

研究主題選擇及優秀作品賞析

環境科學/工程科

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環境科學實驗的基本觀念

□ 科展評分依據：

■ 研究主題：

- 清楚且聚焦研究目的
- 確認對其研究領域的貢獻
- 作品可用科學方法檢驗
- 主題或材料之鄉土性
- 主題與教材之相關性

■ 主題或解決問題之創意：

- 有原創性、有特色可以解決議題的獨特方法

環境科學實驗的基本觀念

□ 科展評分依據：

■ 科學方法之適切性：

- 文獻資料之收集整理
- 設計周全的研究計畫及數據收集方法
- 控因及變因清楚、適當及完整
- 實驗設備器皿與標準方法的使用
- 實驗結果之歸納、分析與討論
- 結論與建議之心得、創見

過去有些環境科學的作品，初步構想都很好，但缺乏對已有環保科技的瞭解，也沒注意國內外相關的環保法規或標準，因此在科學方法之適切性上表現不理想，難以成為優秀的作品。

環境科學實驗的基本觀念

□ 科展評分依據：

■ 學術性或實用性價值：

- 收集足夠的數據來證實和釋義
- 對於更深一層的研究有相當程度的構想
- 對科學、社會或經濟上有產生影響的潛力
- 作品有實際上的應用度，並對社會有貢獻

環境科學實驗的基本觀念

■ 展示及表達能力：

- 海報資料有邏輯性的組織
- 運用圖、表及照片表達實驗結果
- 表達過程之生動程度
- 了解與作品相關的基本科學原理
- 了解結果跟結論的釋義及限制因素
- 清楚、簡潔、經縝密思考過的回答問題
- 團體作品中，所有的作者對於作品都理解且都有貢獻

一般而言，清晰的表格製作會比文字說明更具吸引力；經精心整理繪製的圖或照片更比表格要生動。但不要表與圖所表達的是同一實驗結果，也不必把所有實驗結果直接按圖或表說明其趨勢（例如隨什麼參數上升或下降），而缺乏進一步的整理、分析、歸納與探討。

環境科學實驗的基本觀念

■研究或實驗日誌之詳實情況：

將平日實驗的日誌整理準備好，也有助於評審老師之瞭解實驗期程、實驗次數、品管程度與數據的可靠性，絕對為優勝作品的必要資料。

環境科學實驗的基本觀念

□ 與科學實驗教學相關的其他建議：

- 重視學生的想法：科學實驗教學除老師單向的知識傳授外，也應常有機會讓學生發表意見與想法，蠻多學生的突發構想、瘋狂點子、純真或隨意的意見，經討論修正後常會成為非常棒的研究主題。
- 培養學生多利用圖書館或網路，查閱最新、最好的科學論文：一般而言，圖書的資料多屬已有二十年以上的科學知識，一項科學實驗作品，若其參考文獻多為圖書或政府的出版品資料，多半已無創新性了。
- 多利用鄉土性實驗材料或主題：特別是地球科學、環境科學與應用科學的實驗作品，能利用鄉土性實驗材料或主題能與當地實際環境配合，以解釋現象與解決問題，常更能發揮科學研究的基本精神。

環境科學實驗的基本觀念

□ 與科學實驗教學相關的其他建議：

- 請學生多注意身邊不尋常的現象：有一年國際科展，一位韓國學生的研究動機起源於每當放假日在幫忙家裡清理農場動物糞便時，他發現祇有駝鳥的糞便不臭，其他動物糞便都有臭味，因此他懷疑是否駝鳥的腸道系統有可除臭味的細菌存在，開始著手分離駝鳥腸道系統及糞便中的細菌，分別進行培養及除臭實驗，真的找到一些除臭效率很高的細菌，完成一篇優秀的作品。
- 培養學生對科學實驗的興趣，而不是為得獎而參加科展：參加科展祇是一次的活動，千萬不可把是否得獎看得太重，而不經意流露出對未得獎學生的失望或不滿，以免讓學生失去對科學實驗的興趣和信心。透過科展提高同學對科學實驗的興趣與好奇，驗證課本與生活面的知識，才可能培育出未來的科學家。

研究主題選擇

□ 何謂具優勢的環境科學實驗主題：

- 主題是否具學術上之創意？
- 主題是否具解決問題的實用價值？
- 主題或材料是否具鄉土性？

屬於基礎科學的實驗作品，特別強調第(1)項特點，而其主題之選擇與發掘也應從優良的國內外學術期刊去閱讀、去尋找。應用科學則比較注重第(2)或第(3)項特點，可從日常生活的問題去思考，並收集已有解決此類問題的文獻資料，再去定出研究主題的方向。基礎科學的實驗作品若能再兼具第(2)或第(3)項特點，而應用科學的作品也能兼顧學理上的探討與分析，則定為優秀的科學實驗作品。

國內外研究發展趨勢

科技部環境學門研究主題規劃分成六個領域：

- 水：自來水處理、廢水及下水道、水再利用
- 空氣：監測及檢測、空氣污染控制技術、空氣資源管理
- 廢棄物：廢棄物資源化、廢棄物永續管理、處理技術
- 土壤與地下水：污染物宿命、污染物傳輸模式、處理技術
- 環境管理：環境資訊監測、模擬與規劃、環境管理與決策
- 工業安全衛生：安全技術與管理、新興製程安全評估與控制、工業衛生技術與管理、新興行業健康危害評估與控制技術、環境奈米污染物評估與控制技術

國內外研究發展趨勢

環境學門未來規劃

■ 前瞻環境技術的研发：

應用奈米科技與生物科技的環境保護及安全衛生技術，綠色環保與綠色能源科技。

■ 國際環保議題的研究：

PM2.5、溫室效應、臭氧層破壞、水質安全、新興污染物、奈米環境安全衛生及污染物長程運輸等議題

■ 有助於環保產業發展的應用科技：

奈米光觸媒材料及設備，奈米環境材料及設備，高效率、低成本及低能耗的環境污染物的監測儀器及控制設備，大型環境污染整治技術及程序。

國內外研究發展趨勢(Intel ISEF)

	水資源 水污染	空氣污染	水質處理	毒性物質 廢棄物回收	奈米科技	節能減碳 綠色科技	土壤污染 環境生態	解決當地 環保問題
2010	3	1	5	6	2	1	4	13
2011	3	2	4	1	3	7	5	13
2012	5	3	6	4	3	1	8	20
2014	7	6	7	3	6	4	5	5
2015	6	5	10	6	4	4	7	7
2016	9	6	11	3	4	5	7	5

經驗分享與優秀作品賞析

- Intel International Science and Engineering Fair (Intel ISEF)
- Category: Environmental Sciences
Environmental Management
- Awards: Best of Category Award
First Award
Second Award



Intel ISEF 2010 【Second Award】

The Pyrolytic Synthesis of Biochar and Biofuel from biowaste: An Analysis of its potential to Amend Fuel Crisis and Food Security (USA)

An Innovative Method to Evaluate the Effects of the Aquatic Environment on the Chemotaxis of the Amphibian Pathogen Batrachochytrium Dendrobatidis (USA)

Get The Lead Out: The Removal of Lead from Water Using Common Seashells (USA)

2010 【First Award】

Health Effects of Metal Nanoparticles: The Role of Hypoxia Inducible Factor-1 Alpha in MMP-2 and MMP-9 Production by Human Monocytes Exposed to Nickel Nanoparticles (USA)

- ❑ Nano-Nickel and Nano-Titanium dioxide particles have been produced for many years with new formulations and surface properties to meet novel demands.
- ❑ Nanoparticles can translocate from the lungs to the circulatory system.
- ❑ To evaluate the potential systemic effects of metal nanoparticles, we compared the effects of Nano-Nickel and Nano-Titanium dioxide on MMP-2 and MMP-9 gene expression by RT-PCR and MMP-2 and MMP-9 activity by gelatin zymography.
- ❑ Our research provided further understanding and evaluation of the potential health effects of metal nanoparticle exposure₅

Intel ISEF 2010 【 Best of Category Award 】

Environmental Toxin 4-nonylphenol and Autoimmune Diseases: Using DNA Microarray to Examine Genetic Markers of Cytokine Activity (USA)

- ❑ 4-Nonylphenol (4-NP) is an environmentally dispersed xenoestrogen that is used as a surfactant in industrial, agricultural, and domestic consumer products.
- ❑ The potential for human exposure to 4-NP is high because of its widespread use.
- ❑ The U937 lymphocytic cell line was treated with 4-NP (5uM) and estrogen (5uM).
- ❑ Using DNA microarray and conventional RT-PCR, it was determined that 4-NP significantly up-regulated proinflammatory cytokines, while estrogen caused insignificant increases.
- ❑ These effects may be especially harmful in females, as estrogen plays a dominant role in their physiology

2011 Intel ISEF 【Second Award】

The Assessment of Silver Nanoparticles in the Environment on Gene Expression in *C. elegans* (USA)

Embrace Air with Algae Repair (Canada)

Mussels, a Natural Approach to Sewage Treatment: Evaluating *Geukensia demissa* as Biofilters of Local Bay Pollution (USA)

An Experimental Study of the Impact of Airborne Pollutants on the Peak Expiratory Flow (PEF) Rate of Asthmatic Subjects PLUS A Novel Risk Assessment Model to Predict the Adverse Effect of PM10 and TVOCs on the PEF Rate (UAS)

2011 Intel ISEF 【First Award】

AWSS (Autonomus Water Sanitization System) (Argentina)

Because the underground water there is highly contaminated with arsenic and cyanide, a result of the open sky minery, so they have to purify their water supply.

- ❑ Adds chlorine in the beginning of the process to get rid of germ contamination and to oxidize the arsenic.
- ❑ Makes a distillation and a double condensation taking out metaloids and mineral salts.
- ❑ Executes a biotechnological treatment with a fern (PTERIS VITTATA) that absorbs the remaining arsenic that is present after the distillation process.

Intel ISEF 2011 【Best of Category Award】

Mimicking Wetting Behavior of Spider Silk: Studies on Water-Harvesting Efficiency According to the Fabrication of the Pattern of Wettability Gradient (South Korea)

- ❑ Fog harvesting can be an innovative solution to water shortage because it provides clean water ceaselessly without filtering process and power supply.
- ❑ In a wettability gradient surface, droplets spontaneously move toward hydrophilic region.
- ❑ Spider silk is composed of many nodes, and each node has a pattern of wettability gradient.
- ❑ Thus, the water droplets on the spider silk move towards the center of each node and coalesce into bigger ones.
- ❑ In order to mimic spider silk, we suggested a novel method using controlled vapor diffusion and self-assembled monolayer (SAM).
- ❑ A wettability gradient was generated by the method, and verified by surface chemical reaction and droplet movement analysis.
- ❑ Wetting behavior of spider silk was successfully mimicked on surface by this method.
- ❑ A new concept of water-harvesting device inspired by spider silk was designed.



2012 Intel ISEF 【Second Award】

**Molecule Sorting and Highly Selective Methane Detector
(China)**

**Macroinvertebrate and Nutrient Response to Stream
Water Quality after a Wildfire in Medano Creek, Great
Sand Dunes National Park & Preserve (USA)**

**Dig Deeper: Effect of Carbaryl, Pyrethrin and Insecticidal
Soap Application on Cricket (*Gryllus Assimilus*) and
Earthworm (*Lumbricus Terrestris*) Mortality Rates,
Radish Growth (*Raphanus Sativus*) and Soil
Composition (Canada)**

**Acid Mine Drainage Remediation: A Novel Approach,
Phase III (USA)**



2012 【First Award】

What will Grow: Mining Reclamation-Establishing Plant Life on Abandoned Mine Site Waste Fields, II (USA)

- ❑ To determine possible native grasses that would grow on abandoned mine-waste fields in Grant County, NM.
- ❑ Selected six native grasses, introduced at mine-site with sixty test polts.

Intel ISEF 2012 【Best of Category Award】

An Experimental Study of the Impact of Target Volatile Organic Compound (VOC) Emissions on Lung Health Plus a Novel Risk Assessment Model to Predict Their Effect on the peak Expiratory Flow Rate (PEFR); and the Development of a New VOC Adsorption Filter (USA)

- ❑ After experimentation in the field and laboratory (Phase 1), a novel PEFR mathematical model (Phase 2) and a new filter to adsorb indoor VOCs were developed (Phase 3).
- ❑ The PEFR model utilizes over 4 million air quality readings from indoor environments and 112 air samples from test chambers to quantify the impact of each target VOC on the PEFR.
- ❑ Twenty eight test chambers, containing common building materials, were independently constructed and maintained in a controlled environment.
- ❑ The model uniquely quantifies the effect of the most harmful VOCs identified using GC-MS, including Methylene Chloride, 1,2-Dichloroethane, Xylene, Styrene, and Ethyl Benzene, on PEFR.



2014 Intel ISEF Env. Management 【Second Award】

**Biodegradable Breathable Band-Aids(Hong Kong, China)
Developing a Sustainable Water Filtration System for Use
in Low Income Countries(USA)**

**Sustainable Future for Endangered Species? Predicting
the Impacts of the Wilmar Policy on Bornean
Orangutan Populations(USA)**

**Passive Manipulation of Thermal Radiation: Dual Purpose
Condensers to Provide Potable Water (Canada)**

**Engineering a Novel Cimex Lectularius Trapping
Mechanism Utilizing Electrospun Recycled Polymers
(USA)**



2014 Intel ISEF Env. Management 【First Award】

Effect of Antifreeze on a Keystone Species (USA)

2014 Intel ISEF Env. Management 【 Best of Category Award 】

Bio-Waste Materials as Eco-Friendly Mordant in Fabric Dye Process (Malaysia)



2014 Intel ISEF Env. Sciences 【Second Award】

**Investigating the Efficacy of Bioluminescent Mushroom
Panellus stipticus as a Biosensor to Detect the Toxicity
of Water Contaminants (USA)**

**P.A.H. (Polycyclic Aromatic Hydrocarbons) Mixtures:
Using Zebrafish to Elucidate Mechanisms of Toxicity
(USA)**

**Effects of the Environmental Pollutant Acrylic Aldehyde on
Renal Fibrosis (USA)**

Grains of Gold (United Arab Emirates)



2014 Intel ISEF Env. Sciences 【First Award】

An Investigation of the Consequences of Aquatic Single-Walled Carbon Nanotube Exposure Concerning *Daphnia magna* at Varying Concentrations (USA)

2014 Intel ISEF Env. Sciences 【 Best of Category Award 】

Novel Renewable Filter for Heavy Metal Removal: A Practical Application of Functionalized Multi-Walled Carbon Nanotubes (USA)



2015 Intel ISEF Env. Engineering 【Second Award】

Synthesis of a Novel Metal Organic Framework with a PCU Topology for CO₂ Separation in CCS (USA)

Effective Remediation of Air Pollution through an Algal System Integrated with Carbon Mineralization Technology, Phase I: Selection of Algal (USA)

Novel Photocatalytic Pervious Composites for Removing Multiple Classes of Toxins from Water (USA)

Production of Energy and Fertilizer from Ordinary Waste Materials through Micro-Scale Anaerobic Digestion (USA)

Synthesis of Electrospun Nanosilver-Functionalized Nylon 6 Nanofibres for Membrane Water Purification (Singapore)



2015 Intel ISEF Env. Engineering 【First Award】

BioDissolve: The Natural Breakdown of Polystyrene Waste through the Application of Pseudomonas putida to Produce Usable Byproducts (USA)

2015 Intel ISEF Env. Engineering 【Best of Category Award】

International Oil Spill Remediation: The Numerical Simulation of an in-situ Subsea Separator, Part II (USA)



2015 Intel ISEF Earth & Env. Sciences 【Second Award】

Bioassay Determination of Environmentally Safe Levels of Atenolol, Carbamazepine, and Ibuprofen in Waterways (USA)

A Method for Identifying the Photoproducts, Mechanisms, and Toxicity of Petroleum from the Deepwater Horizon by High-Performance Liquid Chromatography and DNPHi Derivatization (USA)

Combating Jellyfish Blight: A Novel Usage of Chondroitin Sulfate within Trashed Jellyfish to Adsorb Heavy Metal Pollutants (South Korea)

Improving the Carbon Use Efficiency of Soil Microbial Communities: A Field Testing and Modelling Approach (USA)

Instantaneous and Cost-Effective Bacterial Counts using Copper Oxide Nanocomposites (USA)



2015 Intel ISEF Earth & Env. Sciences 【First Award】

March of the Molokai Mangrove: The Socio-Economic and Ecological Impacts of Introduced Red Mangrove (*Rhizophora mangle*) on Molokai, Hawaiian Islands (USA)

Rice Straw Power (Egypt)

2015 Intel ISEF Earth & Env. Sciences 【 Best of Category Award 】

Low-cost Heteronanostructure Semiconductor Uses Visible Light Energy to Efficiently Degrade Toxins Threatening Aquatic Life (USA)

2016 Intel ISEF Env. Engineering 【Second Award】

A Novel Hydrogel Based Desalination Technique Using Saponified Starch-g-polyacrylamide and Its Hydrophilic Properties to Harvest Fresh Water (USA)

Design and Implementation of a Sustainable Permeate Gap Membrane Distillation System for Water Purification in the Turkana Basin of Kenya (USA)

Novel Utilizations of Globally Invasive Algal Species: Environmental and Economical Implementations of Fermented Macroalgae (USA)

Effective Remediation of Air Pollution through an Algal System Integrated with Carbon Mineralization Technology (USA)

Solar Powered UV-c Treatment for Fecal Coliform and Enterococcus Bacteria in Storm Water Overflow (USA)

Functionalizing Biochar with Layered Double Hydroxides for Phosphate Removal from Aqueous Solutions (USA)



2016 Intel ISEF Env. Engineering 【First Award】

An Eye in the Sky: Determining the Viability of Using Drones for Agricultural Improvement (USA)

Developing Inexpensive Calcium Alginate Based Scaffolds for Phosphate Sorption in Stormwater (USA)

2016 Intel ISEF Env. Engineering 【Best of Category Award】

Reinventing the Leaf: A Manufactured Biohybrid Photosynthetic System (USA)



2016 Intel ISEF Earth & Env. Sciences 【Second Award】

A Novel Profitable Phytoremediation Process for Reducing Eutrophication at Zero Cost (USA)

Testing the Water Quality of Karst Outflows in the Ozarks (USA)

NEW Low-Cost System Uses Novel Visual Aid to Improve the Quality and Accessibility of Water in Developing and 3rd World Countries (Canada)

Quakify: A Low-Cost, Crowdsourced, Real-Time Solution to Earthquake Early Warning (USA)



2016 Intel ISEF Earth & Env. Sciences 【First Award】

Sea Level Rise and March of the Molokai Mangrove: The Socioeconomic and Environmental Impacts of Sea Level Rise and Introduced Red Mangrove (*Rhizophora mangle*) on Molokai, Hawaiian Islands (USA)

2016 Intel ISEF Earth & Env. Sciences 【 Best of Category Award 】

Staying Afloat: Utilizing the Physiological Adaptation Mechanisms of Marsh Vegetation and the Use of Mathematical Modeling for Barrier Island Restoration (USA)

2012加拿大國際科展國際組金牌獎

林下植物葉綠體囊膜電池

- 林下（陰地）植物長期生活在較少陽光的地方，卻依然欣欣向榮，因此推測這些林下植物應該有較高的光合作效率，才能在鮮少的陽光下生存。
- 針對林下植物的葉綠體囊膜電池 (Thylakoid-sensitized solar cell) 進行研發與其影響參數探討，希望可以找出發電效率更高的葉綠體囊膜電池。
- 實驗結果顯示，大部分林下植物的葉綠體囊膜電池的確較向陽植物來得好，其中又以杜虹電池效果最顯著，其光電轉換效率可達0.3%。
- 實驗參數方面，也得出幾項重要結論：(1)葉綠體囊膜電池的效率比葉綠素電池高三倍；(2)葉綠素的衰退速率較葉綠體囊膜快；(3)最佳的浸泡時間為六小時；(4)碘化鉀為最理想的電解質。

2013臺灣國際科展一等獎

結合幾丁聚醣及聚麩胺酸對重金屬離子吸附之研究-研發吸附暨檢測之循環系統

- 選擇天然易分解的幾丁聚醣和聚麩胺酸 (γ -PGA)，建立有效去除水中鉻離子、銅離子的方法。
- 對鉻離子的吸附模式較符合Freundlich等溫吸附式，於30°C、pH=3 時具有吸附優勢。
- 幾丁聚醣與 γ -PGA 結合製成的複合材料泡綿，大幅提升對銅離子的吸附效果，於30°C下、pH=7， γ -PGA 與幾丁聚醣之比例為6:5 時，對銅離子吸附最佳。
- 研發一套可即時檢測、環保簡易的重金屬離子吸附暨檢測之循環系統。對於2.0ppm、10.0ppm 之鉻、銅離子循環2、3 小時後，殘留率分別降至0.046%、0.074。

2014臺灣國際科展二等獎

那些年我們一起分解的氨氮-微生物處理廢水氮化物探討

- 將食品工業廢水置入高氨氮的固、液態培養基，培養並純化出可耐高氨氮環境的微生物。
- 將其中分解效能較佳之三菌種（RW、ST、ET）加入家庭、工業廢水，氨氮量亦明顯降低。
- 此三菌種無分解亞硝酸鹽的能力。
- 將分解效率最佳的ST菌置入廢水池中進行氨氮處理，發現其亦能有效降低廢水氨氮。

2015臺灣國際科展二等獎


奈米鑽石性能對於重金屬吸附之應用

- 近年螢光奈米鑽石(FND)注入動物細胞追蹤研究如火如荼展開。本組在從事FND與黃花狸藻的研究中，觀察到狸藻外部之吸附情形，推想FND可能會吸附重金屬離子。
- 將硝酸鉛、鋅、鎳、銅、鈷與鐵離子及錯離子水溶液配製FND混合懸浮液。利用共扼焦顯微鏡了解FND之生物共生與吸附特性。於重金屬吸附上運用LM324系統、及ICP-MS測量溶液濃度，且用SEM觀察表面。
- 研究結果顯示，FND具優越吸附離子能力，吸附前後FND表面在巨觀與微觀上有顯著改變；且再利用性極佳，可利用硝酸置換出金屬離子。

2016臺灣國際科展二等獎

高效率藍光LED路燈的再改造及應用

- 由於LED的節能效用，全球已有數百萬盞路燈改用LED路燈。LED路燈含有包括燈的一個面板，一個散熱模組，一個變壓器和鋁基板四個主要組件。
- 整組LED路燈只要輕微受損即被替換丟棄。事實上，被丟棄的LED路燈中，95%的路燈可以繼續被重組利用。
- LED發出白光是由於藍光LED外加黃色螢光劑，植物生長需要紅色和藍色的光。因此，將紅色螢光劑塗佈至透鏡蓋中，並將此透鏡蓋放置移除黃色螢光劑的LED上，使LED能發出藍光及紅光滿足植物需求。
- 回收的LED路燈比白熾燈節省82%的能量，且比市售植物生長燈節省37%的能源。



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