

# 靜態電磁場對線蟲之影響：由細胞自然凋亡所引起之行為遲緩 及加速老化

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## 中文摘要

當外加一個靜態電磁場於線蟲成蟲上，磁場強度在150mT以上且影響四天以上，可以使線蟲的爬行速率變慢。而當磁場強度達到200mT且影響八天時，爬行速率會減少八成以上。由及時反轉錄聚合連鎖反應發現，磁場會影響26個與細胞自然凋亡、氧壓以及癌症相關的基因。我們利用TUNEL螢光染色法以及免疫螢光染色法(*ced-3*抗體)來確認細胞自然凋亡的現象以及位置。並且藉由細胞自然凋亡基因*ced-3*、*ced-4*和*ced-9*的末化突變種來確認。實驗結果證實由磁場所引起的細胞自然凋亡會造成線蟲的爬行速率變慢。

另一方面，我們也發現磁場會加速線蟲的發育。外加 200mT 的磁場後，線蟲的總發育時間以及壽命都會明顯地減少。由及時反轉錄聚合連鎖反應發現，磁場會影響 4 個與發育生長及老化相關的基因，分別是 *clk-1*、*lim-7*、*unc-3* 和 *age-1*。藉由發育以及老化基因的末化突變種，我們確認了磁場會影響發育和老化基因 *let-7*、*unc-3* 和 *age-1*。由實驗結果，我們發現磁場會影響發育以及老化基因 *clk-1*、*let-7*、*unc-3* 和 *age-1*，進而加速線蟲的發育以及老化。

關鍵字：線蟲;磁場;細胞自然凋亡;老化

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**Effect of static electromagnetic field on *Caenorhabditis elegans* :  
reduction of mobility through apoptosis and acceleration of aging  
process**

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**Abstract**

Adult *Caenorhabditis elegans* were treated by static electromagnetic fields (static EMF) and the crawling speed was measured. Reduced mobility was observed when magnetic flux density stronger than 150 mT and the duration of treatment longer than 4 days. Eighty percents reduction of mobility occurred when the flux density reached 200 mT and duration of treatment extended to 8 days. Twenty-six differentially expressed genes among apoptosis, oxidative stress, and cancer were identified using quantitative real-time RT-PCR, indicating a globally molecular consequence responding to static EMF. Induction of apoptosis was verified by Terminal deoxynucleotidyl transferase dUTP nick end labeling (TUNEL) assay and immunostaining using antibody against *ced-3* gene product. Mutations at genes involved in major apoptotic pathway, i.e. *ced-3*, *ced-4*, and *ced-9*, abolished this static EMF-induced mobility reduction; consistent with the hypothesis that apoptosis is associated with the static EMF-induced mobility reduction.

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The current study investigated the possible effect of static electromagnetic field (SEMF) on the development and aging process of *C. elegans*. Nematodes were grown under SEMF of strength from 0 to 200 mT. Development time and lifespan was recorded. Lifespan was reduced from 31 days to 25 days for wild-type nematode. Treatment of 200 mT SEMF reduced development time fro 20% from L2 to L3 stage, 23% from L3 to L4, and 31% from L4 to young adult. Over expressions of *clk-1*, *lim-7*, *unc-3*, and *age-1* was verified by quantitative real time RT-PCR. Surveillance of total development time for mutant nematodes elicited the significant reduction for *lin-4*, *lin-14*, *lin-41*, and *lim-7*, but not for *let-7*, *clk-1*, *unc-3*, and *age-1* mutant strains. Lifespan analysis revealed that *let-7*, *unc-3*, *age-1* was not affected by SEMF treatment. SEMF accelerated the development and shortened the lifespan of nematode through pathways associated with *let-7*, *clk-1*, *unc-3*, and *age-1*.

Key words: *C.elegans* ; magnetic fields ; apoptosis ; aging

## 致 謝

首先要感謝在國立交通大學奈米科技研究所碩士班的兩年中，所有願意在實驗上、生活上以及各方面指導我並支持我的人。感謝一路走來，有很多朋友的陪伴，我們一起努力，一起成長，有你們在身邊的援助，讓我有力量可以走完碩士班這兩年的時光。

兩年的時間，一眨眼就過去了，我所得到的最大的收穫就是除了大學材料工程背景中又添加了生物方面的專長。在這方面，我要感謝我的指導老師 黃國華 教授以及洪耀欽 醫師，在老師的諄諄教誨之下，我開始了解生物方面的知識，並且熟析生物方面的實驗，這是一個相當難得的機會，可以在研究所短短的兩年中，有著跨領域的學習，我覺得我相當幸運。在實驗室當中，我不只獲得老師在學業上的教導，更在生活上收到更多的關懷以及愛心，這方面要感謝師母 洪孟燕 女士，在生活物質方面，師母總是會不定時送美味可口的點心來實驗室，像是米粉、油飯、水煎包、餡餅以及各式各樣的水果等，讓我們的肚子可以品嚐到竹苗的美食以及師母的廚藝。而在做人處事方面，師母也教導我們做人要學會感恩以及積極，我們全部都謹記在心。

求學過程中，最重要的就是身邊的夥伴們。我要感謝大勳、敘安、禮閣、嘉偉、志杰、永昌、高超及新堯，把我訓練成具有生物實驗基礎的人員，尤其是敘安學長以及禮閣學長。再來就是我的同窗阿書、小馬、小明以及其他實驗室的小花、小胖、盈傑等，我們一起打拼奮鬥的日子，我想我一輩子都不會忘記的，也感謝你們在我實驗上的建議與幫助，更感謝你們在生活上的陪伴。最後是實驗室未來棟樑學弟妹們：同是線蟲淪落人一禮貌又認真的佳慧學姊、又再次當學長學妹的大同材料人一玉蘋以及洪寧、慢慢上軌道的家偉及順華以及海陸熱血男兒一宗翰，你們一年來的成長我都看在心裡，加油！明年就換你們了。

最後要感謝我的家人們，感謝你們給我與精神上最大的支持以及經濟上的資助，讓我可以沒有後顧之憂的完成這兩年的學業。

能夠完成這份論文，我要感謝的人實在太多太多，很可惜沒辦法向你們一一致謝，因此在最後感謝所有幫助過我的人，謝謝你們。

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