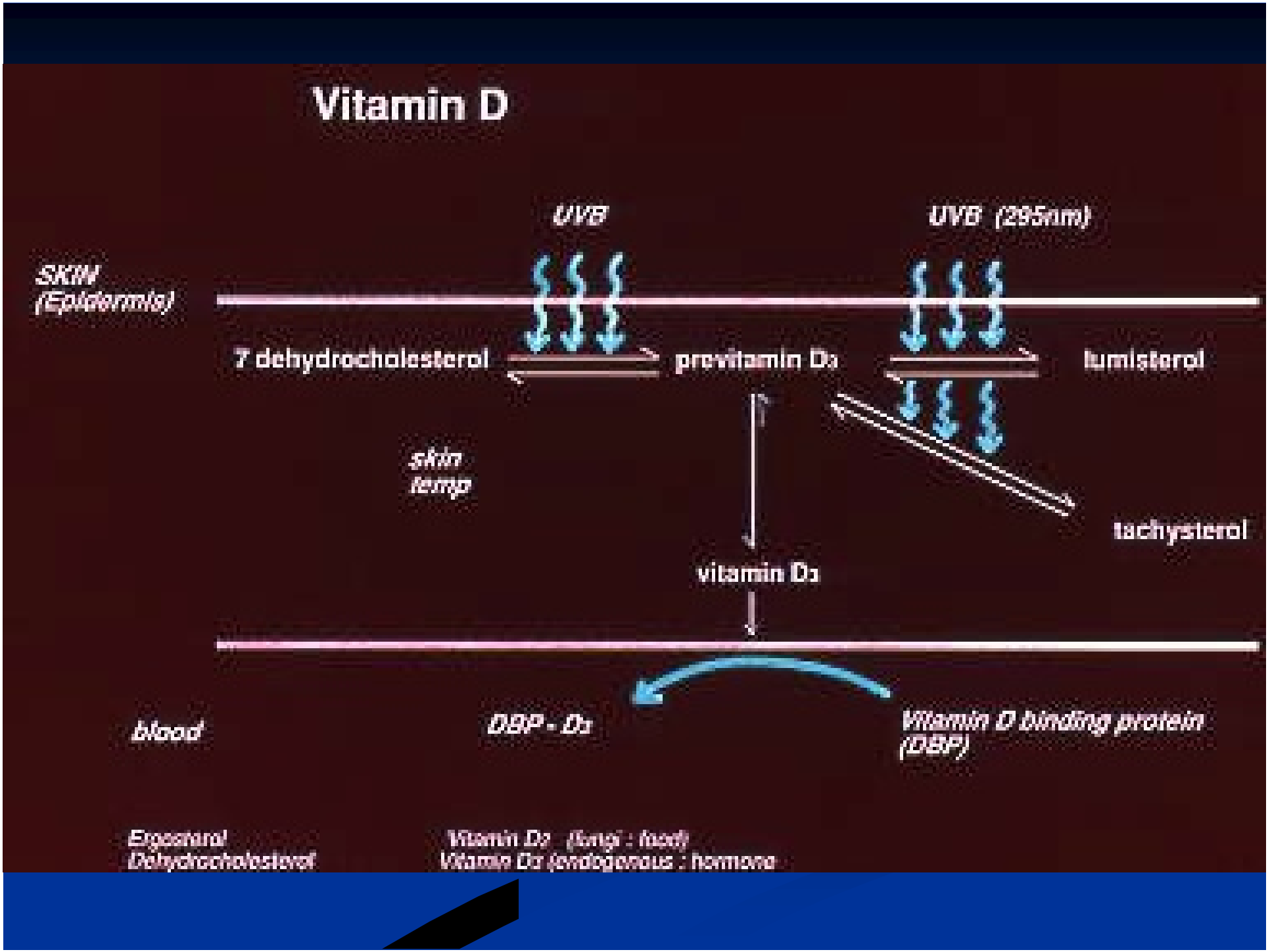
Vit D deplete and 1 MED

- 3 x ↑serum Vit D
- 2X ↑ 25OH D
- 8X 1,25(OH)2 D (4 x upper limit of normal)

Vit D replete and 3 MED

- 7-10 x ↑ serum Vit D in 2/7
- Returned to baseline in 1/52
- 2 x ↑25OH D by 2-3/52
- 1,25(OH)2 D remains in normal range

MED = minimal erythema dose


Vitamin D
UVB
UVB (295nm)
SKIN
(Epidermis)
7 dehydrocholesterol
previtamin D3
lumisterol
skin
temp
tachysterol
vitamin D3
blood
DBP - D3
Vitamin D binding protein
(DBP)
Ergosterol
Dehydrocholesterol
Vitamin D2 (fungi : food)
Vitamin D3 (endogenous : hormone

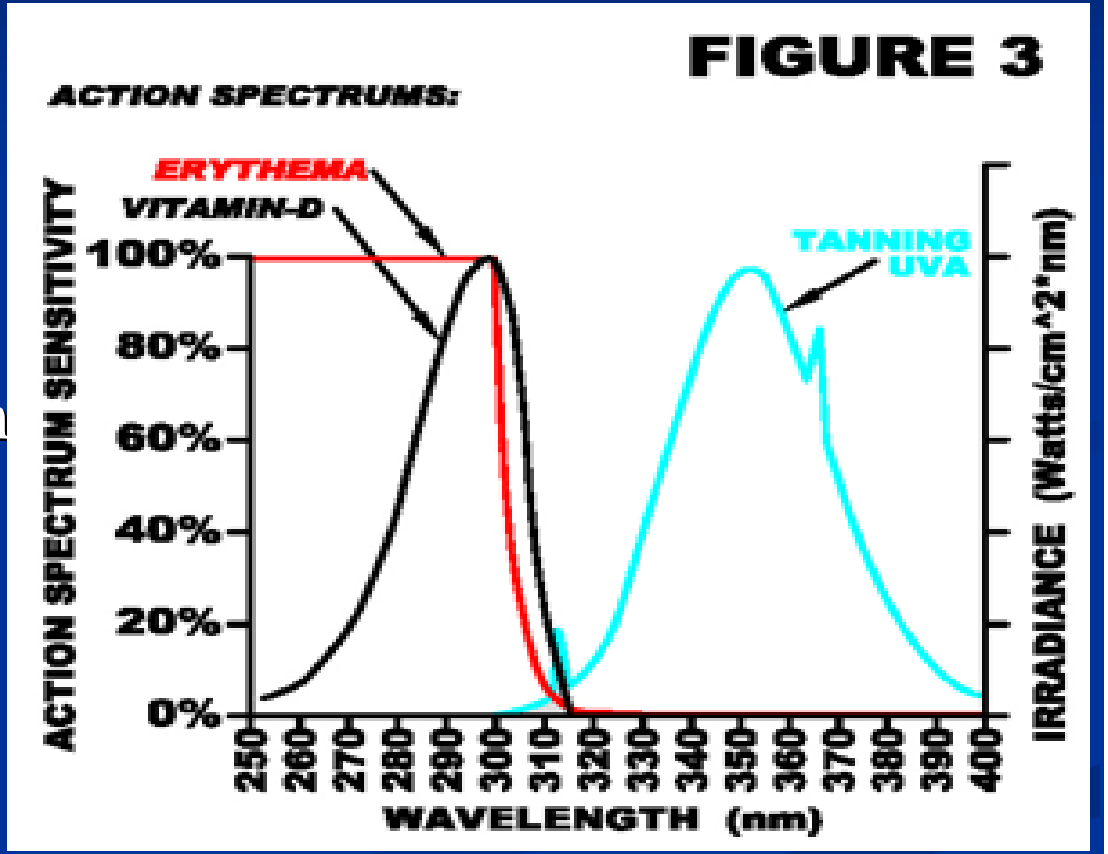
Vitamin D production regulation

- Maximal at suberythemal UVB dose
- Further UV exposure results in production of biologically inert lumisterol & tachysterol
- If synthesised Vit D > amount leached into circulation, remaining Vit D3 in the skin is further degraded by sun exposure

Optimal Vit D without burning / tanning

Diagram from Solarac Lamps

- At lower UVB wavelengths more burning, less Vit D production
- Optimal Vit D ~308nm
- (therapeutic nbUVB)
- *No vitamin D from Tanning lamps*



↑Vitamin D production if exercising outdoors

Vitamin D insufficiency at risk groups

- Elderly
- Darkly pigmented
- Covered-up (religious or cultural, extreme sun protection)
- Obese
- Babies of vitamin D deficient mothers
- Housebound or in institutional care

May require extra oral vitamin D

Vitamin D_3 vs. Vitamin D_2

- Vitamin D3 from sunlight or animal sources
- Vitamin D2 is synthesised from ergosterol (in plants) also by the action of UVR
- Vitamin D2 follows the same hydroxylation pathway and is equipotent to Vitamin D3
- *So dietary vitamin D = skin/ liver / kidney vitamin D*

Oral Vitamin D

- Dietary
  - Oily fish, liver, kidneys, lamb, sun-treated shittake mushrooms
  - Eggs, milk
  - Fortified food, e.g. margarine, soy milk, Anchor (Fonterra) milk

- Cholecalciferol 1.25mg = 50,000IU on R_x

Skin cancer high risk patients

- Oral or parenteral supplementation works well in correcting the deficiency
- Treat vitamin D deficiency with oral supplementation not more solar carcinogen

Vit D supplementation importance

- Vit D supplementation is the logical therapeutic approach to vitamin D deficiency

Ref: Munns et al. Prevention and Treatment of Infant and Childhood Vitamin D Deficiency in Australia and New Zealand: a Consensus Statement. MJA 2006; 185: 268-72.

Vitamin D toxicity

- Difficult to achieve!
- Possible after long-term intake of > 100 000 i.u. daily
- Anorexia, vomiting, diarrhoea,
- Hypercalcemia, hypercalciuria
- Osteoporosis
- Rx withdraw Vit D, low calcium diet, systemic corticosteroids

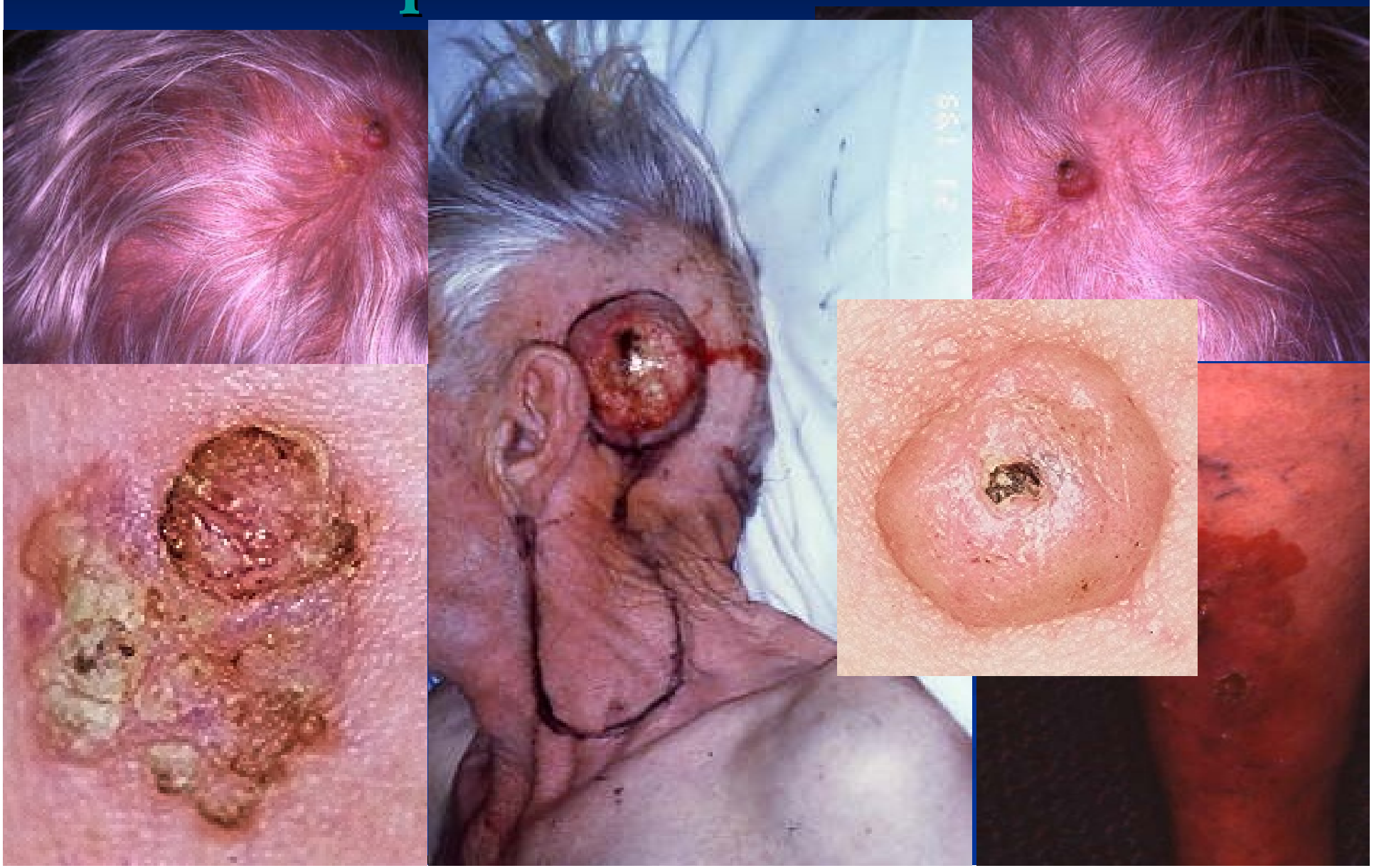
Future

- Better protection
  - Improved sunscreen
  - Photoprotectant clothing / glasses
  - Fashions
  - Window glass (tint etc)
  - Antioxidant
- Better detection?
- Better treatment for skin cancers
  - further immune modulators

Take home messages 1

- Skin cancers ***are*** a big problem in NZ
  - Morbidity
  - $cost
  - mortality

SCC Squamous cell carcinoma



Melanoma

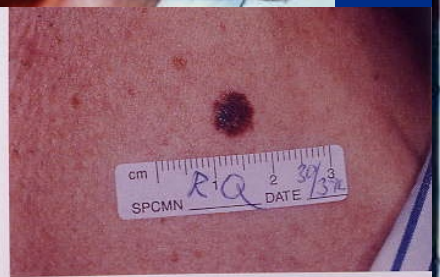
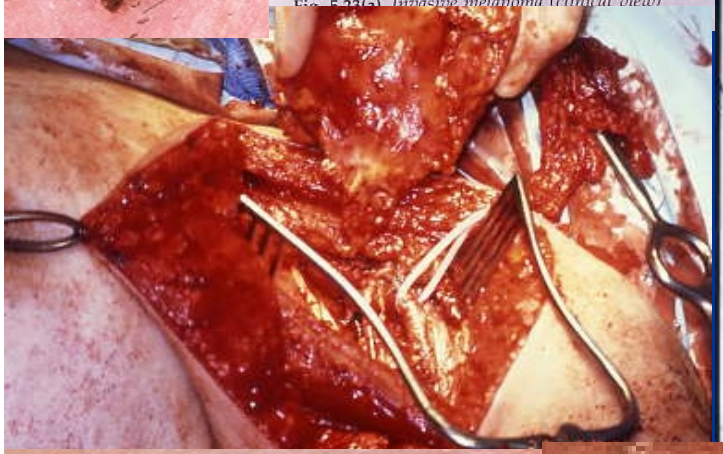


Fig. 5.23(a) *Invasive melanoma (clinical view)*



Take home messages 2

- Sun protection ***does*** help reduce skin cancers (and photoageing)
  - Avoid sun when UVI >3
  - Broad rim hat
  - Wrap-round sunglasses
  - Cover large area (3/4) of skin
  - UPF clothing >30
  - Sunscreen (especially UVA coverage / broad spectrum)
  - Healthy diet

Take home messages 3

- Adequate Vitamin D levels important for optimal health optimal level 80nmol/l?
- Efficient Vitamin D production by
  - Keeping pale (non pigmented /non sun damaged skin)
  - Minimal sun exposure (sub MED)
  - But regular outdoor exercise
  - Healthy diet


LIPOSOME TECHNOLOGY
Daylong
SUNSCREEN
Once daily
sun protectio
Water resistant
Sweat & rub proof
Hydrating for skin
Non-clogging & non-greas
Non-perfumed
KIDS FORMULA
PRESCRIPTION MEDICINE
Cal.D.Forte
Each Tablet contains: 1.25mg Colecalciferol BP
Contents: 12 Tablets
Dose: As required by the Physician
Use: For treatment of Vitamin D deficiency
Storage: Store Below 25°C
Manufactured by PSM Healthcare Ltd, t/a HMG
Healtheries
Osteo-500
CALCIUM SUPPLEMENT
1 tablet 2-3 times daily with food
500mg
100 Tablets
INNOVATORS IN SUNSCREEN TECHNOLOGY
SUN SENSE™
DAILY FACE
MATT FORMULA
SPF 30+
BROAD SPECTRUM CREAM
Oil-Free Base
ego
200mL
AUST L 77654
95027

Conclusion
Health Messages

- Minimal sun-exposure for optimal Vitamin D production

  promote some regular outdoor exercise, walk / cycle to school / work
- Antioxidants - Eat 5+ fruit and vegetables
- Promote dietary oily fish
- Sun protective behaviour lifelong Support SunSmart
- Should we promote more Vit D supplementation / food fortification?
- Regular self-skin / cancer checks