LED for Bio-Industry

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What is Bio-Industry ?

- Production, Ecology related related
  - Agriculture (Agronomy, Horticulture, etc.)
  - Aquaculture (Fishery, Shrimp, Shellfish, etc.)
  - Livestock/Animal Industry
- Life Science related
  - Bio-technology Industry
- Life/Health related
  - Bio-Medical Industry

What is LED ?

- People from different background have different point of view.

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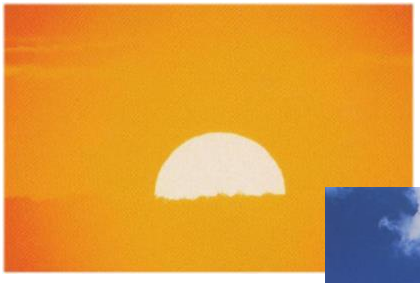
With the help of **LED, we can LED.**

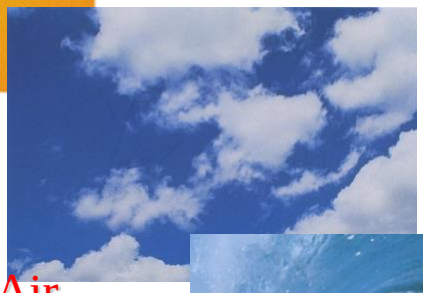
Light
Emitting
Diode

Light up
Eco-friendly
Dream

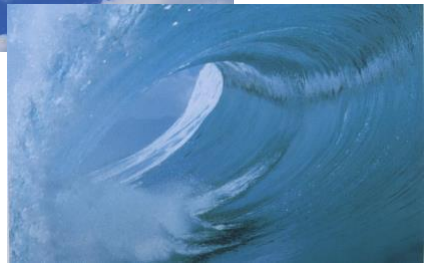
Worldwide replacement of Incandescent Bulb with LED Bulb is the 1st step toward eco-friendly dream.



陽光 LIGHT



空氣 Air



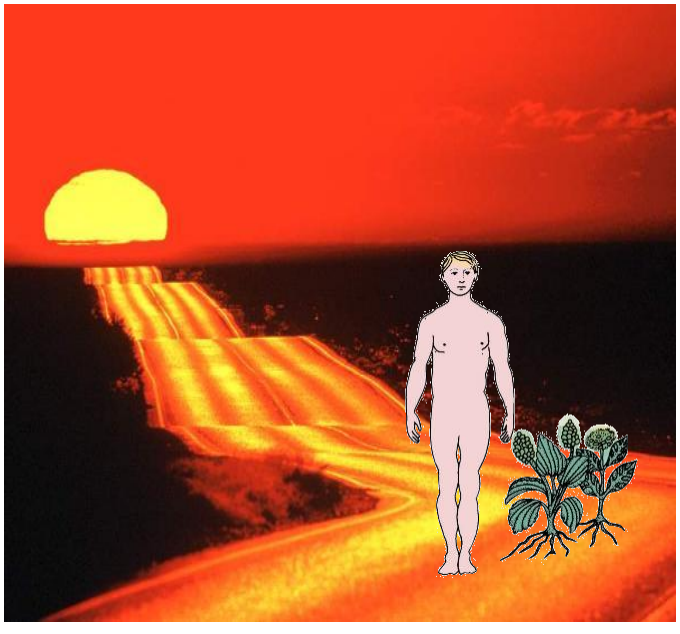
水 H_2O

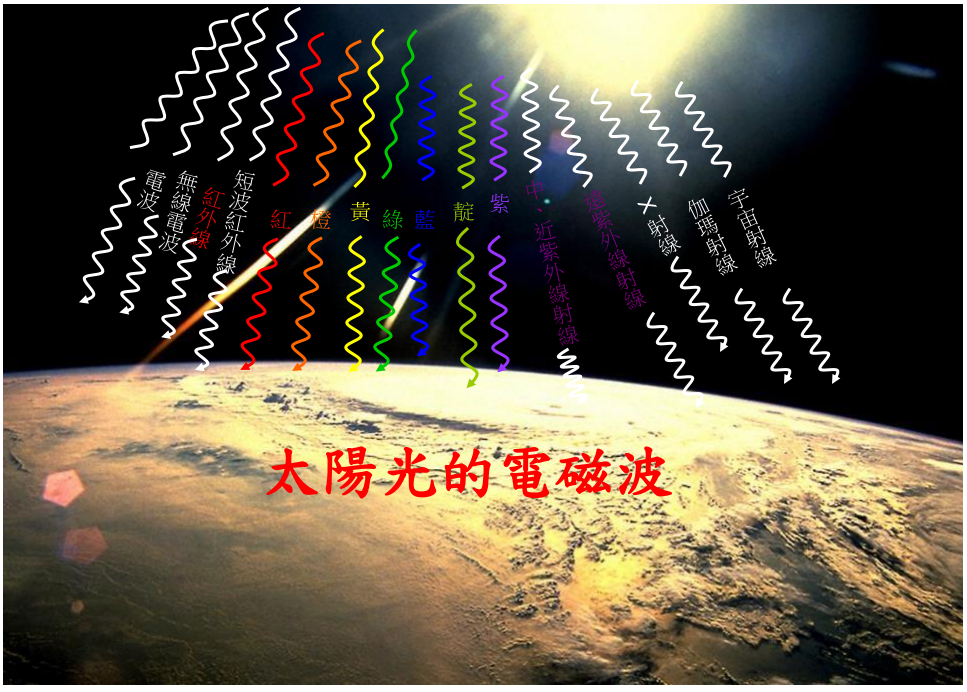
LET THERE BE LIGHT!

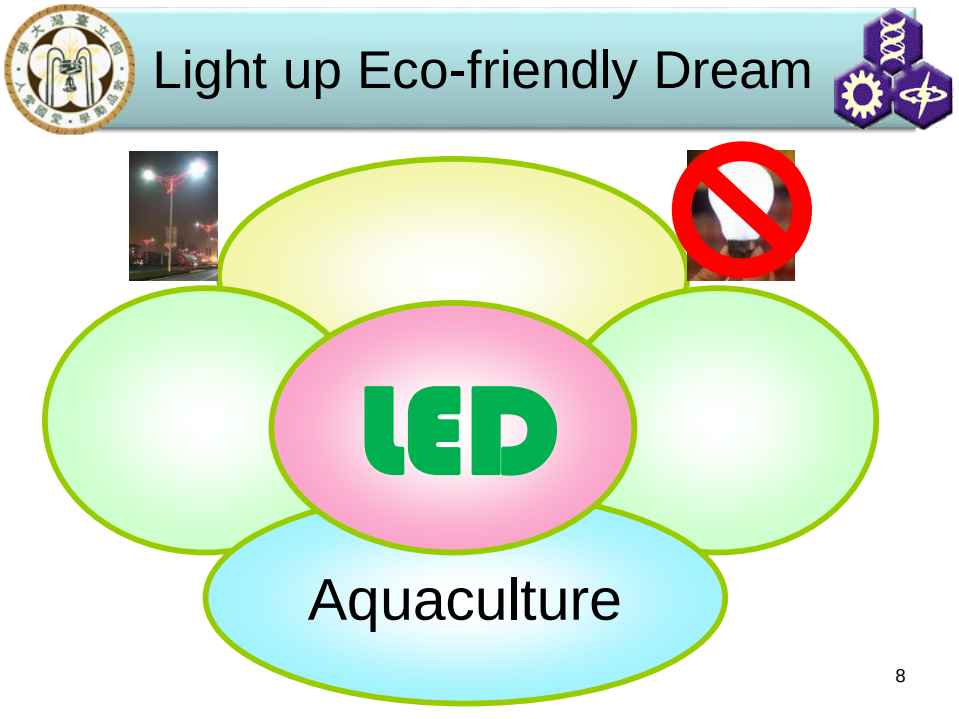
陽光

與

生物




電波
無線電波
紅外線
短波紅外線
紅
橙
黃
綠
藍
靛
紫
中、近紫外線射線
遠紫外線射線
X射線
伽瑪射線
宇宙射線
太陽光的電磁波


Light up Eco-friendly Dream
LED
Aquaculture

Incredible fishing

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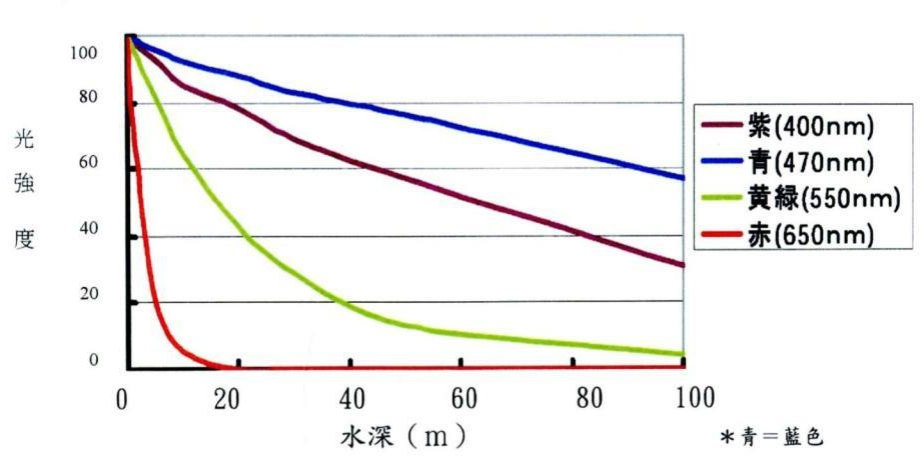
Light intensity remained @ various depth under water for various spectrum of light



To observe night time behavior

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水銀聚魚燈船

Traditional MH lamp

藍色LED聚魚燈船

Blue LED lamp

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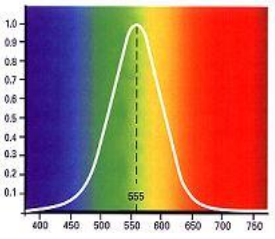
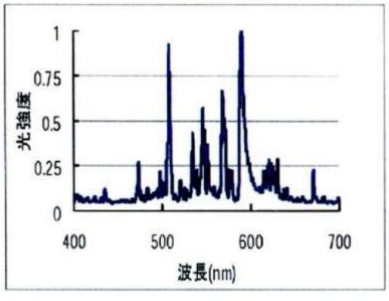
Human 555 nm



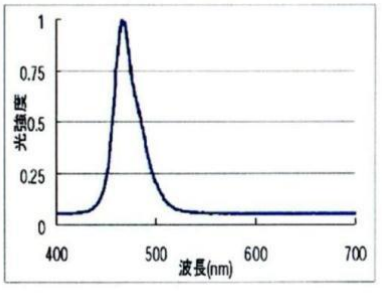
Peak wavelength of calamari's response curve

魷魚(花枝)	482 nm
金花枝	490 nm
槍花枝	494 nm
肯薩基花枝	491 nm
紅花枝	482 nm
螢光花枝	471、484、501 nm

Calamari
Squid
Cuttlefish



Metal Halide Lamp



Blue LED

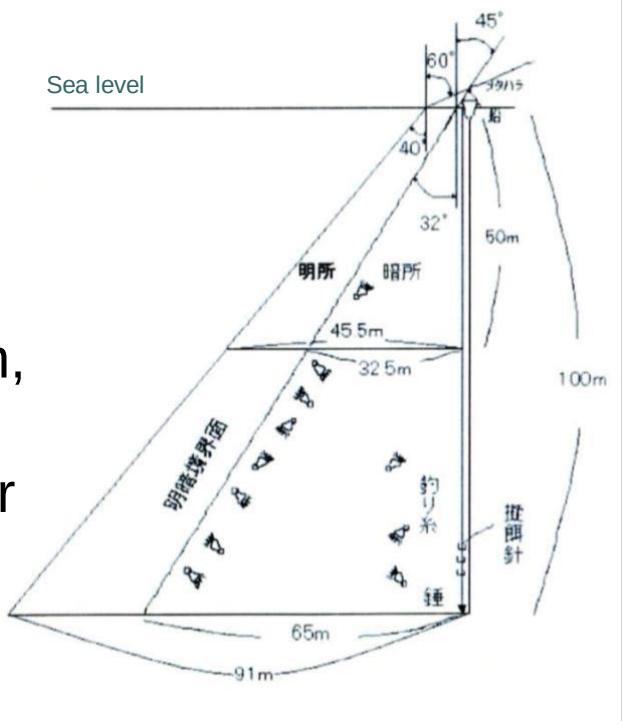
Light source	Ratio of blue portion
Sun	18.2%
Moon	9.74%
Metal Halide Lamp	7.32%
Blue LED	74.1%

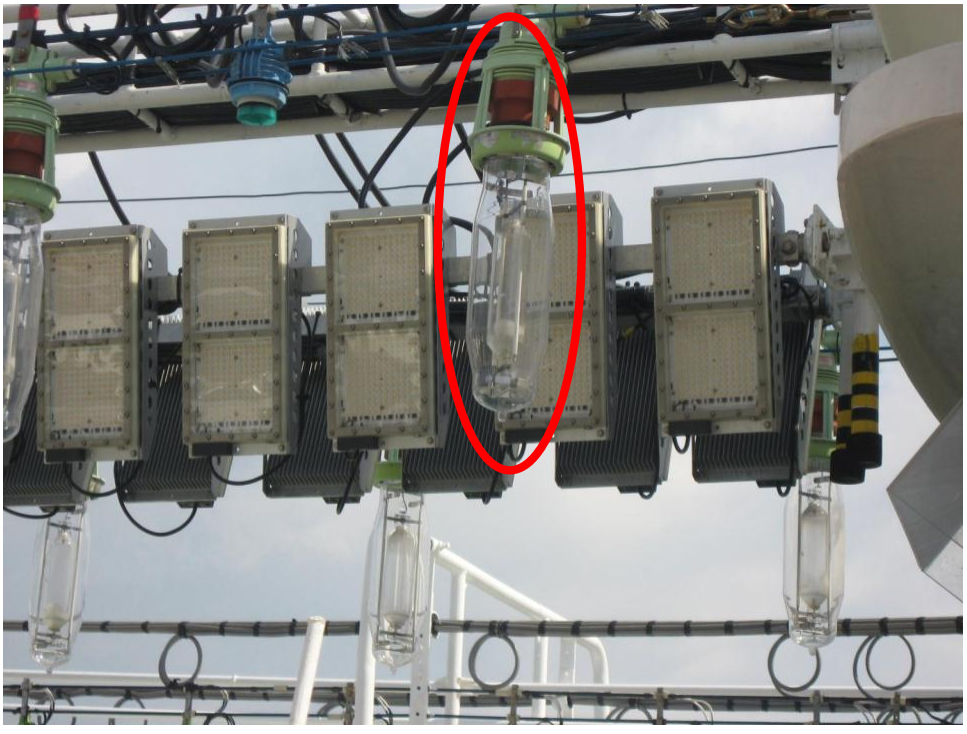
Blue portion in blue LED is 10 times of that in Metal Halide Lamp

Proper Spectrum

Deeper penetration,

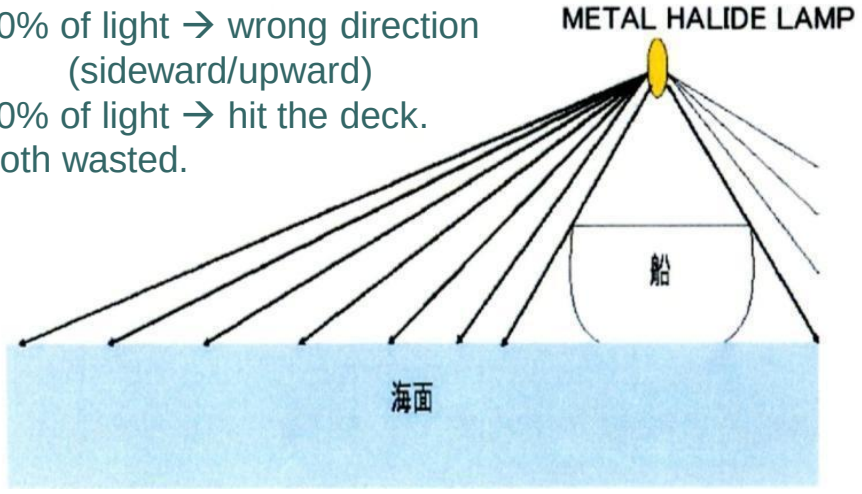
Much wider effective range

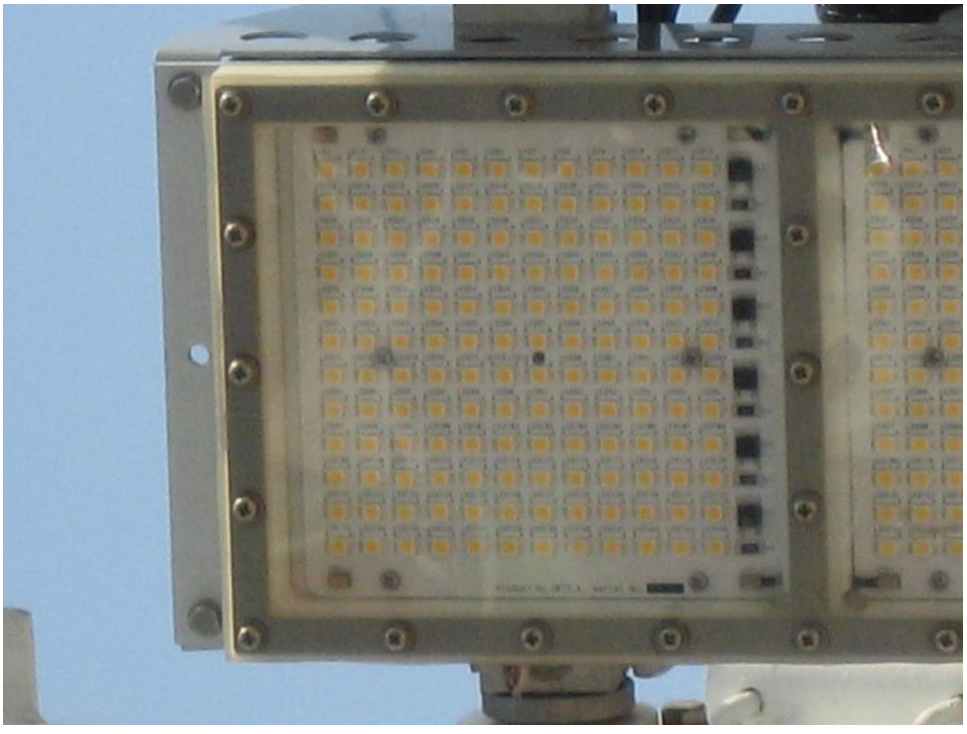


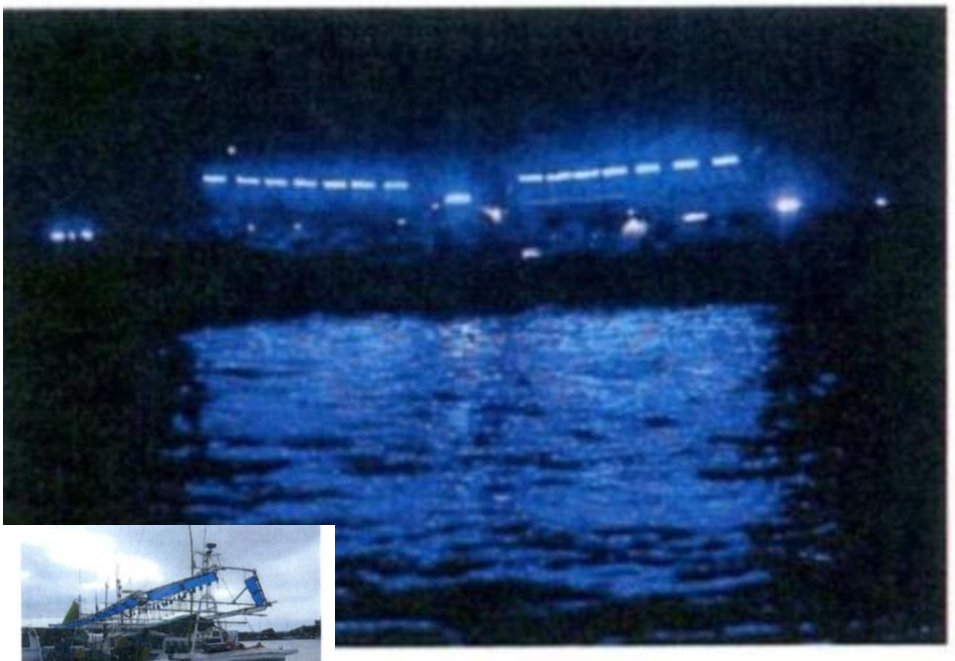


Poor installation subject to the nature of the light source

50% of light → wrong direction (sideward/upward)
20% of light → hit the deck.
Both wasted.



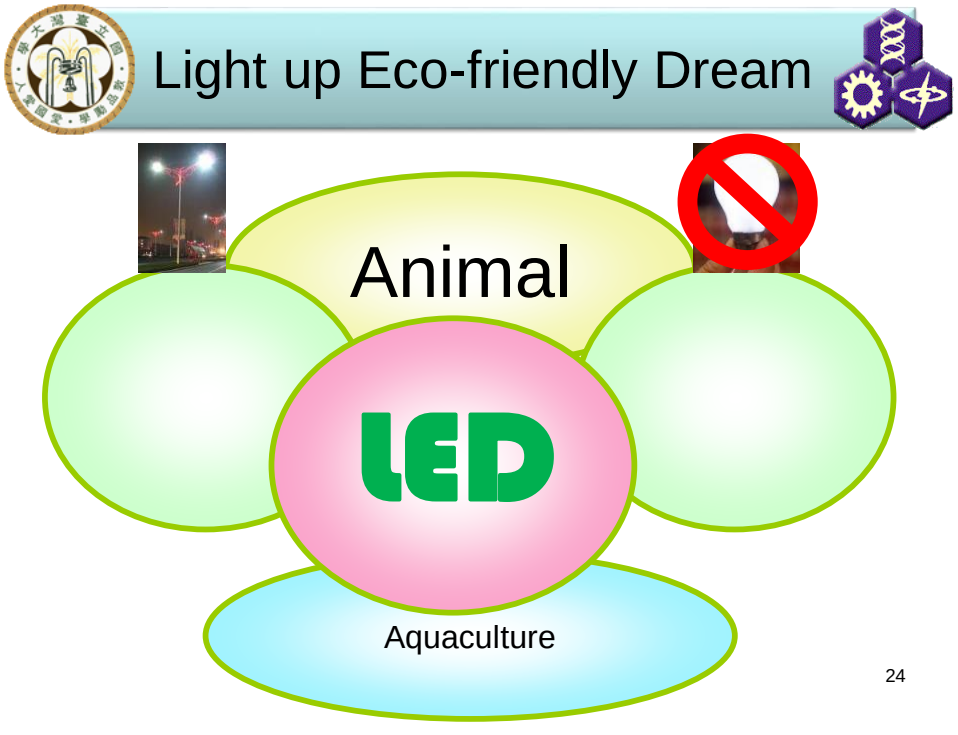




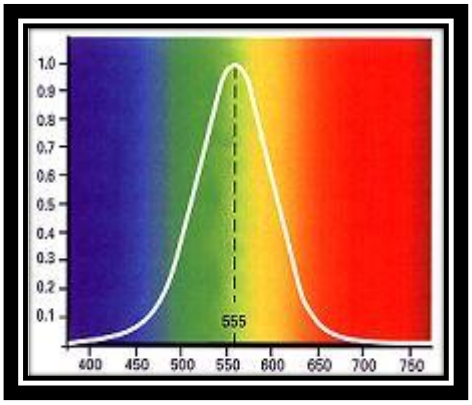
96~98% of power consumption can be saved
by switching to LED
w/o sacrificing the yield

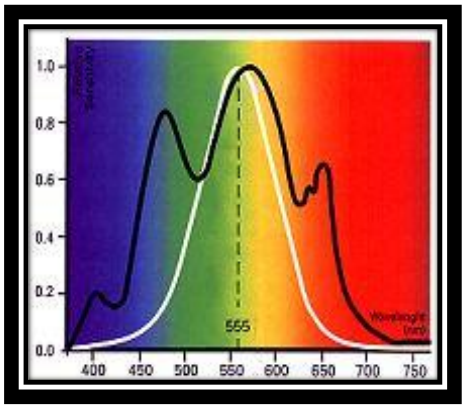
漁船	LED lamps	MH lamps	LED/ MH	總噸數	進行試驗的海域	時間跟捕魚日數	漁獲量	評估
A	2.4kw (36 PANEL)	70kw	1/29	9.9	岩內沖	H16.6.8～7.26（26 日）	57,336 尾	○
B	2.68kw (40 PANEL)	99kw	1/37	13.17	佐渡沖	H16.7.3～28（16 日）	16,352 尾	○
C	2.28kw (34 PANEL)	120kw	1/53	9.5	岩內沖	H15.10.20	4,200 尾	○
D	2.15kw (32 PANEL)	180kw	1/84	9.7	函館沖	H15.7.26～27（2 日）	2,400 尾	×

註１） 所謂的「評估」，是LED漁船和金屬鹵素燈漁船在同海域、同時間內的漁貨量的比較，大概同等量程度的漁貨是○、比較少的則是×。



Different response curve





Human

Chicken

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Chick for KFC ?

Blue and Green

Blue

綠光與藍光之LED燈泡，皆能促進白肉雞之生長，但綠光所造成的刺激是在生長前期，而藍光卻是在稍後的階段。白肉雞於孵化後，應是先照射LED綠光燈泡約10天，再接受藍光之照射。

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節錄自 魏與周，2010 發光二極體（LED）應用於家禽生產之研習

綠光　雞肉雞　雞胸肉

- 綠光的效果主要是在肌肉衛星細胞的增生與轉變。雛雞於孵化後，位於肌肉中肌纖維（也就是肌細胞）的數目已確定下來，不會再增加，只會變大，除非肌肉細胞受損或其他因素，致使肌肉的衛星細胞被致活，轉變成肌纖維，才會增加肌纖維。
- 雛雞照射綠光後，每公克肌肉之衛星細胞的數目增加，而且衛星細胞上對生長激素之受納器之基因表達增加。
- 飼養於綠光下雞隻的胸肉也較重，換言之，綠光也有促進衛星細胞增生與轉變成肌纖維之效果。

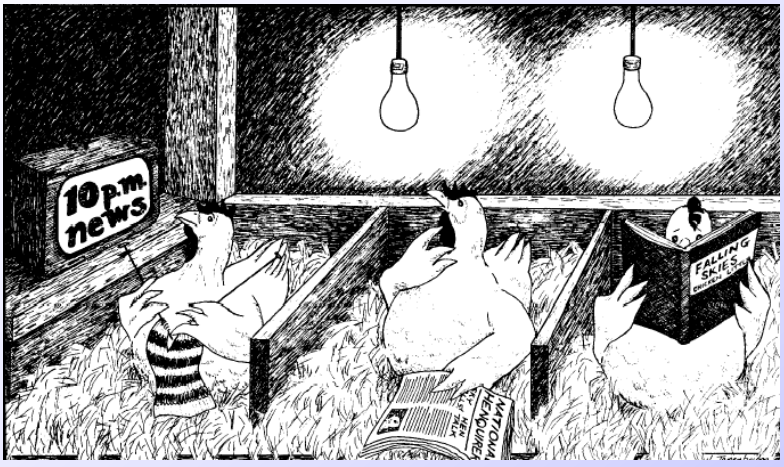
節錄自 魏與周，2010 發光二極體（LED）應用於家禽生產之研習

藍光 vs. 雄性白肉雞

- **藍光**能刺激生長中雄性白肉雞**雄性素**之分泌，
- 雄性素早已被證明能增加**蛋白質**的合成，
- 達到促進蛋白質蓄積的效果。

節錄自 魏與周，2010 發光二極體（LED）應用於家禽生產之研習

Winter season need supplemental light (control of photoperiod)



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Green light for egg hatching

綠光可刺激雞胚衛星細胞數目的增加，對孵化後雞雞的生長有促進的效果。

照片提供 周楚洋

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Red LED promote estrusto 催情

- Red LED (660 nm) put in the ear of **turkey and ostrich** @ anestrus (乏情期)
- successfully seduce male to approach and mate.
- Effect is much better than red bulb and red FL hanging overhead.

- Red LED 660 nm紅色光源，不僅可以刺激雌禽下視丘的GnRH（激性腺素刺激素）、腦下垂體的FSH（激濾泡素）、LH（排卵素）之mRNA的表現，以及與排卵相關相關內泌素如動情素、助孕素於血漿中之濃度，也抑制了與籟抱相關、位於腦下垂體的泌乳素之mRNA的表現。

節錄自 魏與周，2010 發光二極體（LED）應用於家禽生產之研習

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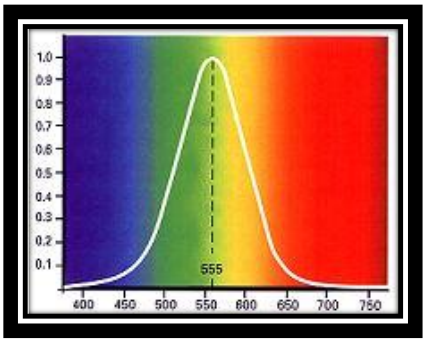
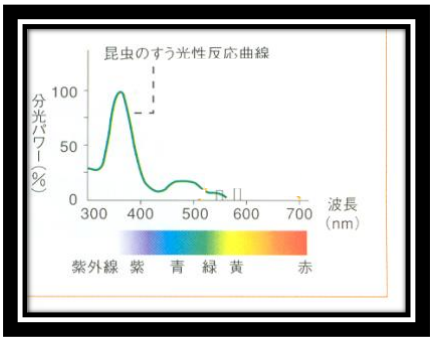
Different response curves





Human Insect

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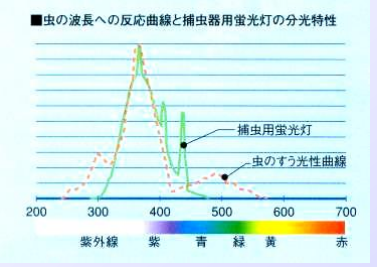
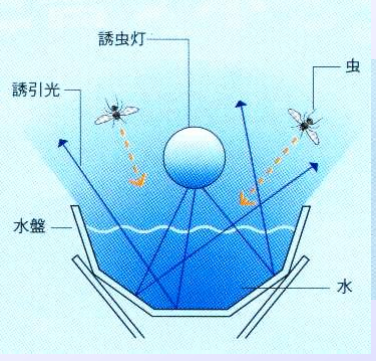
Insect Trap





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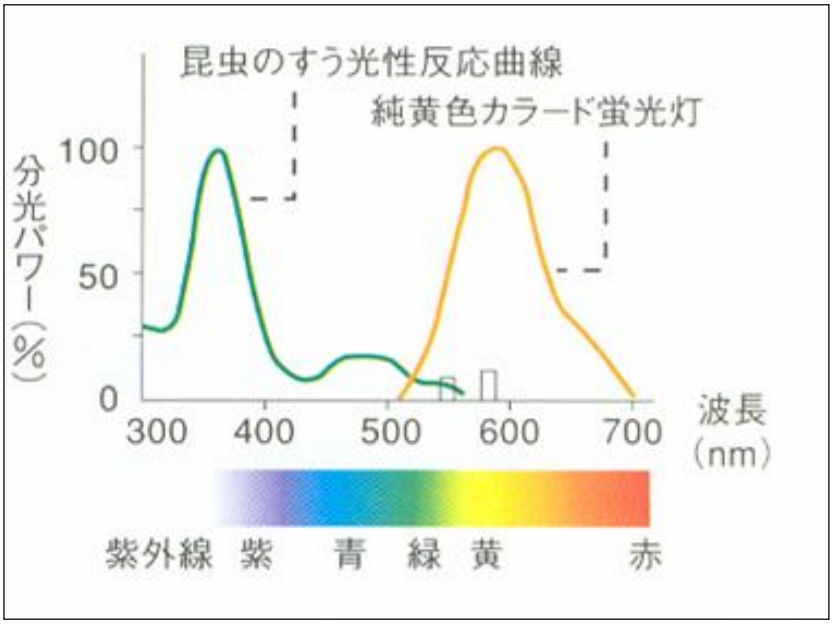
Yellow light keep flying nocturnal insects away



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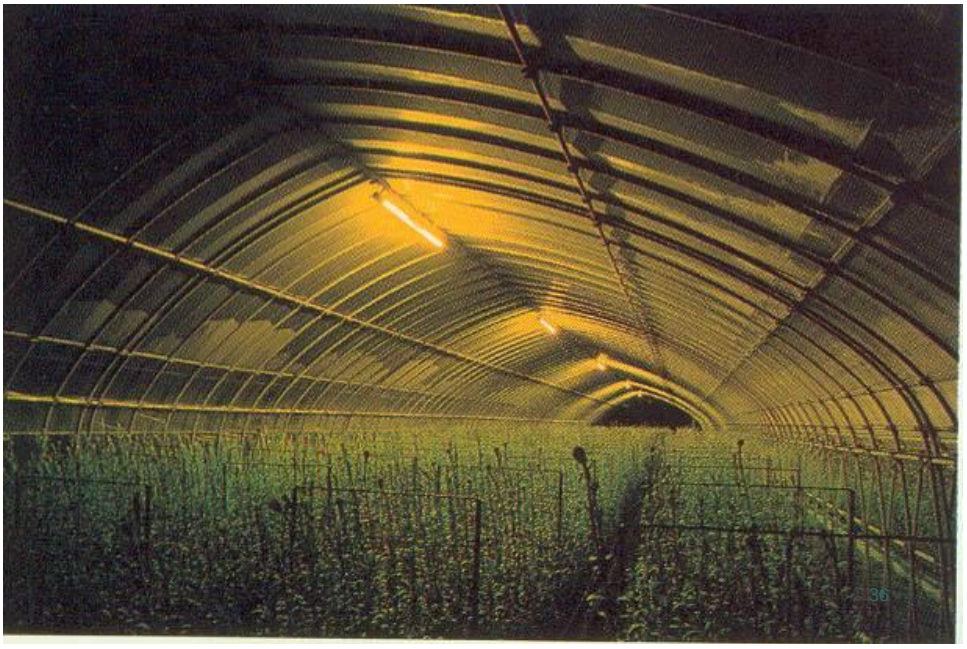
Night time inside a greenhouse



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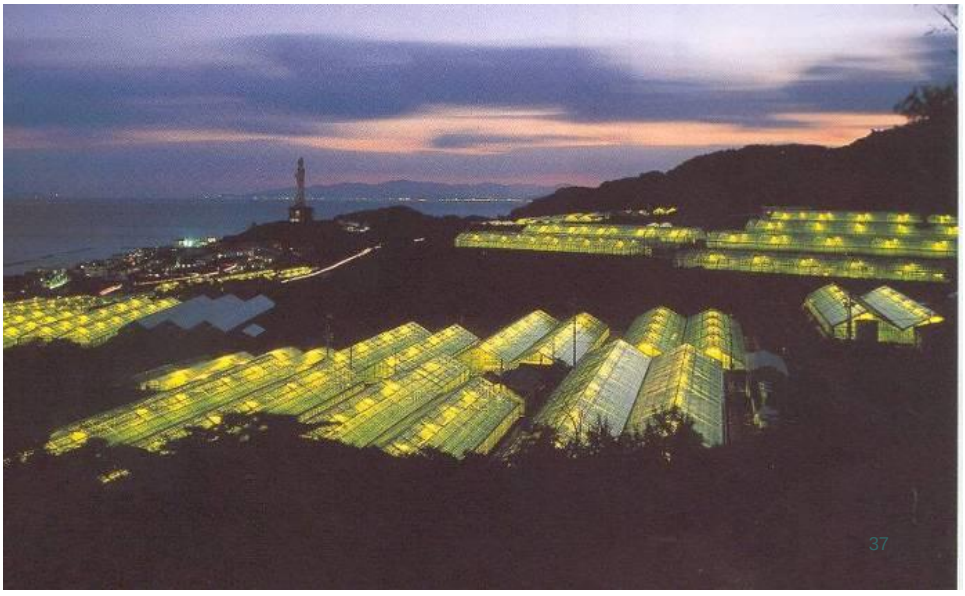
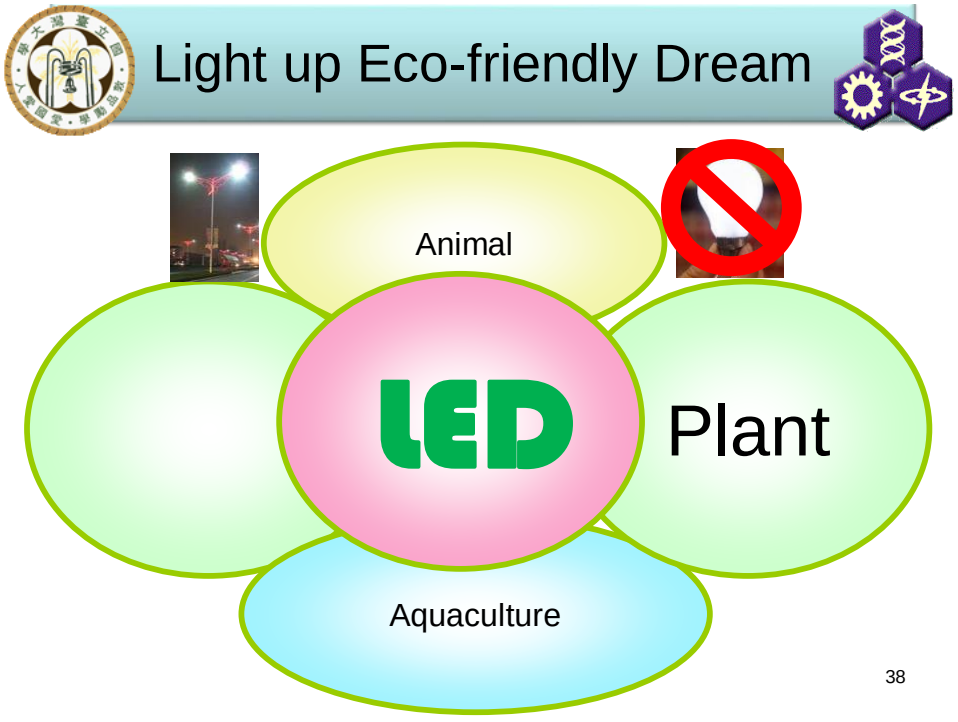
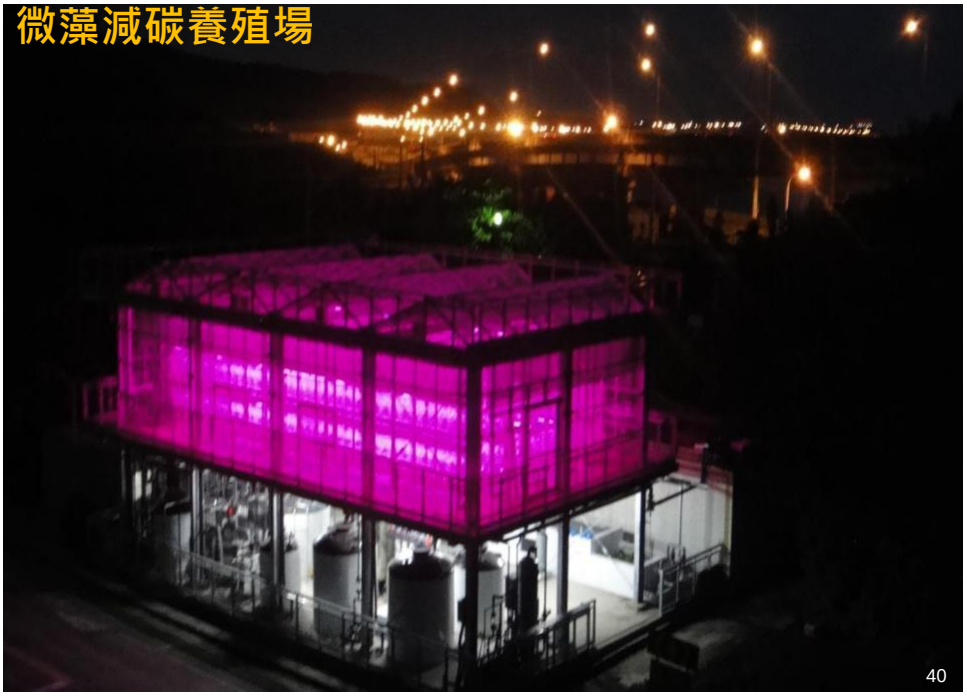
Night view outside greenhouses



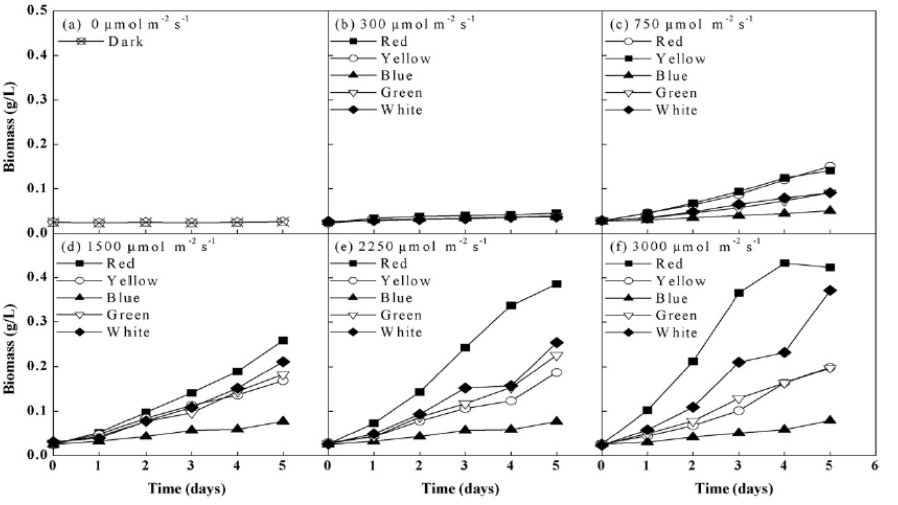


微藻減碳養殖場

火力發電廠所產生的排煙經過脫硫後用來培育藻類，讓藻類吸收CO_2轉化為Biomass並產生氧氣，減少CO_2 的排放量。



光質對螺旋藻生長的影響



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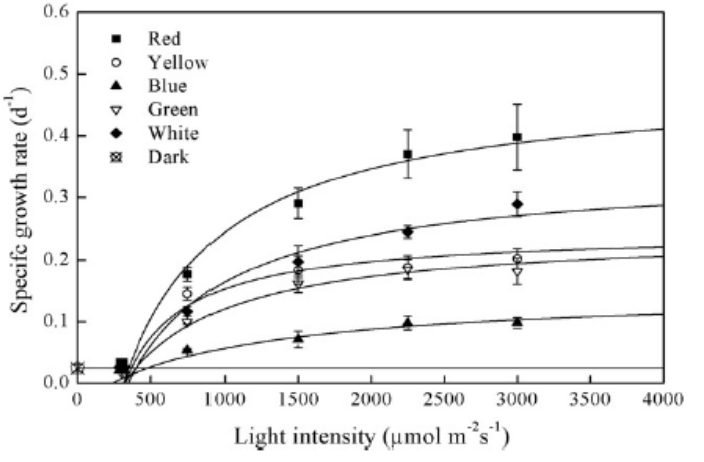
生長模式



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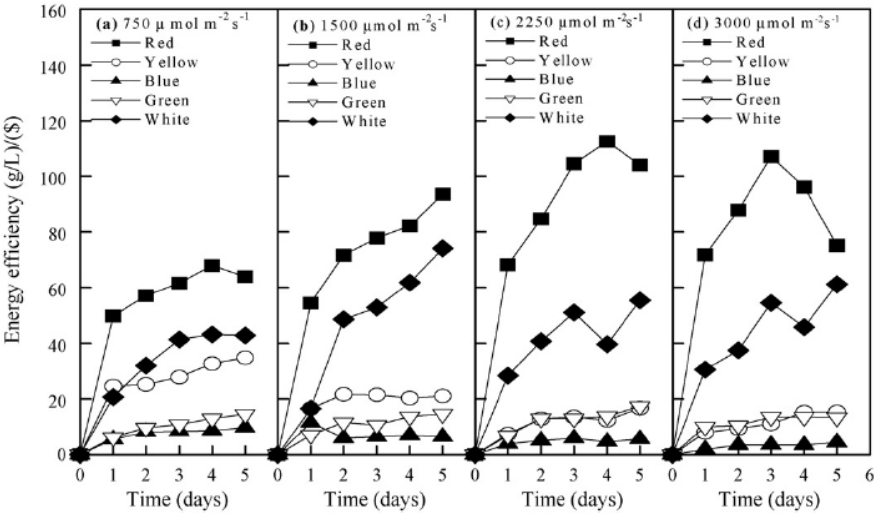
生長模式

$$\mu - \mu_0 = \frac{\mu_{\max}(I - I_0)}{K_s + (I - I_0)}$$

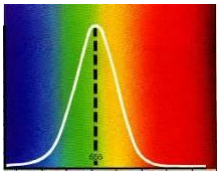
Light sources	μ_{max} (day^{-1})	K_s ($\mu mol\, m^{-2}\, s^{-1}$)	I_0 ($\mu mol\, m^{-2}\, s^{-1}$)
Red	0.44	461.2	391.3
Yellow	0.22	459.4	366.0
Blue	0.12	1460.4	475.6
Green	0.22	781.3	397.1
White	0.32	773.5	398.4

[a] μ_0 was set at 0.02 (day^{-1}) in the fitting.

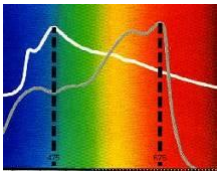
Biomass/耗電成本



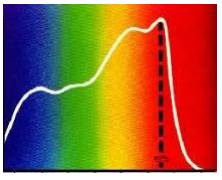
Different Response curves



Lux

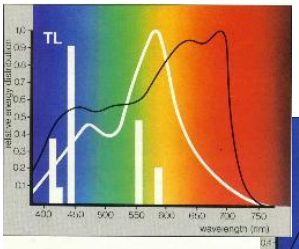


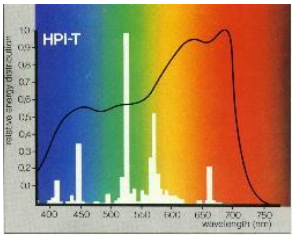
W/m^2

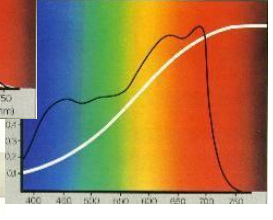


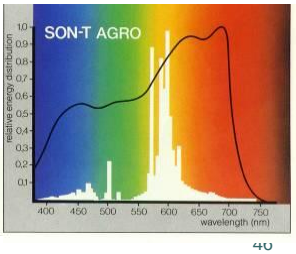
µmol/m^2/s

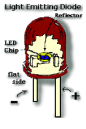
Artificial Light Source





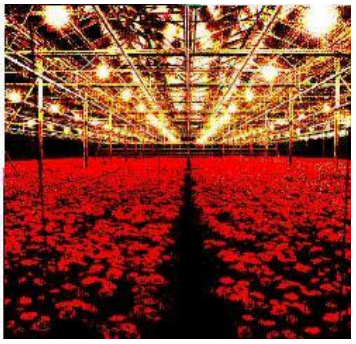




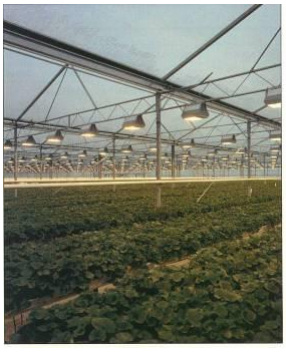


Light Responses of Plant

photoperiodism



photosynthesis



photomorphogenesis

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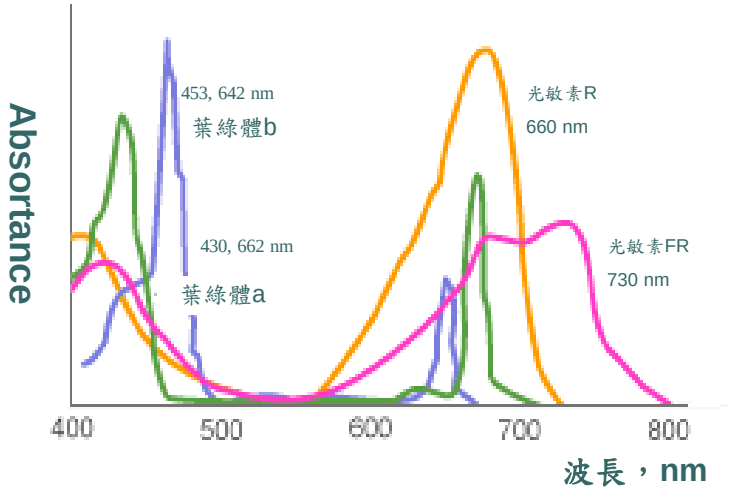
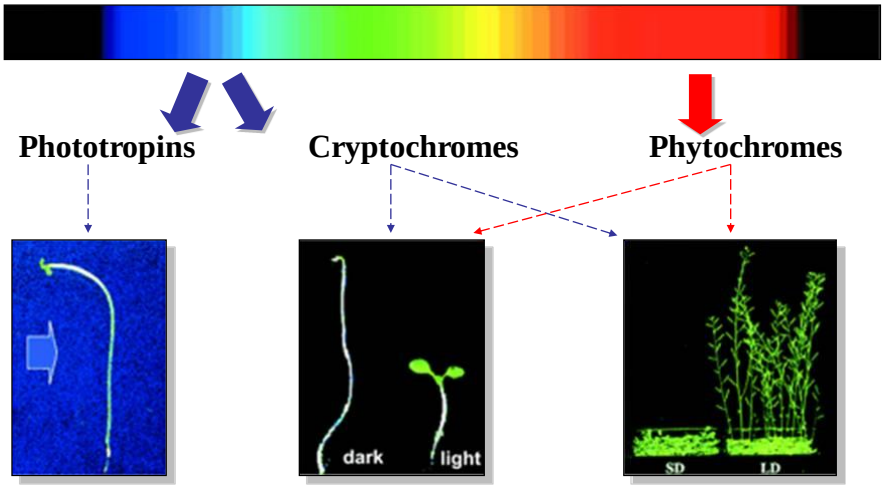
Absorption Spectrums of Photo Receptors (Chl.a,b & Phy.r, Phy.fr)



48

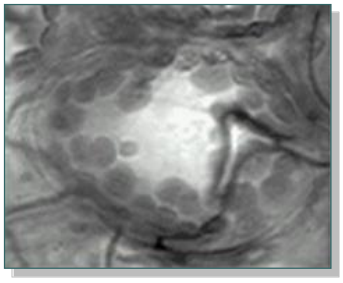
Photomorphogenesis 光形態發生



49

phototropins (flavin-containing)
Blue Light Photoreceptor

向光性



葉綠體移動

氣孔開閉

50

LED for Horticultural Lighting

- Used to be light source for
  - Tissue Culture
  - Growth Chamber
- Recently, light source for
  - Leafy vegetables

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Tissue Culture Lab.

Florescent Lamps + AC

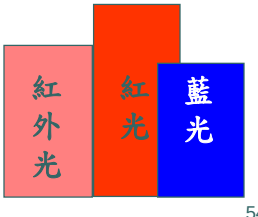
52

Mass production of Tissue Culture plantlets

Florescent Lamps are widely used

53

Adjustable Intensity, Quality, Frequency, Duty Ratio



方等2001中華民國專利
方等2002 、2003美國專利
方等2001中國專利

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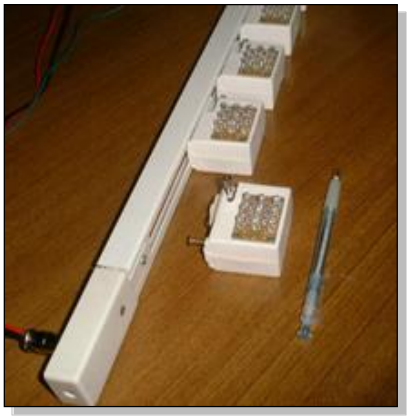
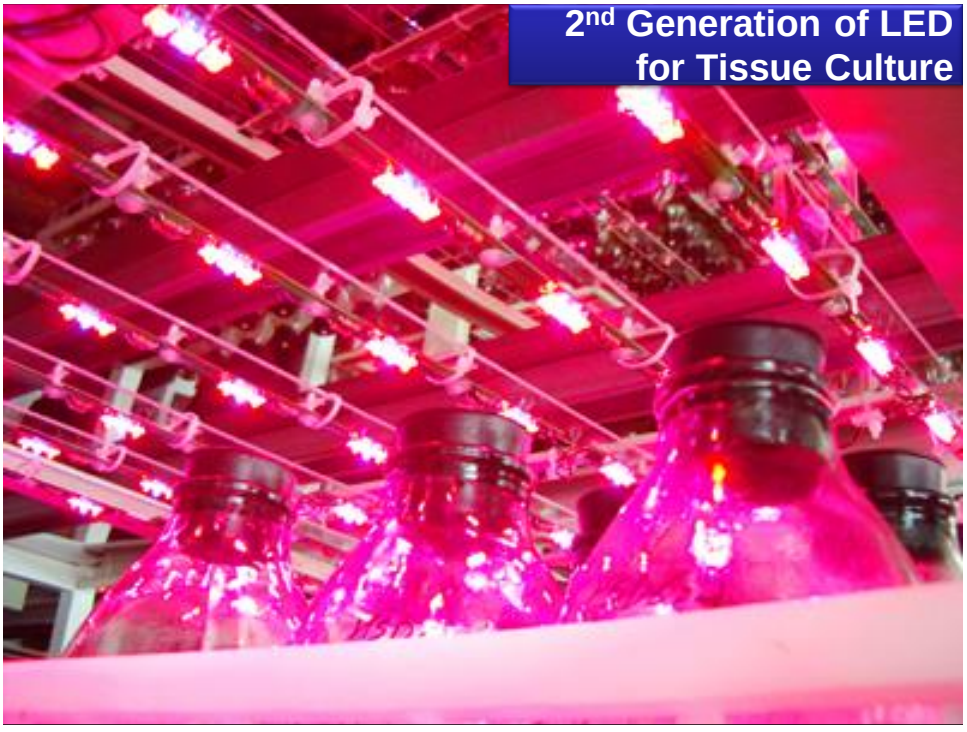
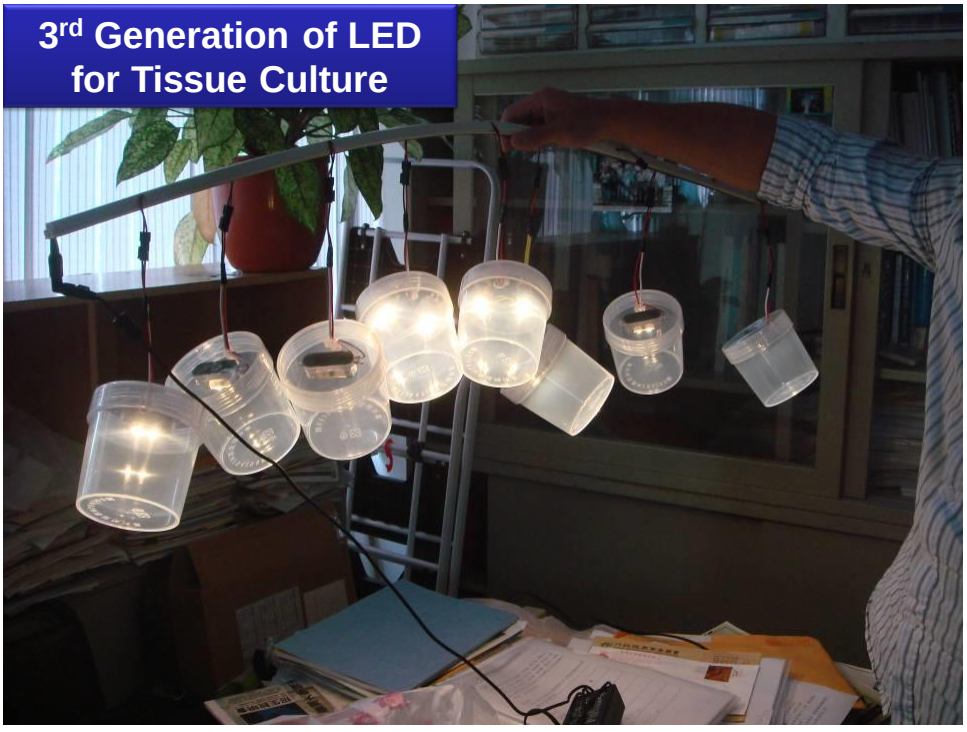
1st Generation of LED for Tissue Culture



55

2nd Generation of LED for Tissue Culture

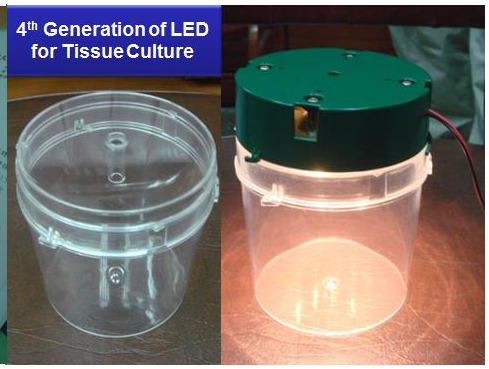

2nd Generation of LED
for Tissue Culture


3rd Generation of LED
for Tissue Culture

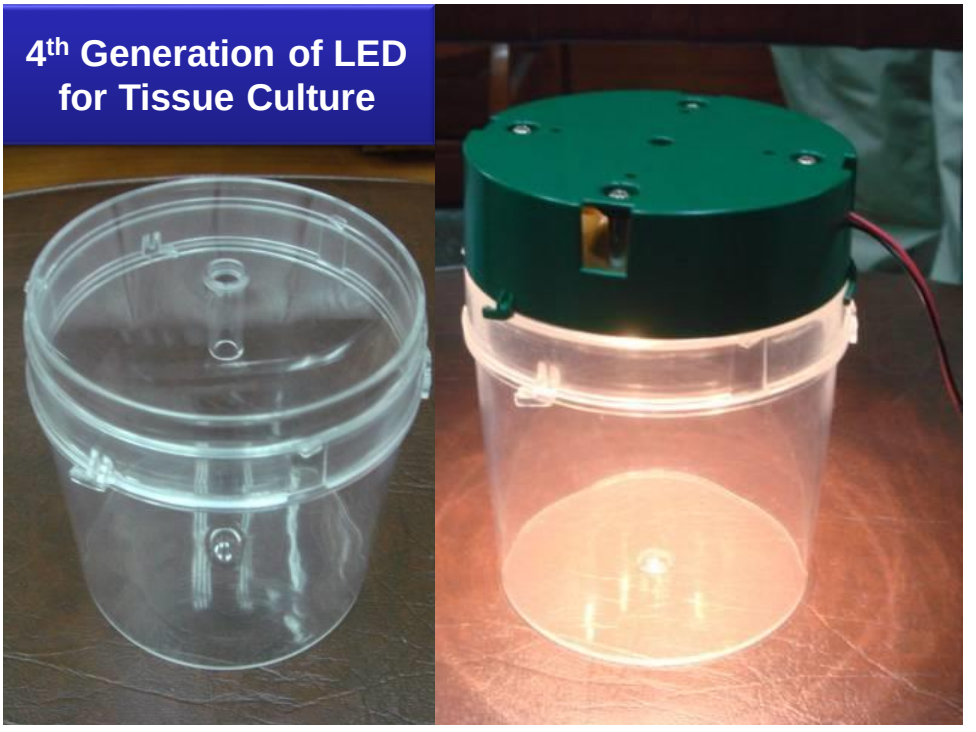
3rd Generation of LED for Tissue Culture

4th Generation of LED for Tissue Culture

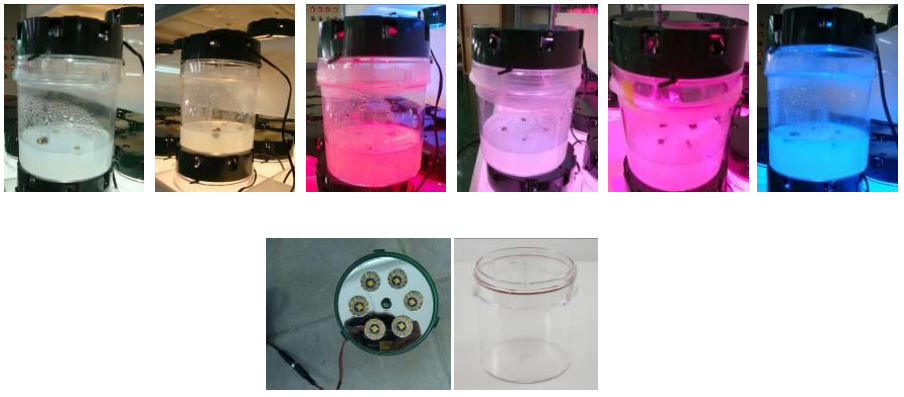
4th Generation of LED for Tissue Culture



4th Generation of LED for Tissue Culture



Cool White Warm White 6R 1B1G8R 1B9R 6B



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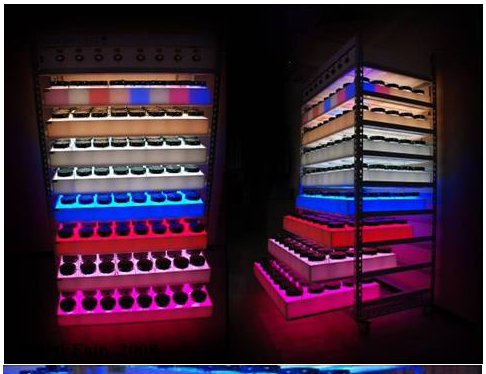
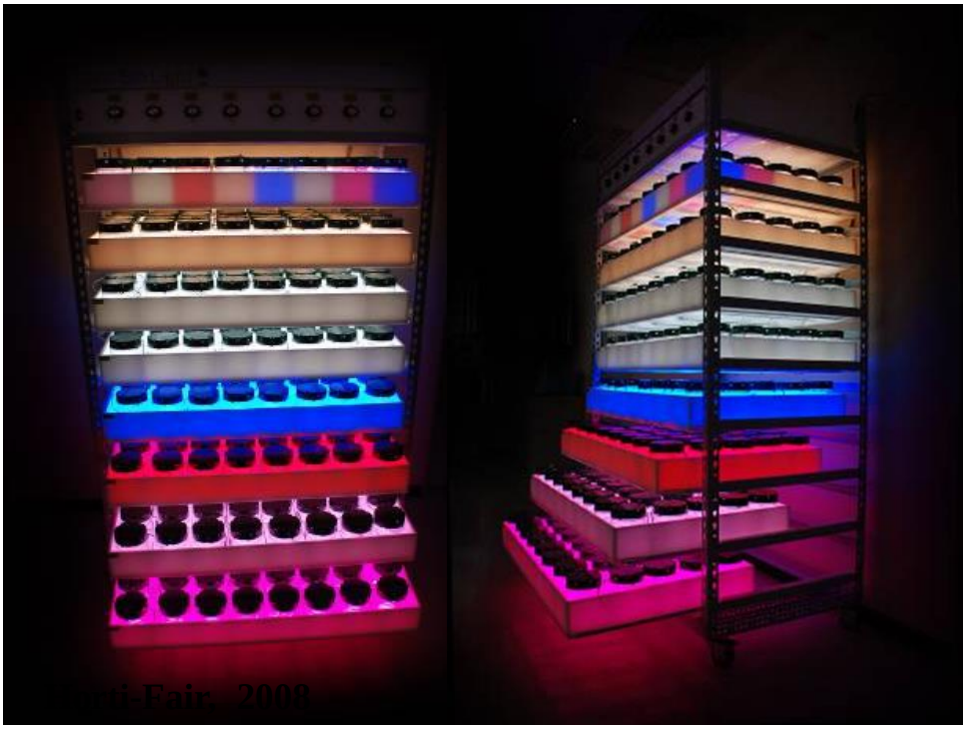
Horti-Fair, 2008

TC lab of the National Natural Science Museum, Taiwan

60



65



4th Generation of LED for Tissue Culture

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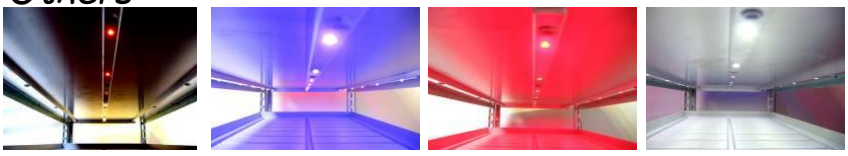
Horti-Fair, 2008

Uniform distribution of *E Light* compare with other LED light bench

E Light

Others



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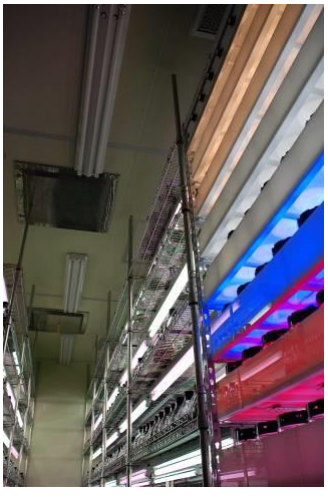
Horti-Fair, 2008

TC lab of the National Natural Science Museum, Taiwan



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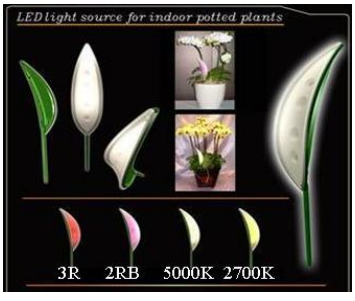
Horti-Fair, 2008

2008 Horti-Fair

光葉 (i_Light)



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陳與方 2007 中華民國專利

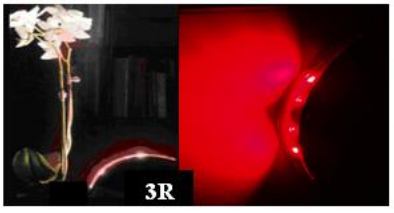
Specifications

- Voltage: 100 ~ 240 V
- Power: 1 W

- Electricity fee
  - 0.0048 US$ per 24 hours
  - Assuming 0.2 US$ / kW.hr

74

4 colors are available



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MAGAZINE - SINCE 1937

GROWERTALKS

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BANK OF THE WEST
ELLEGAARD A/S7
ATLAS MANUFACTURING INC.
PROGREEN EXPO
FINE AGROCHEMICALS

Finally ··· My favorite product

Usually it's a machine or greenhouse innovation, or perhaps some ingenious packaging. But this year it's a silly little light (three LED lights, actually in one of four colors), shaped like a leaf, and intended to be used to illuminate your indoor houseplants. It's both functional and stylish—the light actually helps the plants survive indoors. And it looks cool! Just as lighting your outdoor plants does. It's called the "I-Light, from Nano Bio Light Technology in Taiwan, and the initial estimated wholesale cost is about $35 a pair. You can see how it lights up that orchid that's sitting next to the inventor, Dr. Fang. E-mail him at info@nano-wave.com.tw. It's brand new, and barely on the market, so I don't know how hard or easy it will be to find, but I'd buy a pair or two for my house!

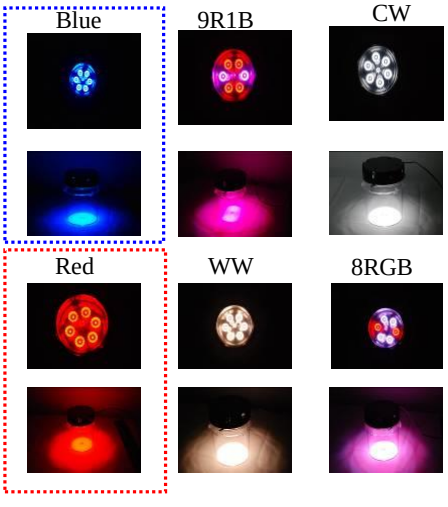
See you next time,

Chi

Chris Beytes
Editor & Publisher
GrowerTalks & Green Profit

http://www.ballpublishing.com/growertalks/CurrentNewsletter.aspx

mini E-Light



Mini E-Light v1

Mini E Light v2

2009/07/22, 23

Bio-Mechatronics Conference

Effects of Red and Blue Light-Emitting Diodes on Callus Induction, Callus Proliferation, and Protocorm-Like Body Formation from Callus in *Cymbidium* Orchid

Le Van Tuong HUAN and Michio TANAKA

Department of Horticultural Science, Faculty of Agriculture, Kagawa University, Miki-cho, Kagawa 761-0795, Japan

Purpose	Spectrum
Callus induction	100% Red
Callus proliferation	75% Red + 25% Blue
PB formation	25% Red + 75% Blue
PPFD =	45 µmol m^{-2} s^{-1}

The effects of light generated by red and blue light-emitting diodes (LEDs) on callus induction from protocorm-like body (PLB) segments, callus proliferation and PLB formation from callus in *Cymbidium* orchid were investigated. The cultures were placed in 'LED PACK 4' incubators under different ratios of red and blue LED light (100% red LEDs, 75% red LEDs+25% blue LEDs, 50% red LEDs+50% blue LEDs, 25% red LEDs+75% blue LEDs, and 100% blue LEDs) at 45 μmol m^{-2} s^{-1} with a 16-h photoperiod or put under plant growth fluorescent (PGF) light with the same light intensity and photoperiod. Among the treatments, 100% red LEDs was the most effective for callus induction from PLB segments. Callus proliferation was best in the 75% red LEDs+25% blue LEDs treatment but was not significantly different from that in PGF light. The highest PLB formation from callus was obtained in 25% red LEDs+75% blue LEDs. The results suggested that LEDs are the effective light source for callus induction, callus proliferation and PLB formation from callus in *Cymbidium* orchid.

Keywords: callus, *Cymbidium*, light-emitting diodes, orchid, protocorm-like body

2009/07/22, 23

Bio-Mechatronics Conference

Controlled E-Light

具備氣簾

具備溫控能力

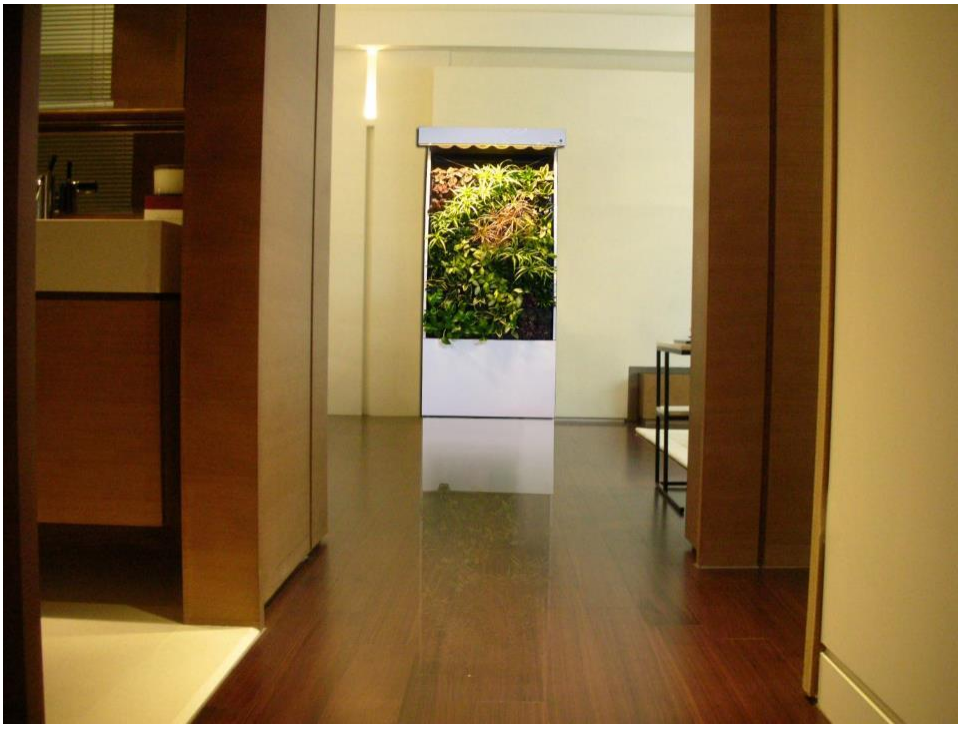
光量十段控制

可改為栽培水耕蔬菜

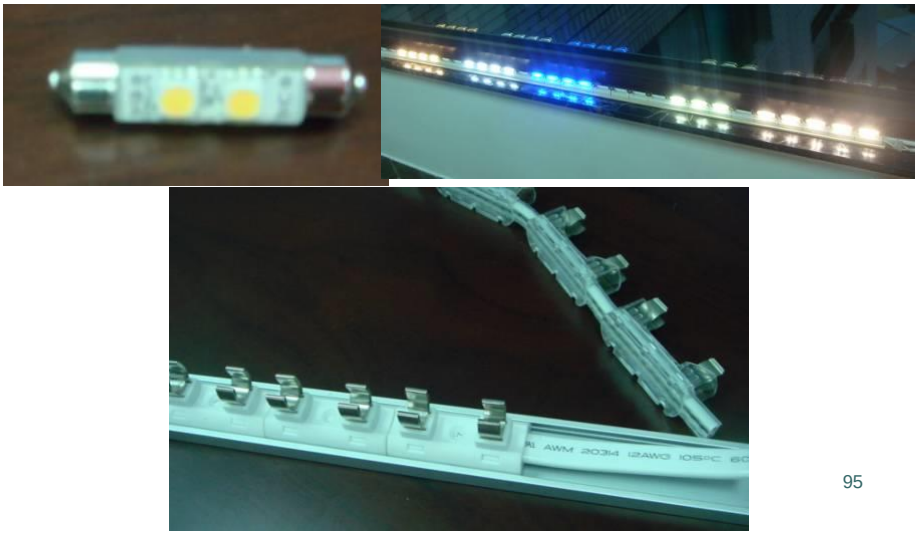
- 上層育苗 (70株)
- 下層育成 (15株)

- 櫥櫃型設備 (18株x 3層)

植物生長綠牆



Detachable LED light (2006)
雙頭燈



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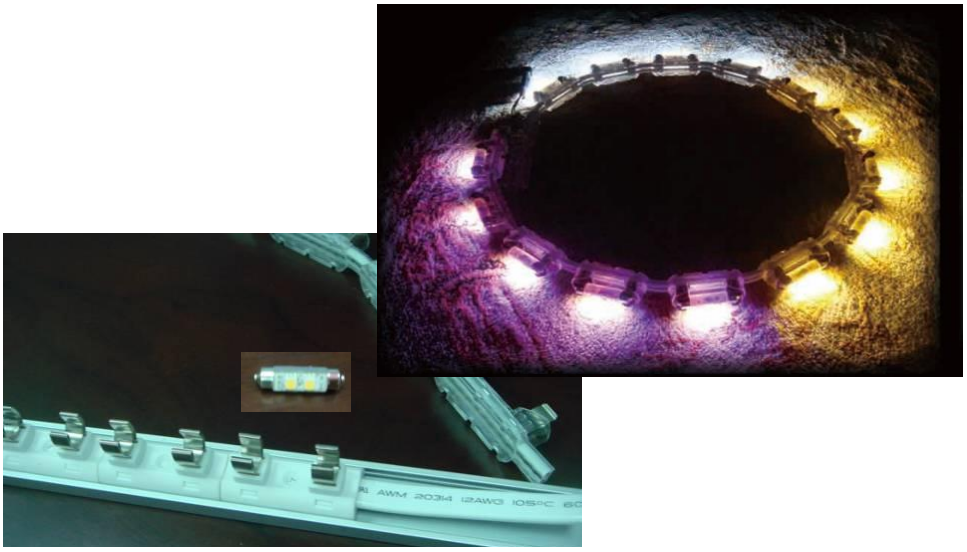
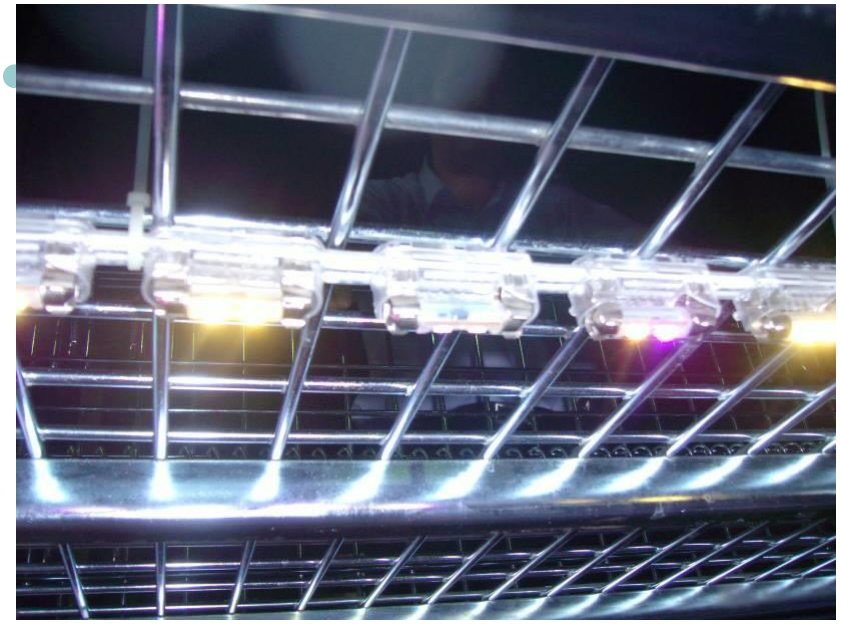
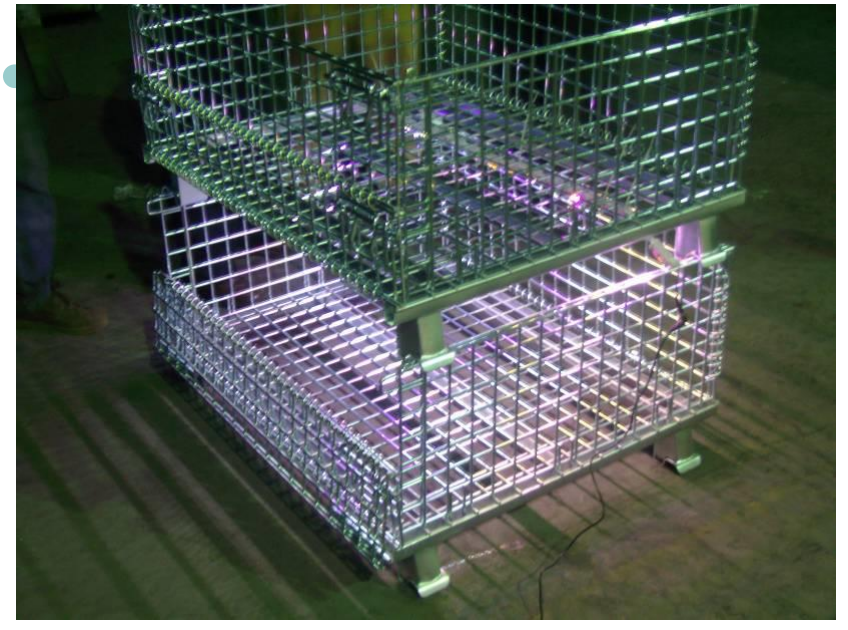
Detachable LED light (2006)
雙頭燈







2010 台北花博


near future.


同時適合用於植物補光、居家照明與美容醫療
ght up Eco-friendly Dream in the near future

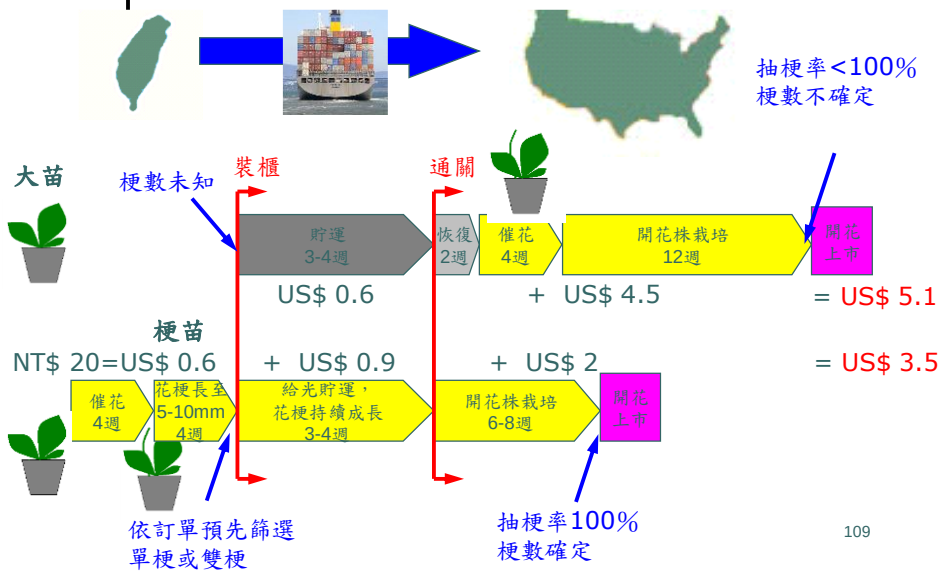
五層

六層

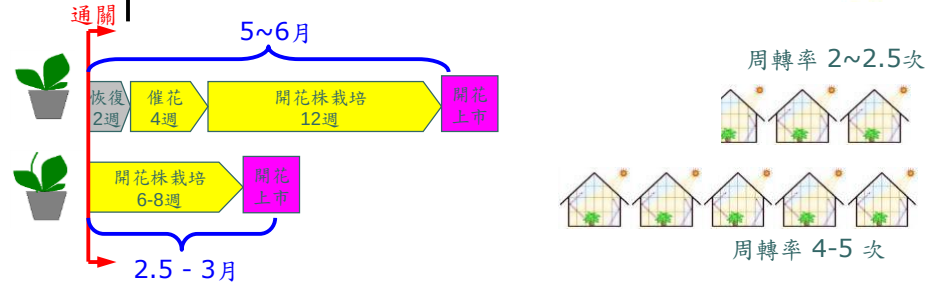
產業應用

LED雙頭燈應用於
蝴蝶蘭花梗苗海運補光

帶梗苗運輸模式 單株成本分析



帶梗苗運輸 溫室周轉率分析



- 以 25 株/m^2 估算，若每株獲利 US$ 1，一次周轉獲利 US$ 25/m^2 ，一年多 2 – 2.5 次周轉率，增加獲利 US$ 50 ~ 75/m^2 。
- 以 300 坪的溫室在溫室面積沒有擴充的情況下，由於商業模式的改變，可增加獲利49,500~74250 美元，相當於 170~260 萬台幣的獲利。

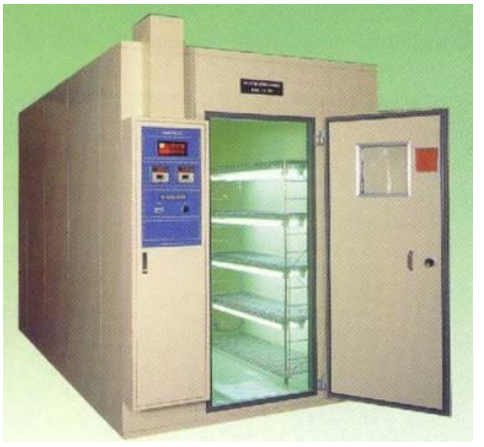
新舊台車設計與運輸分析比較

40 呎貨櫃 12 x 2.3 x 2.56	舊台車(本研究)	新台車(本研究)
裝載量	15840 株 (80 x 6 x 33)	17472 株 (112 x 6 x 26)
台車數量	33 架	26 架
回收	五去一回	七去一回
耗電	11 kW (T5燈管) 8 kW (LED燈管)	3.6 kW (LED 雙頭燈) 0.48 x16 x3 x 6 x 26

其他細節（略）

- 甚麼光量?
- 如何提高均勻度?
- 哪一種光譜?
- 海運之後，開花品質?
- 節電設計
- 模擬/實際海運的結果

Growth Chamber



Florescent Lamp + AC

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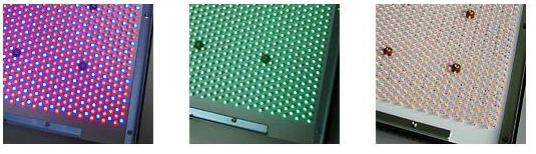
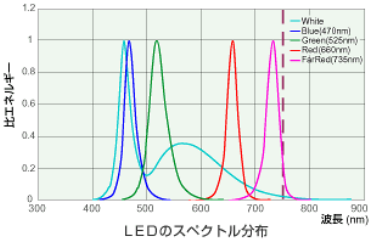
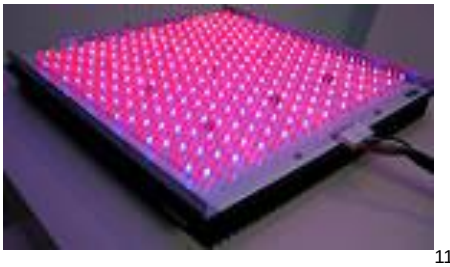
FL can be replaced by LED Panel





LEDのスペクトル分布



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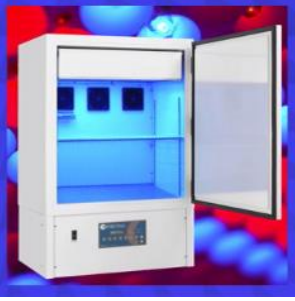
E-30 LED Lighting Options

- Trichromatic – RED, BLUE, FAR-RED
- RED, FAR-RED
- RED, BLUE
- BLUE ONLY
- Pulsating LEDs



各類栽培研究實驗

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http://www.metaefficient.com/archives/leds/

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Lightsicle Array
Intracanopy
Overhead

Application of LED in growing vegetables started in 1991 NASA's mission to MARS project

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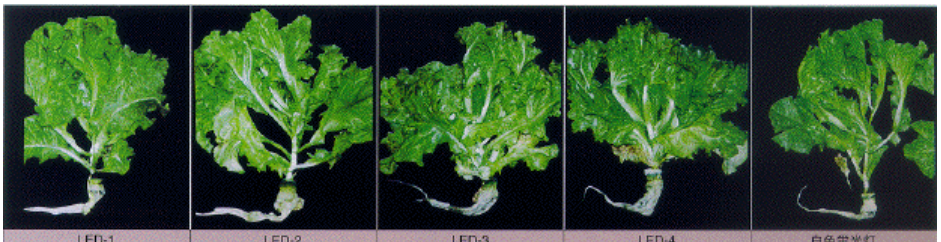
LED for Leafy Green



LED-1	LED-2	LED-3	LED-4	白色蛍光灯
全光量 80	100	100	100	50
赤色／青色光 72／8	95／5	92／8	90／10	

試験区	LED-1	LED-2	LED-3	LED-4	白色蛍光灯
地上部新鮮重（g／株）	31.1 ±6.2	61.8 ±12.5	80.9 ±14.4	82.7 ±16.9	35.7±8.4
地上部乾重 （g／株）	0.9±0.2	1.8 ±0.4	2.4 ±0.4	2.5 ±0.5	1.2±0.3
草丈 （cm）	32±3	29 ±2	25 ±1	24 ±3	30±2
根部乾重 （mg／株）	188±20	244 ±49	298 ±48	342 ±68	211±42

※栽培日数34日、値は22株の平均値±標準偏差。

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LED with R/B = 9:1 is much better than other two

Sunlight in Greenhouse | **CW FL** in Growth Chamber | **LED with R/B=9:1** in Growth Chamber

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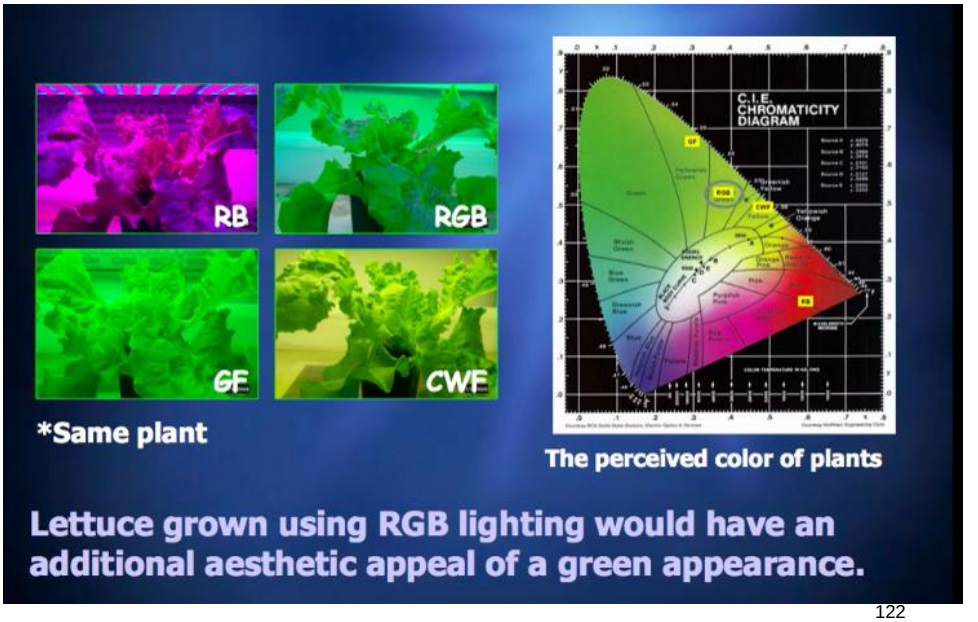

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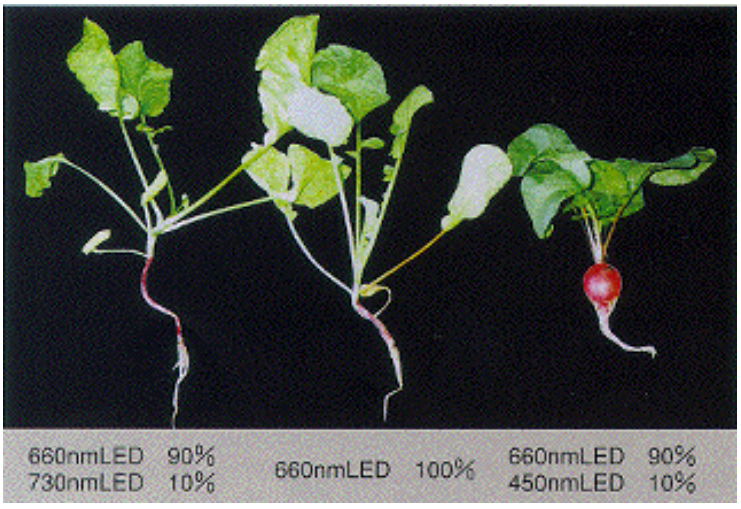
Without Blue, No Harvest



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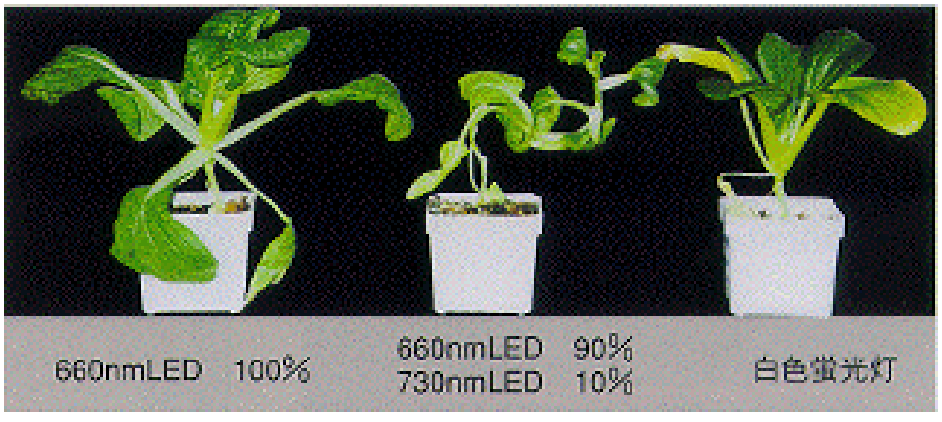
Without Blue, Upper part too thin



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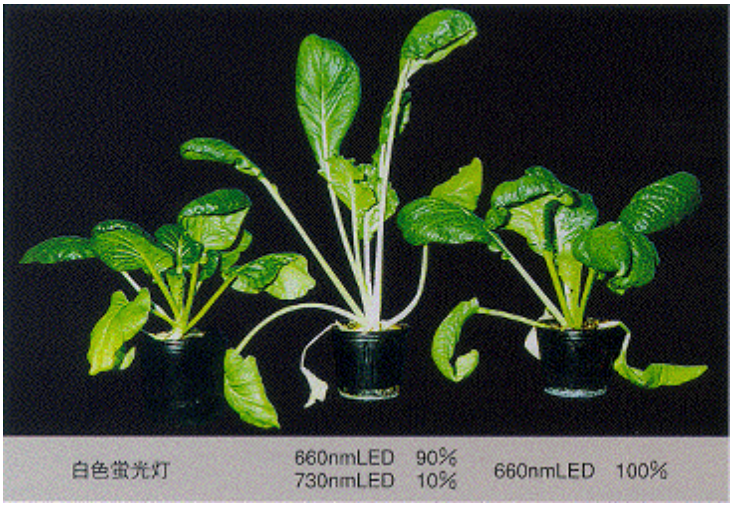
缺藍光，卻有紅外光，更纖細



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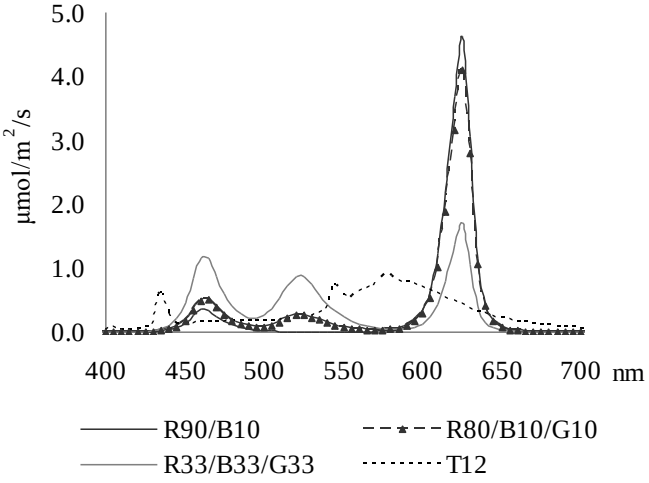
LED蔬菜栽培



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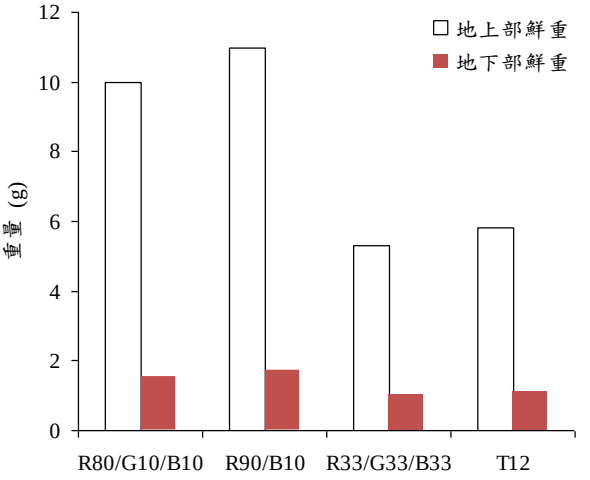
葉萵苣14 天之重量比較



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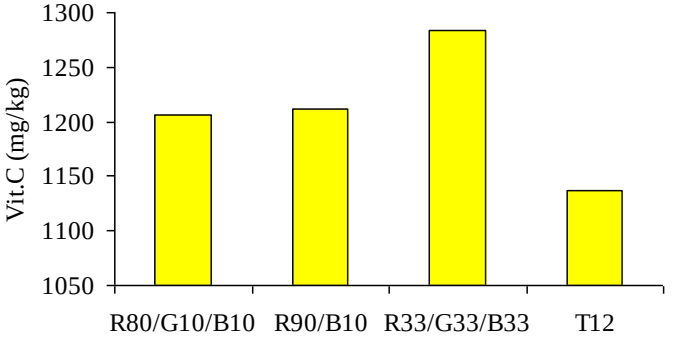
萵苣維他命C含量之比較

- LED栽培之萵苣維他命C含量均較T12栽培者含量高，尤其以等比例混光之白光最顯著



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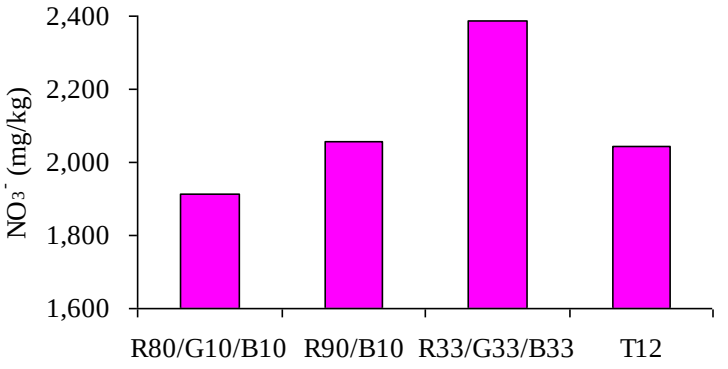
萵苣硝酸鹽含量之比較

- 加強紅光可降低硝酸鹽含量（< 2100 ppm）
- 加入少量綠光可進一步減少硝酸鹽含量（<2000 ppm）



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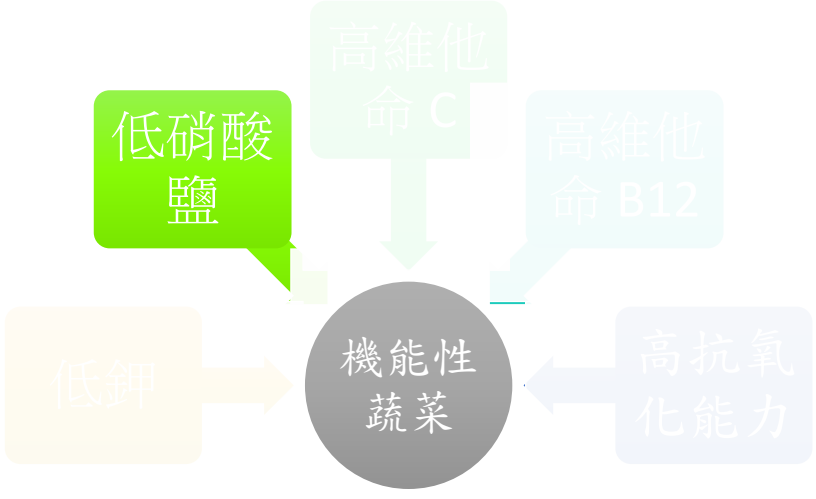
如何量產低硝酸鹽蔬菜



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至少有一打的方法

1. 降低氮肥供應
2. 提高栽培密度
3. 添加氯化銨
4. 減壓栽培 (Hypobaric)
5. 提高植株內風速
6. 介質減量
7. 選擇介質種類
8. 選擇栽培法
9. 選擇品種
10. 提高日累積光量
11. 控管採收時間點
12. 增加紅光

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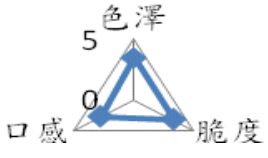
葉萵苣官能品評

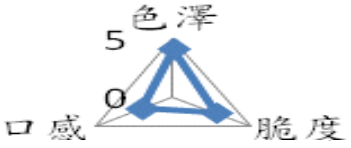
(a) R80/G10/B10

(b) R90/B10



(c) R33/G33/B33

(d) T12



機能性蔬菜

- 機能性（Functional）一詞源於日本
- 機能性蔬菜是指經過特殊栽培方式，使蔬菜具有本來沒有的營養成分，或提高/降低特定成分，使蔬菜變成專門的機能性蔬菜。
- 2015 年 4 月，日本厚生省修正食品標籤制度法，將生鮮具有機能性之蔬果也納入機能性食品之認證。

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品質？

- 安全 (可追溯)：無農藥、無塵土、無蟲(卵)、低硝酸鹽、低生菌數 → 儲存期長
- 機能性 (可量測)：礦物質、精油、葉綠素、葉黃素、抗氧化 (ORAC 值, DPPH 清除率) 、維生素C、類胡蘿蔔素、花青素、總酚…
- 口感、口味、外觀、色澤、形狀、新鮮度

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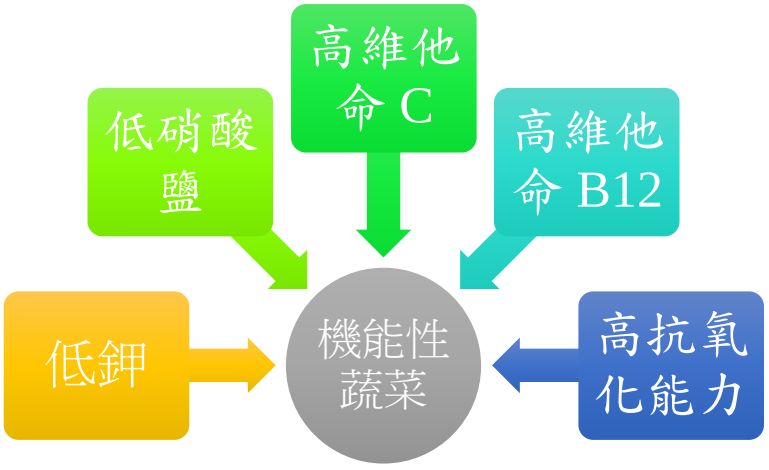
機能性蔬菜可能具備之功效



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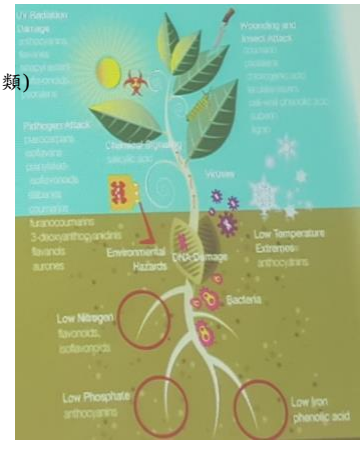
提高二次代謝物含量的方法

環境逆境 → 活性氧物質 (ROS) → 二次代謝物（抗氧化物質）

類苯基丙烷(苯丙酯類)
Phenylpropanoids

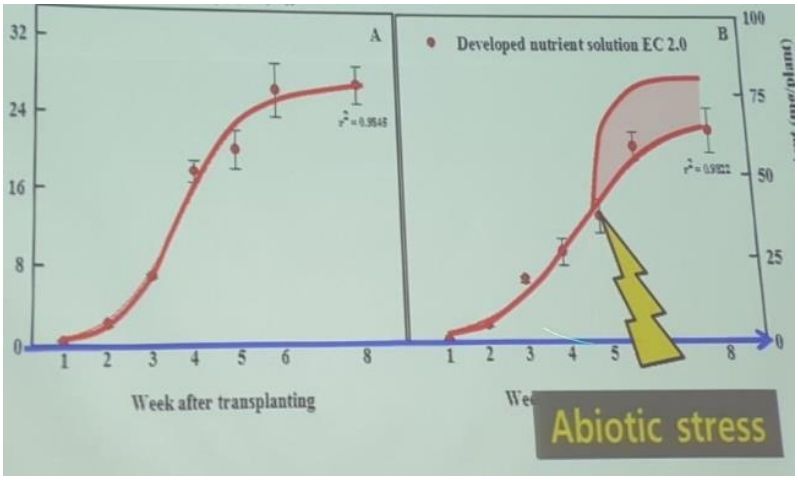
- 傷害
- UV
- 低溫
- 養分不足
- 化學信號
- 感染



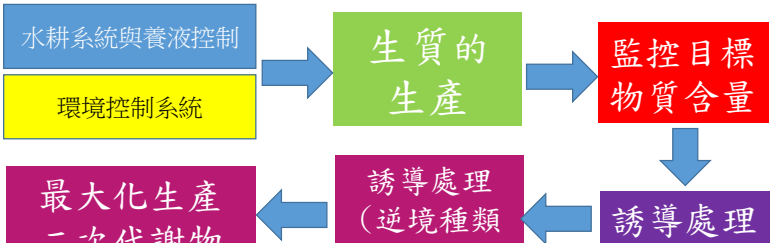
物理誘導:
　　環境逆境
化學誘導
生物(感染)誘導

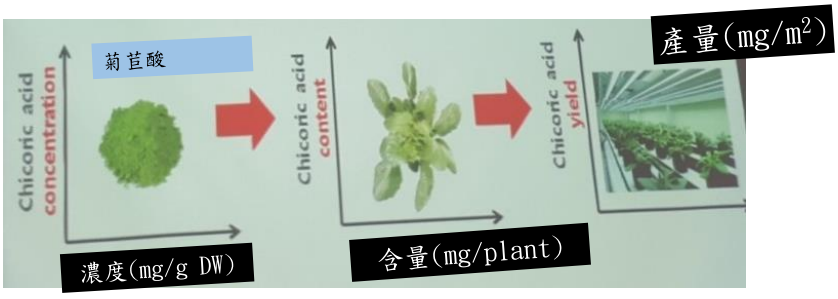
施以逆境的時機點

菊苣酸含量，g

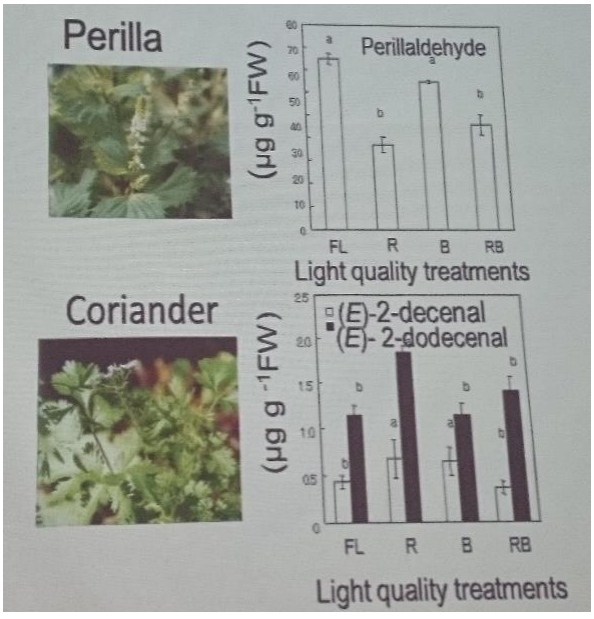


植物工廠中生產藥用作物之策略



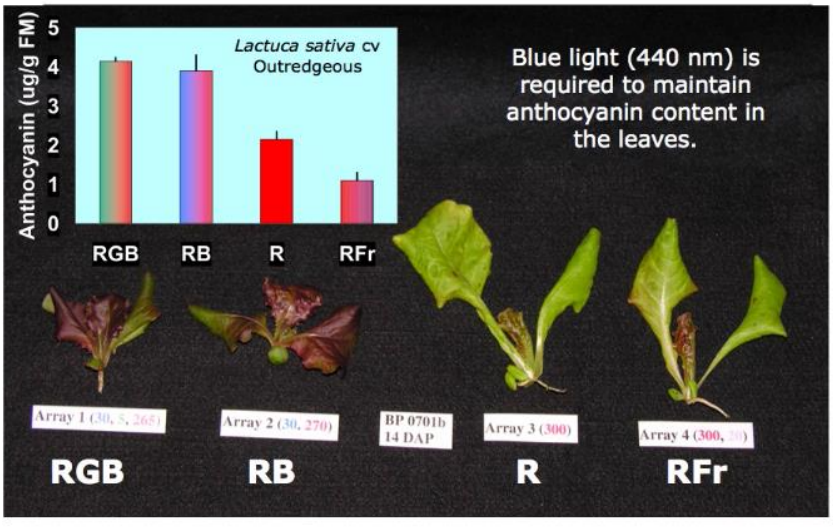


光質影響
紫蘇與
芫荽的
精油含量

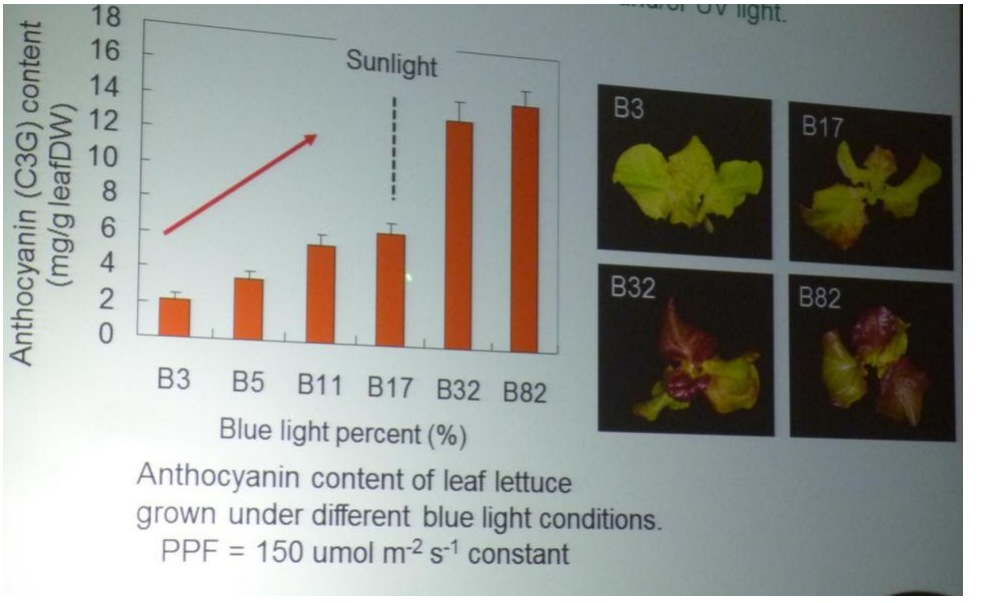


Ohashi-Kaneko, 2015

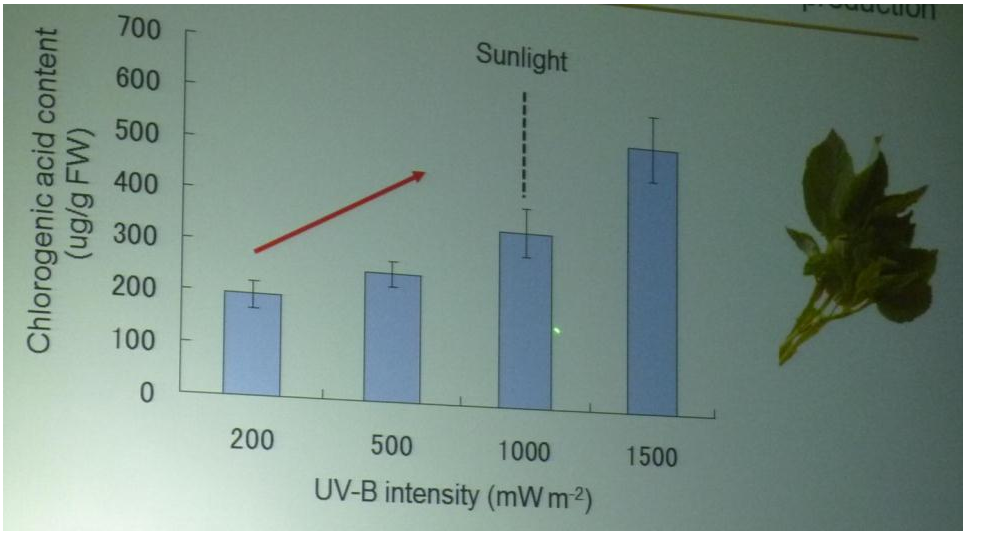
Light quality has significant effect on anthocyanin concentration in leaves.



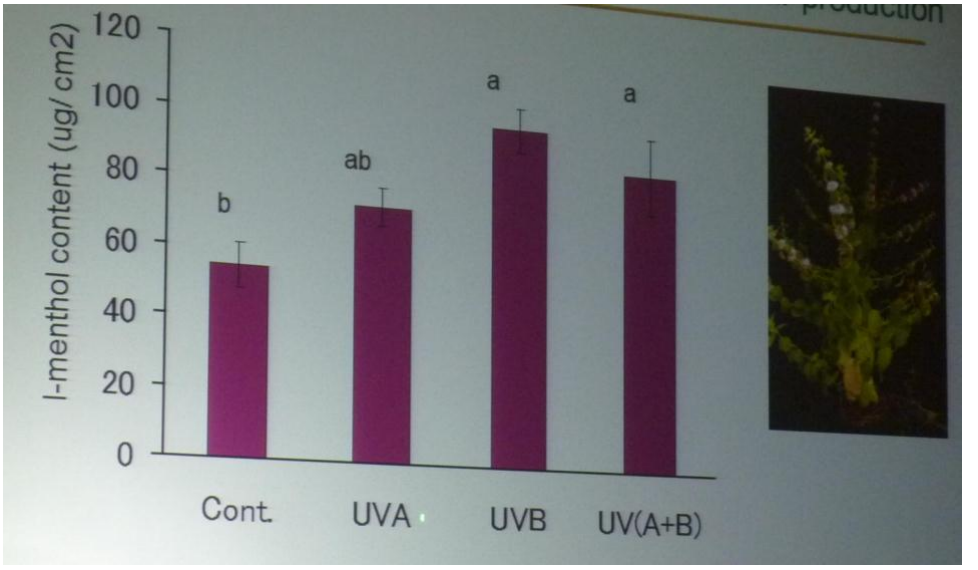
More Blue, More Anthocyanin (花青素)



More UVB, More Chlorogenic Acid (綠原酸)



UVB is better than UVA for l-menthol (左旋薄荷) production



紫甘藍芽—富含營養及抗氧化能力

- 紫甘藍富含維生素 B、C 和 E、花青素和纖維素

- Yamaguchi *et al.* (2006)
  - 使用螢光燈健化紫甘藍芽
  - 健化天數增加，抗氧化能力亦提高

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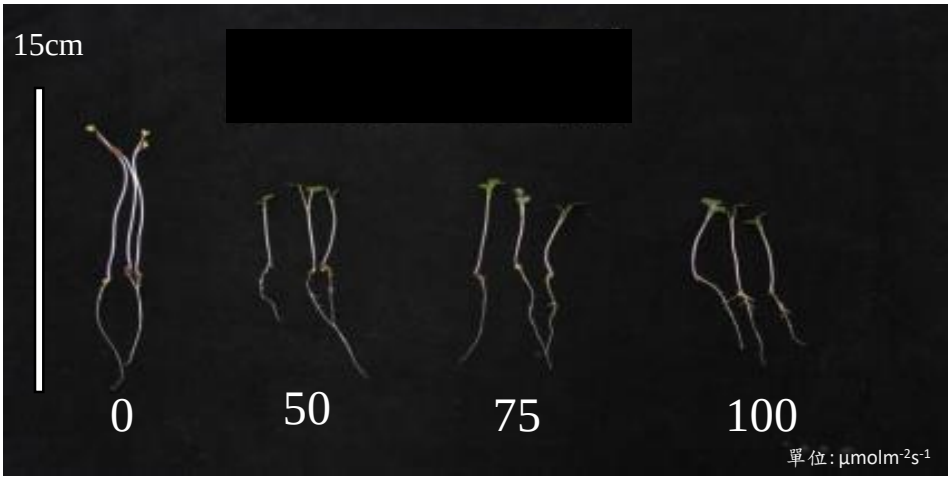
不同光量對紫甘藍芽之影響



（本研究室未發表之成果） 對芽菜並非光量越高越好 145

不同光量對紫甘藍芽抗氧化力之影響

光量 (μmol $m^{-2}s^{-1}$)	花青素 (units/g FW)	總酚 (mg/g FW)	過氧化氫酶 (units/g)

多酚類化合物存在於自然界的植物體，可強化血管管壁，抗動脈粥狀硬化和抗癌的作用。

花青素具有抗氧化、抗發炎特性，並可提升免疫力，減少氧化壓力造成組織受損，維持身體健康方面扮演重要角色

過氧化氫為代謝產物，過多對有機體造成損害，為避免損害，產生過氧化氫酶 (Catalase) 催化過氧化氫分解，亦即代表當植物遭受逆境時，植物體內過氧化氫酶的含量將增加。

（本研究室未發表之成果）

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不同光量對紫甘藍芽抗氧化力之影響

DPPH 清除率:探討抗氧化物之供氫能力，供氫能力越強，DPPH 清除率高。

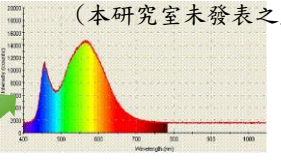
還原力:以普魯士藍生成量作為指標，將赤血鹽還原成黃血鹽，黃血鹽再利用 Fe^{3+} 形成普魯士藍，愈藍代表抗氧化物質還原力越強。

螯合亞鐵率 :藉 Fe^{2+} 與 Ferrozine 的複合物呈色反應，測得抗氧化物對 Fe^{2+} 的螯合能力。

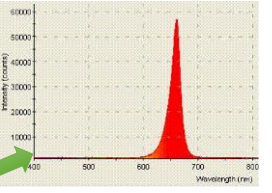
($\mu mol\ m^{-2}s^{-1}$)	(%)	(%)	(%)

（本研究室未發表之成果）

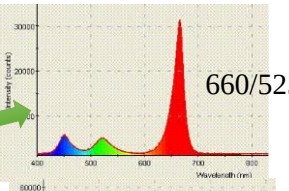
（本研究室未發表之成果）



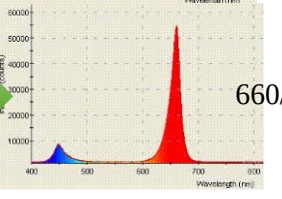
CW
5000 K



RED
660 nm



4RGB
660/525/450 nm



5R1B
660/450 nm

圖 1. 不同光環境綠化 3 天對蘿蔔嬰生長的情形

（本研究室未發表之成果）

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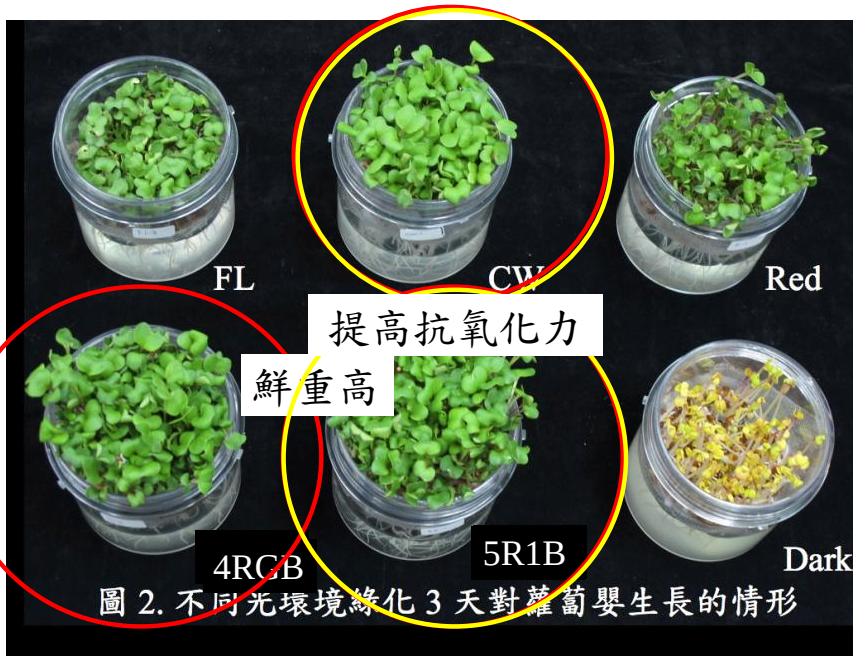
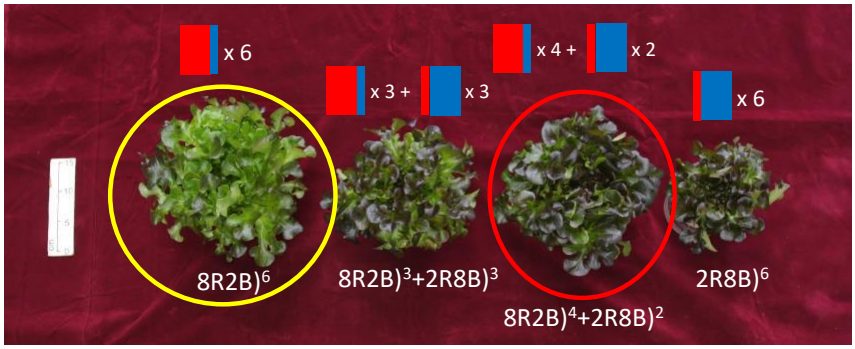


圖 2. 不同光環境綠化 3 天對蘿蔔嬰生長的情形

（本研究室未發表之成果）

150

不同光質下調控紅橡萵苣生長與花青素



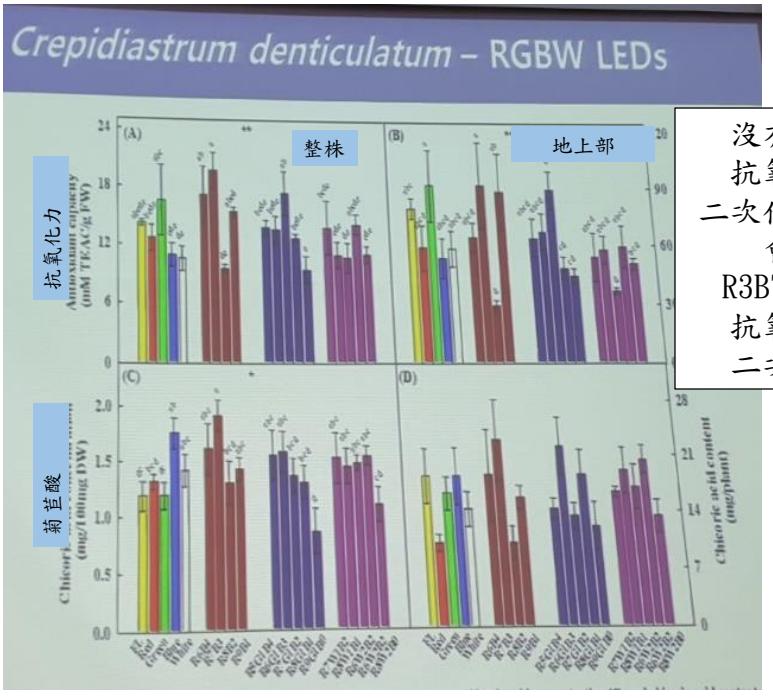
* bar = 15 cm

生長好
花青素低

生長好
花青素高

（本研究室未發表之成果）

紅藍配比比單色光更能提高萵苣之總酚含量



沒有藍光時
抗氧化力與
二次代謝物含量
會下降
R3B7 可提高
抗氧化力與
二次代謝物

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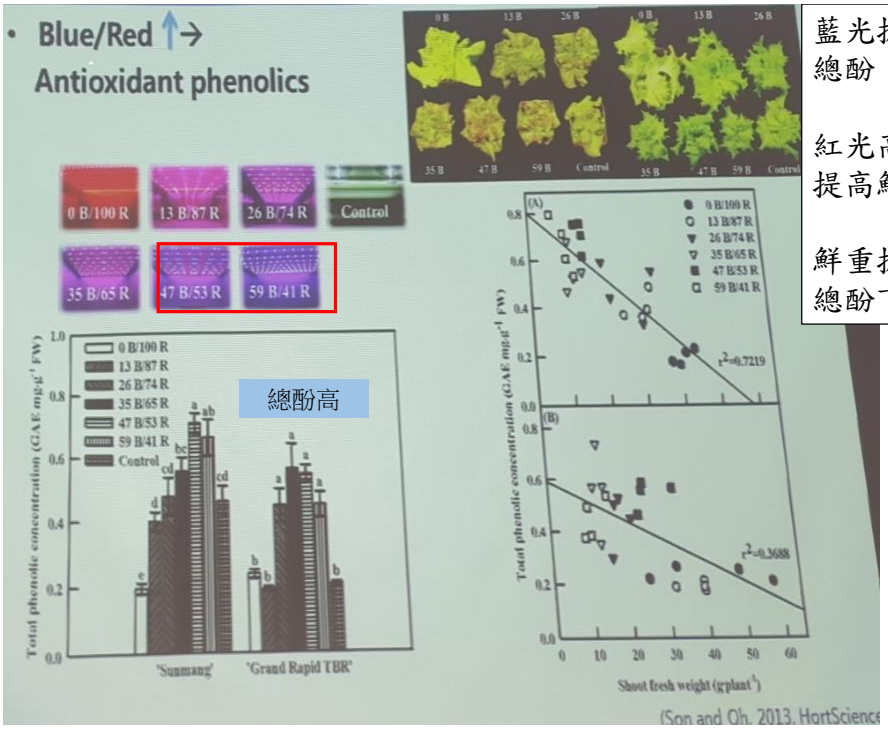

藍光提高
總酚

紅光高
提高鮮重

鮮重提高
總酚下降

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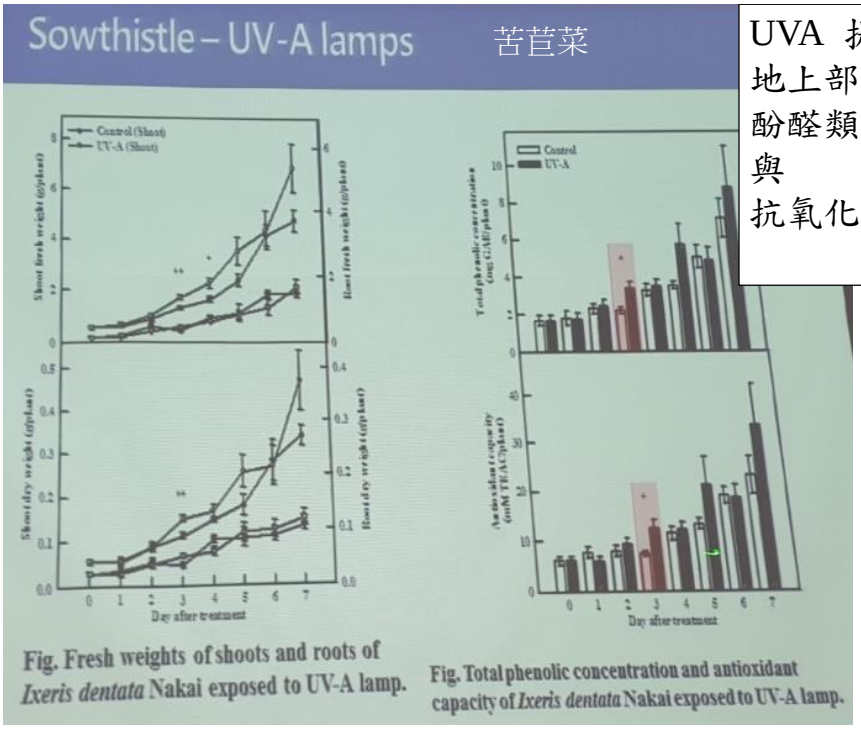

Fig. Fresh weights of shoots and roots of *Ixeris dentata* Nakai exposed to UV-A lamp.

Fig. Total phenolic concentration and antioxidant capacity of *Ixeris dentata* Nakai exposed to UV-A lamp.

UVA 提高
地上部鮮重、
酚醛類含量
與
抗氧化能力

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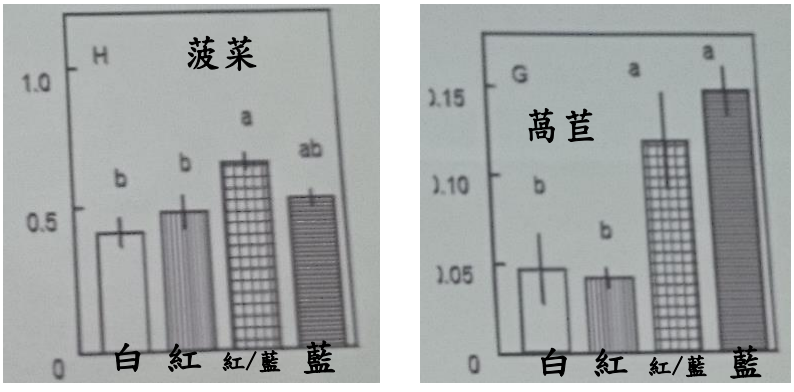
光質影響維他命C 含量 (mg/g FW)



Ohashi-Kaneko, 2015

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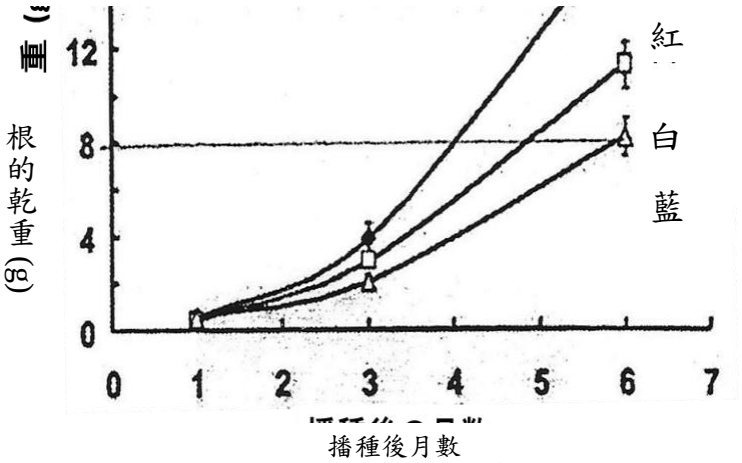
日本村上農園高機能蔬菜

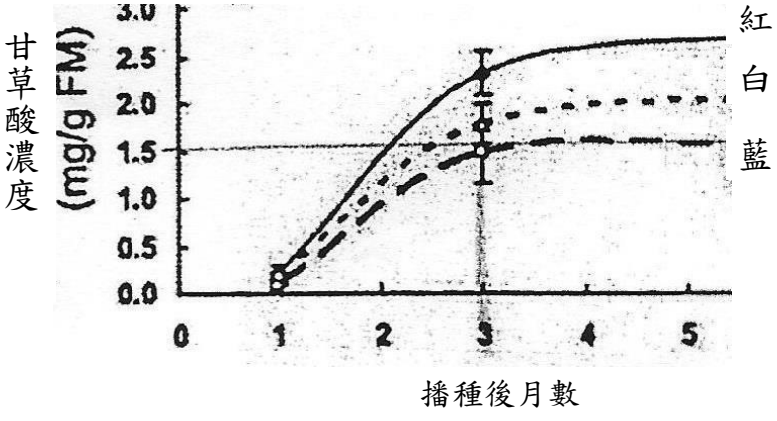
- 栽培蘿蔔嬰、青花菜、紫甘藍等苗菜。
- 商品名：B12 蘿蔔嬰
- 容量：60 g (30g 可食)
- 價格：100 JPY/包（等於 0.83 NTD/g）
- B12 含量：22～130 μg/100g

參考資料：http://murakamifarm.com/company/release/2015/06/12/001751/
http://www.agriculture-jp.com/news_C0zo2l7zi.html

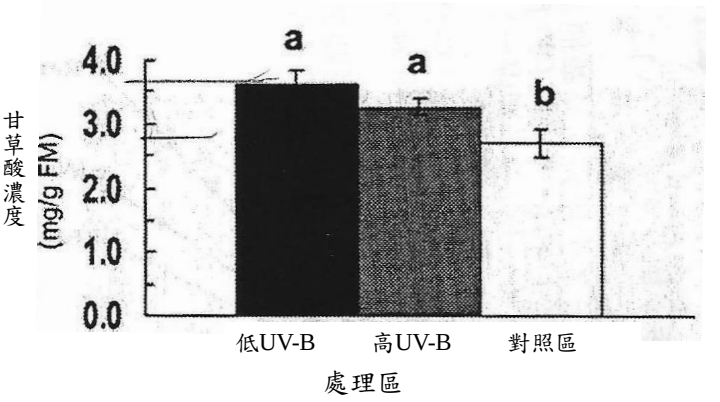
光質對甘草根部乾重的影響



光質對甘草根部甘草酸濃度的影響

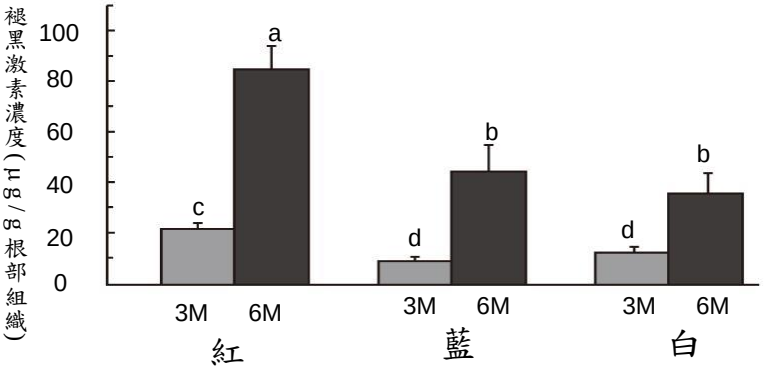


UV-B照射對甘草根部乾草酸濃度的影響



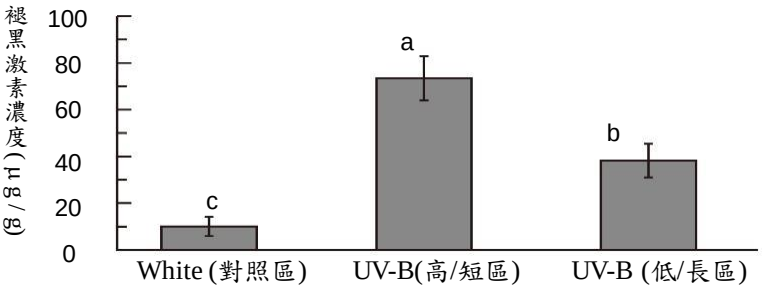
以0.43 Wm^{-2}的低UV-B照射15日，1.13 W m^{-2}的高UV-B照射3日

光質對甘草根部褪黑激素濃度的影響



以紅、藍與白色螢光燈栽培3個月(3M) 或6個月(6M) 的甘草 (Glycyrrhiza uralensis)，其根部所含的褪黑激素（melatonin)濃度（μg/g ）。
PPF: 300 μmol m^{-2} s^{-1}; 氣溫: 明期28 ℃ /暗期26℃ (Afreen, et al., 2006).

光質對甘草根部褪黑激素濃度的影響

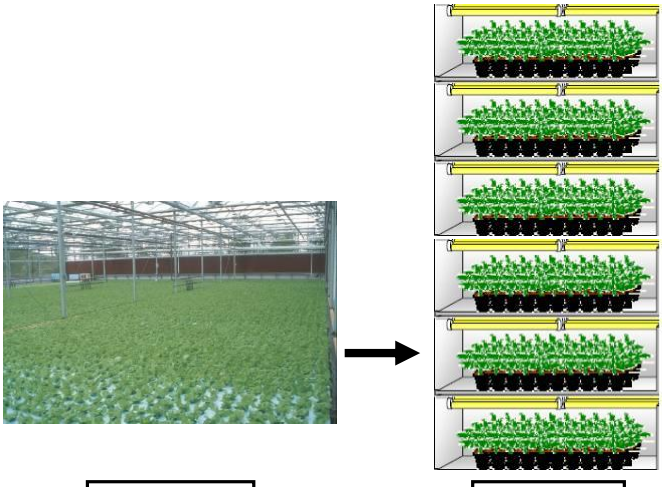


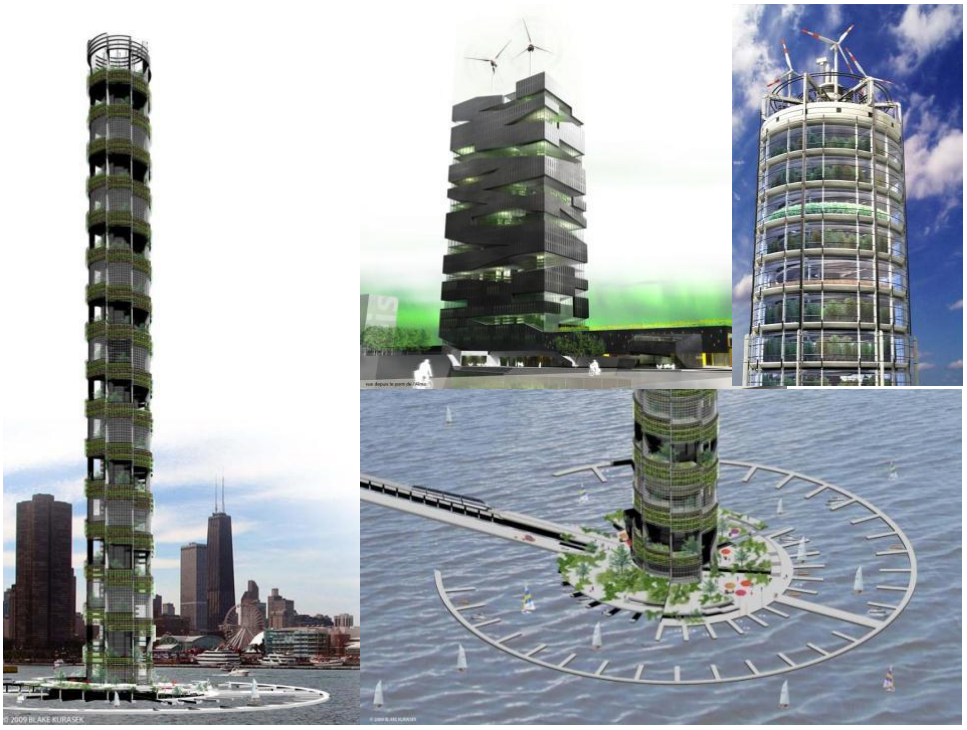
播種3個月後的甘草在①白光（對照區）中栽培15日，②照射白光12日及強烈紫外線3日（3日累積照射量為54.2 W • hr/m^2），高/短區），③照射弱紫外光（UV-B、280-315 nm) 15日（15日累積照射量為103.2 W • hr/m^2，低/長區）後根部所含褪黑激素濃度。

所有處理區的PPF(光合作用光量子通量) 皆為 300 μmol m^{-2} s^{-1}。

植物的生育條件：PPF：300 μmol m^{-2} s^{-1} ，無UV-B照射。相對濕度：65-70%；CO_2 濃度：1000 μmol mol^{-1}；氣溫： 明期28 / 暗期26°C (Zobayed, et al., 2006).

Vertical Farming / Plant Factory





Artificial light source in PF

1. 金屬燈 MH
2. 高壓鈉燈 HPS
3. 螢光燈管 FL（曾是主流）
4. 冷陰極管 CCFL
5. 發光二極體 LED（主流）
6. 有機發光二極體 OLED (未來?)

Fluorescent lamp Multi-layer(10)
2004 NFT leaf lettuce

Fluorescent lamp Multi-layer(7):1 layer = 38cm
2007 NFT leaf lettuce

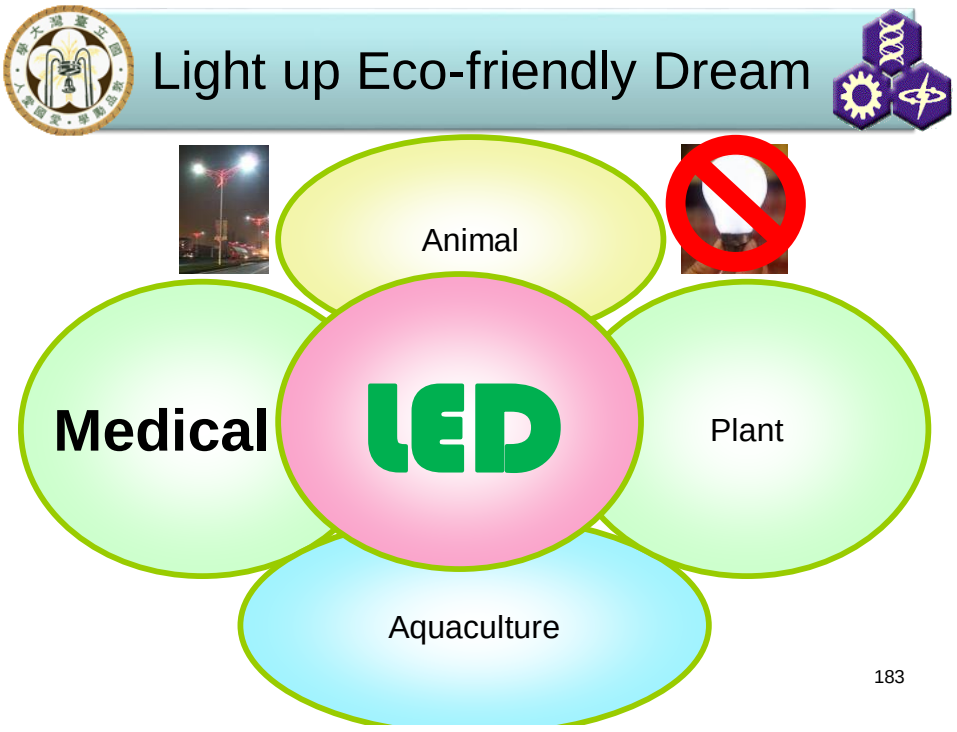
LED蔬菜工廠

- 植物栽培用光源爲改良型水冷式紅色LED（660 nm）。
- 以薄膜水耕法(NFT)栽培生菜、芹菜等葉菜
- 產能：5900株/日，150萬株/年。

栽培區


マイコミジャーナル


多半採用無土栽培模式



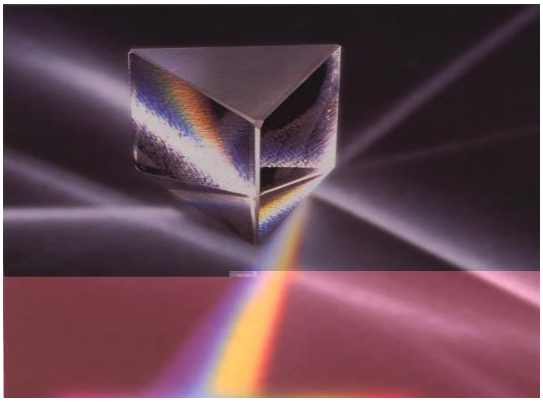
光療的歷史超過百年

- 早在上個世紀初就已有許多光療的研究在進行
- 1903年, 丹麥樊霓瑞博士(Dr. Niels Ryberg Finsen)因成功地運用光治療皮膚結核病而獲頒諾貝爾醫學獎
- 1960年,各項重要研究及報告確認光對生物系統之影響, 並證實偏正光在最理想的能量與波長時, 可產生生物刺激作用並促進細胞膜活動

光 21世紀 未來的醫學

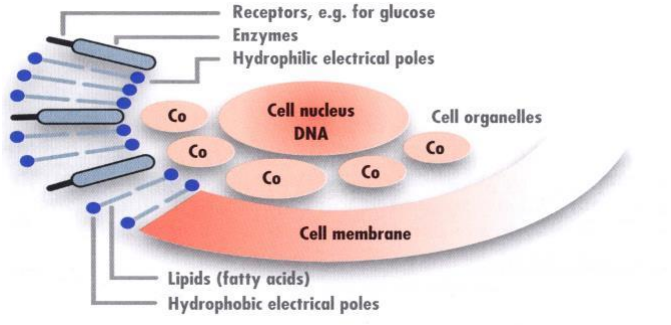
LIGHT—MEDICINE OF THE FUTURE

--DR. JACOB LIBERMAN

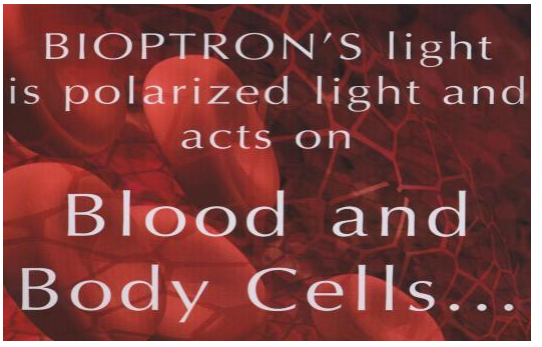


偏正光（polarized light）

- 在促進細胞膜活動上扮演了極重要角色
- 可增進細胞再生及提昇自體治療潛能



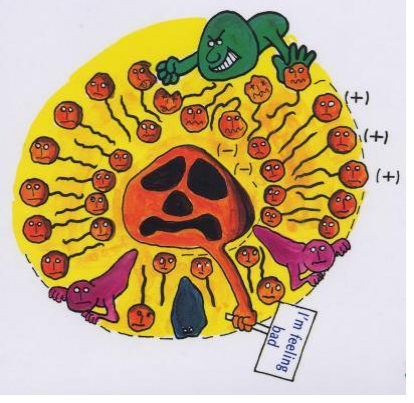
偏正光對人體及血液細胞的影響



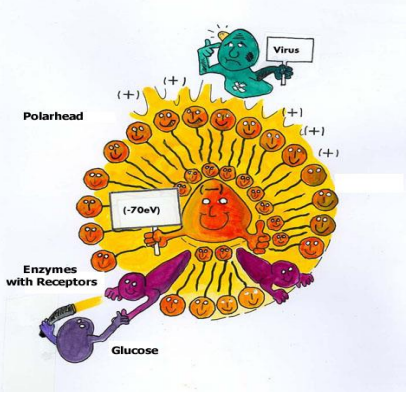
增強 抵抗及防禦能力　　促進新陳代謝

消除發炎　　減輕疼痛

促進細胞活化及增強免疫系統



治療前



治療後

ELSEVIER

Journal of Photochemistry and Photobiology B Biology 29 (1995) 3–15

Journal of PHOTOCHEMISTRY AND PHOTOBIOLOGY B BIOLOGY

Invited Review

Visible light induced changes in the immune response through an eye–brain mechanism (photoneuroimmunology)

Joan E. Roberts

Fordham University, 113 West 60th Street, New York, NY 10023, USA

Received 22 March 1995, accepted 20 April 1995

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0031-8655/88 $03.00+0.00

INVESTIGATIONS ON BIOLOGICAL EFFECT OF POLARIZED LIGHT

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(*Received* 21 *January* 1988; *accepted* 25 *April* 1988)

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THE EFFECT OF POLARIZED LIGHT ON THE RELEASE OF GROWTH FACTORS FROM THE U-937 MACROPHAGE-LIKE CELL LINE

Peter Bolton, Mary Dyson and Steve Young

Tissue Repair Research Unit, Division of Anatomy and Cell Biology, United Medical and Dental Schools of Guy's and St Thomas's, Guy's Hospital Campus, London SE1 9RT, U.K.

The Use of Polarized Light in Aesthetic Surgery

Miodrag M. Colić, M.D., Ph.D., Nataša Vidojković, M.D., Milan Jovanović, M.D., and Goran Lazović, M.D.

Belgrade, Serbia and Montenegro

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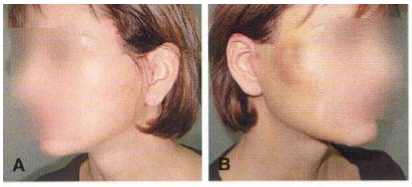


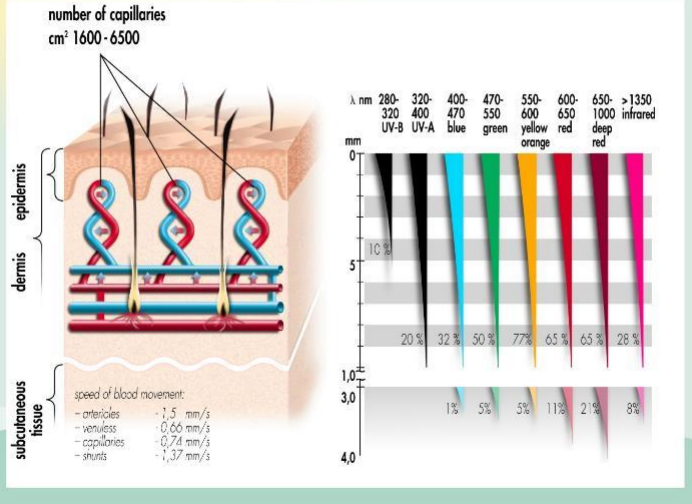
Fig. 3. Treated (**a**) and nontreated (**b**) sides of the face after face-lift (day 5 after surgery).

Fig. 4. Left eye treated with polarized light after blepharoplasty (day 7 after surgery).

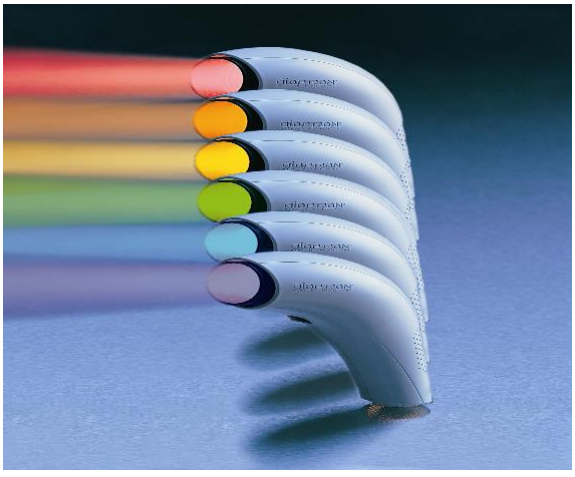
Fig. 5. Moderate result after left eye exposure to polarized light (blepharoplasty, day 5 after surgery).

Fig. 6. Right eye treated with polarized light after blepharoplasty (day 5 after surgery).

不同波長光在人體皮膚內的傳導



使用濾鏡可調整光譜



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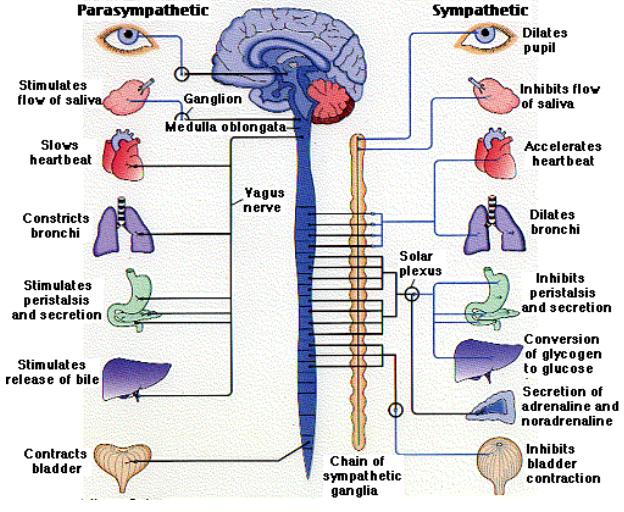
autonomic nervous system (ANS)

Parasympathetic nervous system (PNS) **sympathetic nervous system (SNS)**



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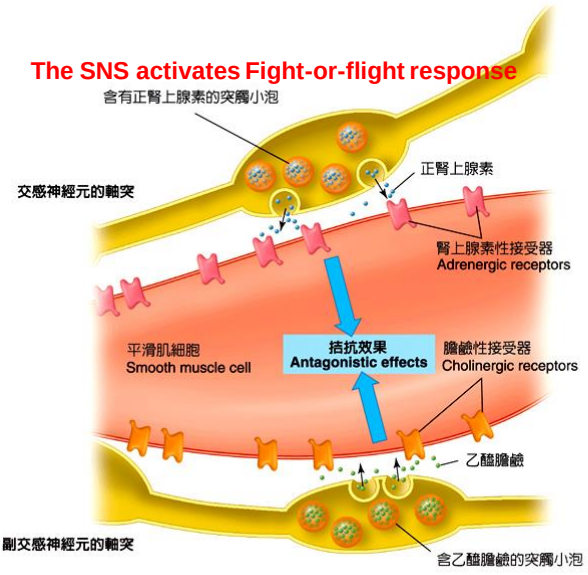
The SNS activates Fight-or-flight response



The PNS activates rest-or-digest response

Fight-or-flight response
戰鬥或逃跑反應

Antagonist
相互對抗

休息或消化反應
Rest-or-digest response

Meditation

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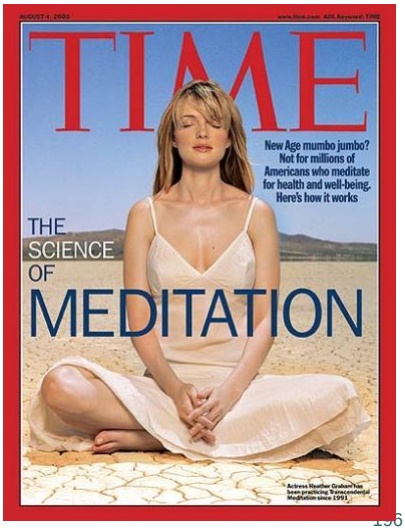
PNS can be activated by meditation

- slowing down of the heartbeat
- lowering of blood pressure
- constriction of the pupils
- increased blood flow to the skin and viscera
- peristalsis of the GI tract
- 副交感神經主導的膽鹼素路徑（cholinergic pathway）可以降低細胞素並抑制不當的發炎反應，使免疫反應達到平衡的狀態。



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Seasonal Affective Disorder (SAD)

- According to the National Institute for Mental Health, approximately 10% of Americans currently suffer from SAD and related disorders.
- SAD is a disorder characterized by drastic mood swings and depression that occur during the fall/winter months and diminish in the spring.
- SAD sufferers have the following symptoms : Depression, Feeling "out of sorts", Irritability, Increased appetite, Weight gain, Excessive sleeping, Decreased energy & interest, Inability to concentrate
- SAD can be relief by reducing melatonin in brain through Light therapy (1980,Alfred Lewy)

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Light Box for SAD, jet lag and shift work fatigue

BRIGHT LIGHT BOX

NEW! 33% Brighter and with Built-In Timer

SUNSHINE SIMULATOR®

Although our lives, health and well-being are dependent upon the sun, most of us do not get enough sunshine everyday. Bright light is used for alleviating symptoms associated with seasonal affective disorder (SAD), jet lag, shift work fatigue, seasonal change and insomnia. Get your daily "dose" of sunshine and boost your body's sense of well-being, alertness and energy with the HappyLite Plus Sunshine Simulator.

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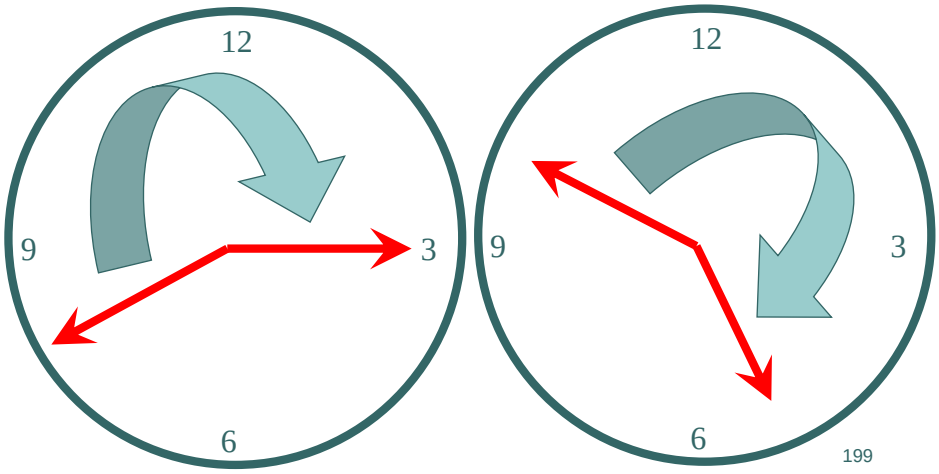
Biological Clock



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LED Photomodulation

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Acne

- 3 months treatment with Blue and Red light combine to cure acne vulgaris.
  - **Blue (415nm): anti-bacterial**
    - 4.23 mW/cm^2 , 15 min/day, in total 320 J/cm^2
  - **Red (660 nm): anti-inflammatory**
    - 2.67 mW/cm^2 , 15 min/day, in total 202 J/cm^2

British Journal of Dermatology，2000:142:973-978

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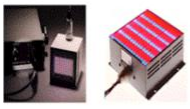
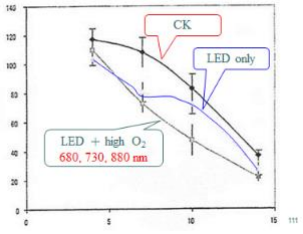
Red and Far-red enhance cell recovery



Relative speed of Wound healing



- BioBeam 660

- BioBeam 940
  - 退化性關節炎
  - 慢性肌腱炎
  - 網球肘
  - 風濕性關節炎
  - 背痛
  - 五十肩

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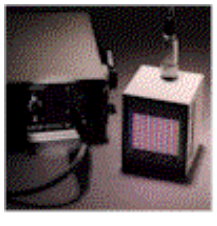
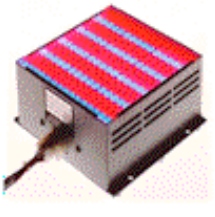
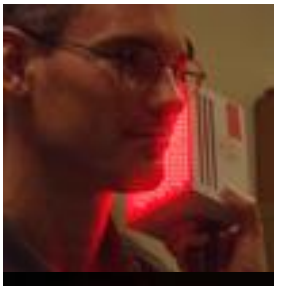
Red and Far-red enhance cell recovery







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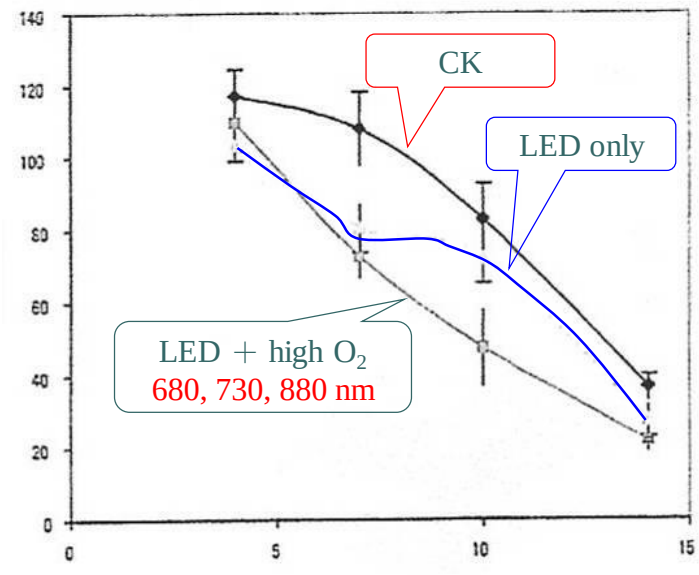

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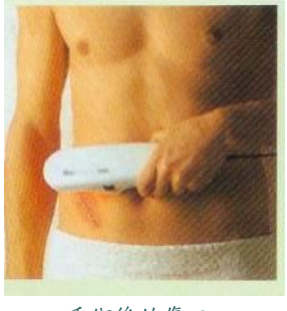
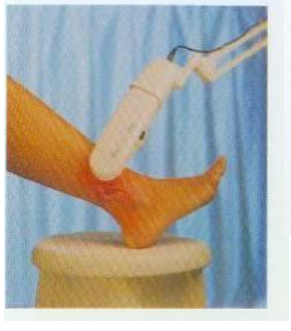
BioBeam 660



手術後的傷口



糖尿病患傷口潰瘍

褥瘡性潰瘍

截肢切除的傷口

單純性皰疹

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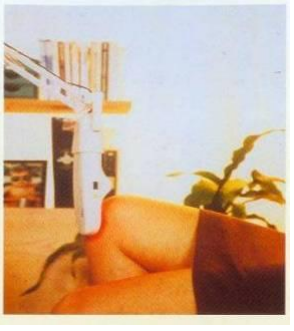
BioBeam 940

- 退化性關節炎
- 慢性肌腱炎
- 網球肘
- 風濕性關節炎
- 背痛
- 五十肩



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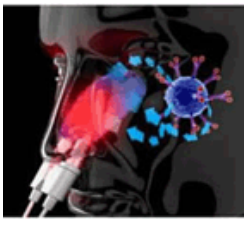
BIOnase

660 nm

- allergic rhinitis
  過敏性鼻炎
- Hay fever
  花粉熱



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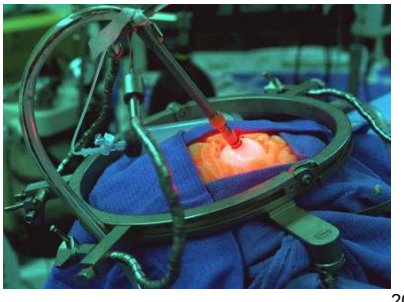
Photodynamic Therapy (PdT)

- Photofrin + Light
- To cure cancer and more
- Skin cancel can be cured by PdT



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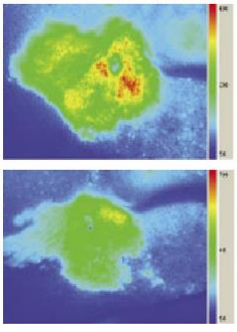
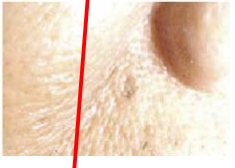
PdT for skin cancer

5 treatments





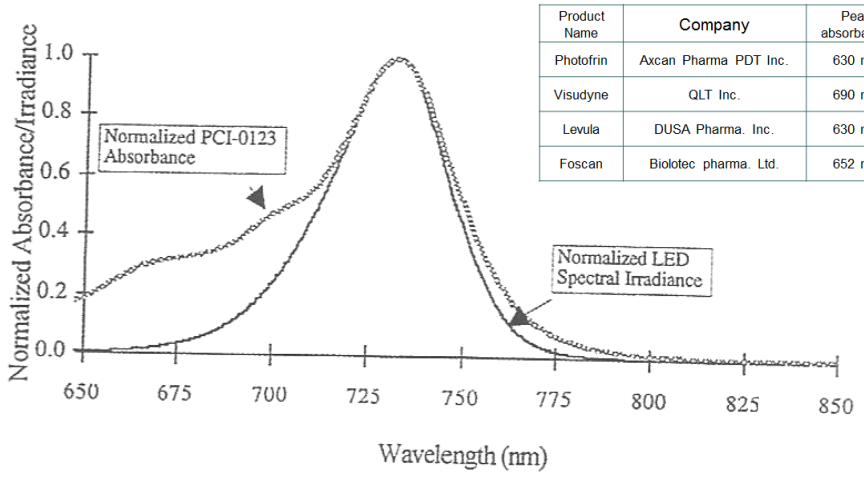
6 treatments

Bowen's disease 皮膚波文氏症(原位癌)
Actinic keratosis日光角化症(前期癌)
Actinic cheilitis日光唇炎(前期癌)
Basal cell carcinoma (基底細胞癌)
Squamous cell carcinoma (鱗狀細胞癌)
Cutaneous T-cell lymphoma (皮膚T細胞淋巴癌)

PdT for other illness

- Age-Related Macular Degeneration
  (老人退化性黃斑症）
- Coronary Artery Occlusion
  (心臟冠狀動脈阻塞）
- Rheumatoid Arthritis
  (類風濕性關節炎）
- Psoriasis（乾癬症）

Photosensitive pigment
PCI-0123 absorbance peak @ 732 - 735 nm



Photosensitive pigment

Product Name	Company	Peak absorbance
Photofrin	Axcan Pharma PDT Inc.	630 nm
Visudyne	QLT Inc.	690 nm
Levula	DUSA Pharma. Inc.	630 nm
Foscan	Biolotec pharma. Ltd.	652 nm

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Photosensitive pigment

Product Name	Company	Peak absorbance
Photofrin	Axcan Pharma PDT Inc.	630 nm
Visudyne	QLT Inc.	690 nm
Levula	DUSA Pharma. Inc.	630 nm
Foscan	Biolotec pharma. Ltd.	652 nm

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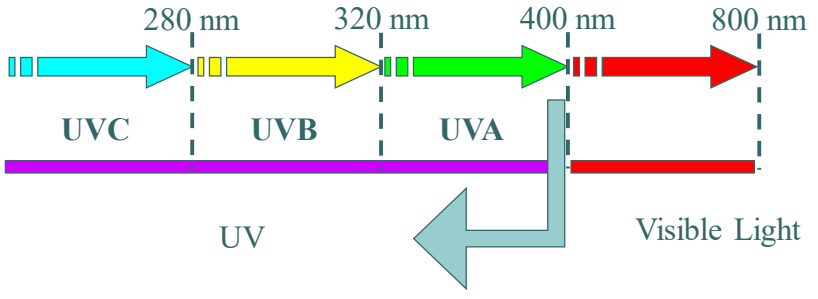
UV A,B,C



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紫外線 對皮膚的影響

短波 長波

UVC (UVB)	UVB (UVA-2)	UVA (UVA-1)

200 nm 290 nm 320 nm 400 nm

曬傷

色素沈澱

皮膚老化

皮 膚 癌

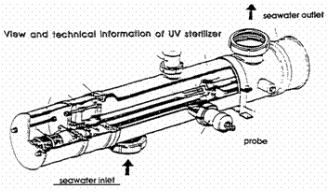
只要陽光不要 紫外線

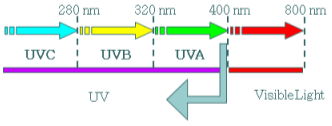
光老化

紫外線 可穿透真皮層，破壞膠原纖維及彈性蛋白，並刺激麥拉寧黑色素形成，使肌膚發生異常或老化

UVC for water disinfection

(菌種)	(劑量) DOSE	(菌種)	(劑量) DOSE
Bacillus anthracis 炭疽桿菌	45.2	Staphylococcus albus 白色葡萄球菌	18.4
S.enteritidis 沙門氏腸炎桿菌	40	Staphylococcus aureus 金黃色葡萄球菌	26
B.megatherium sp.(veg.) 巨大牙胞桿菌	13	Streptococcus hemolyticus 溶血性鏈球菌	21.6
B.megatherium sp.(spores)	27.3	Streptococcus lactus 乳鏈球菌	61.5
B.parathyphosus	32	Streptococcus viridans 綠色鏈球菌	20
B.suptilis	71	Saccharomyces ellipsoideus 橢圓形釀母菌	60
B.suptilis spores	120	Saccharomyces sp. 黃酒酵母菌	80
Corynebacterium diphteriae 白喉棒狀桿菌	33.7	Saccharomyces cerevisiae 啤酒釀母菌(麵包	60
Eberthella typhosa 愛倍德氏傷寒桿菌	21.4	酵母菌)	
Escherichia coli 大腸桿菌	30	Brewers' yeast 啤酒酵母菌	33





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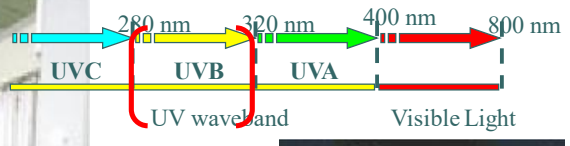
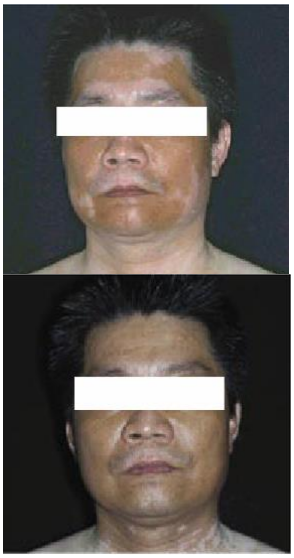


311 nm



Conclusion

Only part of the applications in Bio-Industry were mentioned.

With the help of Light-Emitting Diode,

maybe OLED / LET later,

we can Light up Eco-friendly Dream.

This is part of the Life Evolution Design.

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Thank you for your attention*!*