

Electroporation for microalgal biofuels: A review

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Electronic Supplementary Information

S1. Research trends in publications relating to electroporation studies for sustainable biofuels

A keyword analysis and keyword-correlation analysis were performed using cluster analysis. We analyzed the use of electroporation (EP) technology for animal cells and plant cells over the few past decades as shown in Figure S1. We found that EP studies for mammalian cells increased more than EP for plant cells, and the gap between them increased and broadened until 2016. In 2007-2008, both the trends showed a significant increase in EP for mammalian cells and plant cells. We sought a relationship between the year and the number of EP studies for mammalian cell and EP for plant cells. The trends of those studies showed that that the applications of EP in both cells have been sharply increasing in this field.

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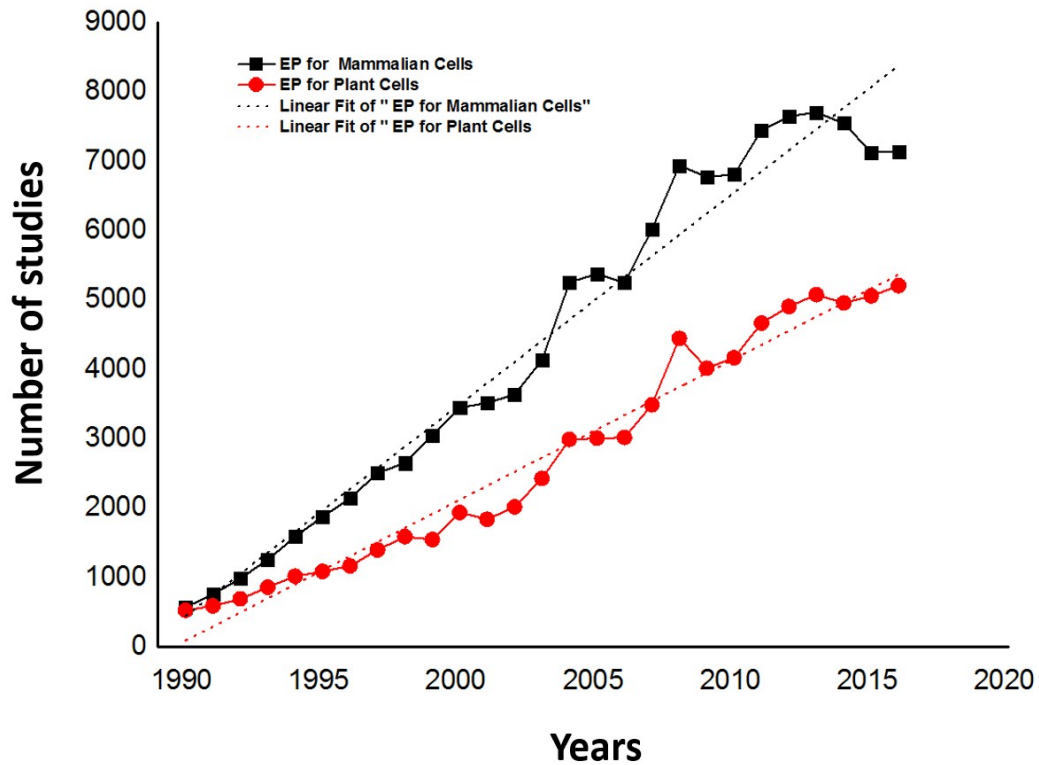
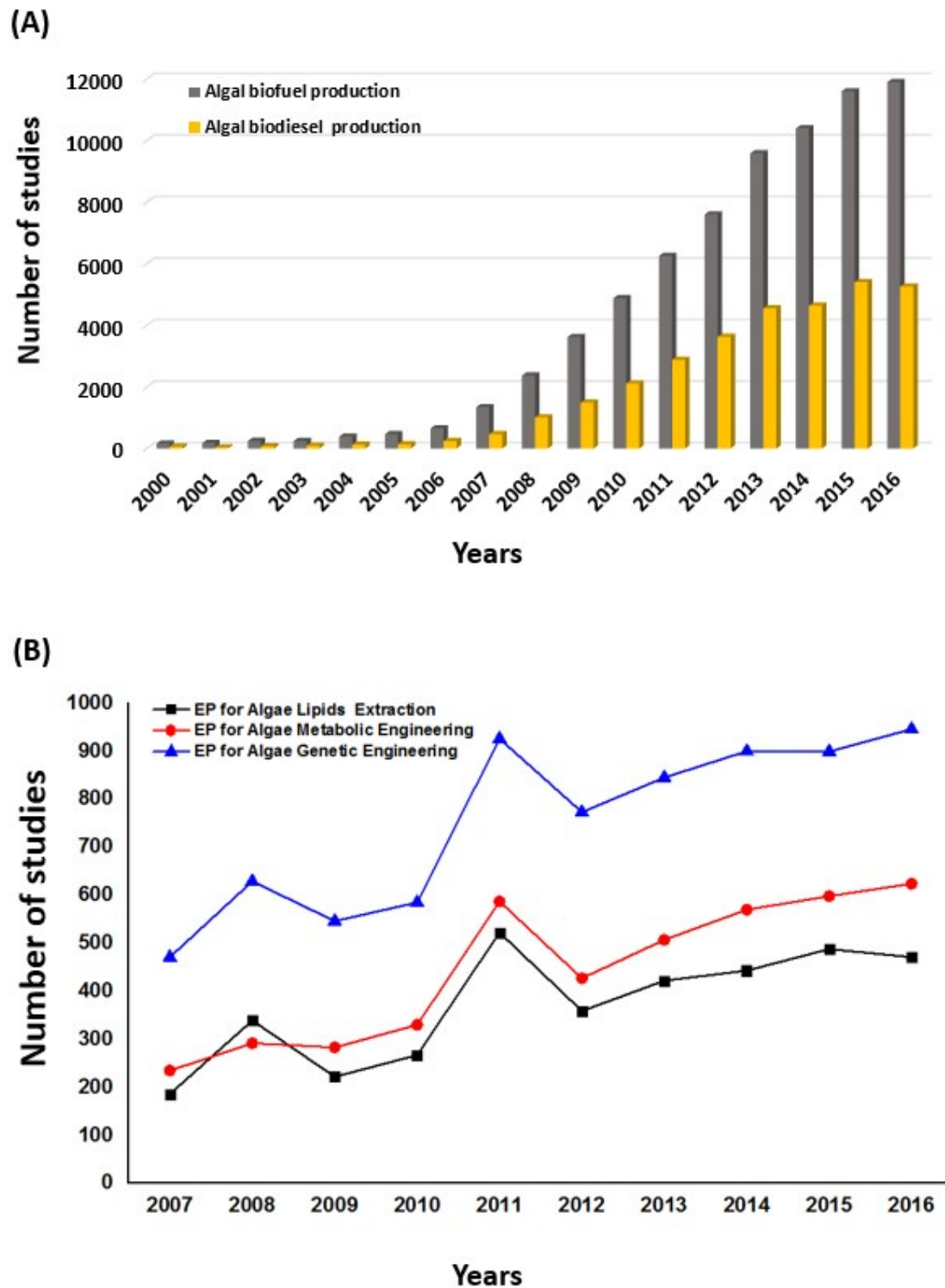


Figure S1. Research trends in publications related to EP technologies on mammalian cells and plant cells for the past 27 years (1990-2016). The two dotted lines are linear regression lines of the number of studies on the applications of EP in mammalian cells and plant cells.

We also collected and analyzed several research trends related to algae biofuel production and then found that the number of studies on the topic of algae biofuels increased except in 2016. The number of the studies continually increased dramatically between 2007 and 2015. Studies on algal biodiesel production have been rapidly increasing during the periods of 2007-2013 and 2014-2015, respectively. Studies on algal biodiesel production accounted for almost half of the studies on algal biofuel production as shown in Figure S2A. Studies related to EP applications in the field of algae biofuel production have been gradually rising for the last decade, and there was a large fluctuation in 2011 as shown in Figure S2B. This may imply that EP has been becoming more and more significant in the field of microalgal biofuel production in a combination of microscale technologies, such as microfluidics and MEMS.



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Figure S2. Research trends in EP studies related to microalgae biofuel production. (A) Algae biofuel production in the past 17 years (2000-2016). (B) The trend of EP studies on algae lipid extraction, metabolism engineering, and genetic engineering in the past decade (2007-

2016).