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The ultimate bioengineering challenge

In our ultimate bioengineering challenge competition, we asked early-career bioengineers to theoretically tackle some of the most pressing global health challenges. They have risen to the occasion with enthusiasm, creativity and innovation.

Global health strives to create a healthier and more equitable world by addressing the root causes of health disparities and fostering sustainable, long-term improvements in health outcomes. However, many essential healthcare solutions, such as vaccines, medical devices and diagnostic tools, remain costly, inaccessible or inadequately designed for areas with limited resources. For example, most vaccines require cold storage and distribution, which can be challenging in regions with unreliable electricity supply. Similarly, life-saving medical devices, such as oxygen masks, often depend on limited or unaffordable resources, such as medical oxygen. Importantly, many crucial devices and treatments rely on high-cost and complex components, hindering their local engineering and manufacturing. Solutions are thus urgently needed that work in the low-resource environments that are a reality for many healthcare professionals and patients around the world.

Therefore, we called on early-career bioengineers to come up with innovative ideas to tackle some of these challenges. While engineers often enjoy creating complex and high-tech designs, the ultimate engineering challenge may be to keep it simple, address a specific, urgent problem and use local, low-cost resources.

Three challenges were awaiting solutions: an off-grid bio-based cooling technology for short-term cold storage; an edible vaccine in a low-maintenance plant; and a self-sustained oxygen mask. Excitingly, we have received contributions by teams of students and post-doctoral researchers from over 15 countries. With the help of our external judges, we selected one winner for each challenge, on the basis of novelty, creativity, feasibility and frugal engineering approach. This was not an easy decision, as many outstanding ideas were submitted.

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The winners of the bio-based cooling technology for short-term cold storage challenge are Diana I. Gutierrez Parada, Luciana Rodríguez Martino, Valentina Mejia Salvador and Pablo Rivero from the Universidad Privada Boliviana in Bolivia. This team of students designed a biorefrigerator, on the basis of passive cooling and biodegradable, locally sourced materials. The biorefrigerator is engineered to maintain a stable temperature of 0 to 8 °C for at least 12 hours without requiring electricity, thereby enabling the storage and distribution of life-saving vaccines, such as the Bacillus Calmette–Guérin (BCG) tuberculosis vaccine.

Carson Campbell from the Westlake University in China and Esteban Azagra from the University of Chicago in the USA won the challenge of designing an edible vaccine in a low-maintenance plant, proposing a transgenic chloroplast-based system for mRNA vaccine expression in lettuce. Lettuce, which can be grown at low cost and in low-maintenance conditions, contains edible chloroplast-containing tissues, which can serve as expression platforms for a vaccine vector. Using biolistic transformation to introduce a gene cassette into chloroplasts, an mRNA vector can be released inside immune cells to trigger an adaptive immune response.

Finally, Xuan Peng, Xinne Zhao and Željko Janićijević from the Helmholtz-Zentrum Dresden-Rossendorf in Germany tackled the challenge of engineering a self-sustained oxygen mask, exploiting the CO_2-to-O_2 converting capabilities of microalgae to design a microalgae-biomaterial hybrid wearable device that can provide extended O_2 supply and water collection. This self-sustained oxygen mask is composed of sustainable materials suitable for biodegradation, thereby facilitating mass manufacturing and contributing to a circular economy.

We would like to congratulate our winners and hope that this competition showcases how supporting bioengineers, particularly early-career researchers, in engaging in global health can be a powerful catalyst for developing solutions that improve health outcomes worldwide. Whether they end up working in global health directly or not, such problem-solving skills will ultimately make them better engineers. And maybe, with the right funding, these innovations may even become a reality.

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