KNOX
GRAMMAR
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DA VINCI DECATHLON 2018

CELEBRATING THE ACADEMIC GIFTS OF STUDENTS IN YEARS 5 & 6

IDEATION

TEAM NUMBER _______________

1	2	3	4	Total	Rank
/15	/15	/15	/15	/60	

IDEATION

BLAST FROM THE PAST

BACKGROUND

One of the **questions** most frequently asked by young children to their parents is this:

*What if **dinosaurs** were alive today?*

Some answers will divert attention to the 'still really big' animals that inhabit our world today, whether they be on **land** or in **oceans**, while other children might simply be met with the **much-maligned** phrase "don't be silly". Rarely will parents actually discuss the **ethical** and **practical** consequences with their five-year old child, which is rather disappointing.

Indeed, it took a multi-million dollar Hollywood film franchise to provide a somewhat realistic answer to this age-old question. The **Jurassic Park** series was, for many children and adults alike, a realisation of hours spent happily and wildly **dreaming** of a world where giant lizards longer than jumbo jets roamed the Earth.

In this set of films, based on the book by Michael Crichton, preserved dinosaur blood and therefore **DNA** is found inside **prehistoric** gnats and ticks trapped in **amber.** This DNA is harnessed by a company, called InGen, in order to create a theme park inhabited by dinosaurs, all contained on an island in the North Pacific Ocean. As you might imagine, the plot soon spirals into **disaster**…

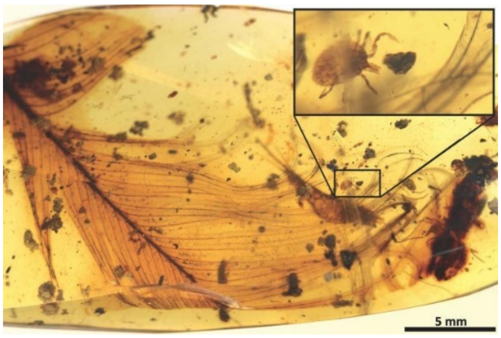
Returning to reality, in January of 2017, palaeontologists at North Carolina State University claimed to have recovered '**protein fragments'** from a fossilised dinosaur rib. This, however, was met with much scepticism, with most other palaeontologists and also biochemists suggesting that fragile **organic matter** such as this simply could not have survived for such an extended period of time.

More recently, in December 2017, the story of Jurassic Park appeared to have manifested itself, with a preserved dinosaur feather found in **amber**, with a **tick** clinging onto it. However, studies by Oxford University ruled out the presence of any DNA because the tick was unfortunately so close to the surface of the amber as not to be sufficiently enveloped.

Nevertheless, our planet is **vast**, and phenomena such as fossilisation, amber preservation and even natural cryopreservation mean that there is the **smallest chance** that organic dinosaur matter does still exist somewhere in the world. Although it will remain **incredibly difficult** to find even if it is out there, it is **not impossible.**

THE PROBLEM

Imagine this: a group of scientists are undertaking an expedition to **Antarctica**. During their journey through the icy landscape, they see an avalanche occur on one of the mountains in the near distance. When the snow settles and the air clears, it appears that a **cave** on the side of the mountain has been revealed. **Intrigued,** the scientists veer off course towards it.



The cave only consists of one passage, boring its way into the centre of the mountain. The temperature inside drops **lower** than any previously recorded by man. At the end, the scientists are met by a **gruesome discovery** – the severed head of a ***Tyrannosaurus Rex,*** perfectly preserved in the ice. This was to be the most **unexpected** of discoveries, and one with the potential to **change the course of human history.**

The specimen is taken to the **CSIRO labs** in Canberra, Australia. A full sequence of *Tyrannosaurus* DNA is **extracted**. This, however, is not all. DNA from three other species of dinosaur, an *ankylosaurus, brachiosaurus* and *pachycephalosaurus,* are all found through remnants of flesh and blood from the mouth and teeth of the original specimen. Perhaps the *Tyrannosaurus'* last couple of **meals**…

Immediately, of course, the **debate** begins. **What should be done with this DNA?**

THE DESIGN CHALLENGE

Your **challenge** is to answer the question above. What is the **best course of action** for the CSIRO to take? You should focus on one particular area and present a **five-year plan** for the use of the DNA that has been discovered.

Consider focusing on **one particular** area – this could be health, education, revenue raising, scientific research, social protection or something entirely different. Ultimately, your solution must be highly **beneficial** but must also not pose a **threat** to society.

Your answer can include one or more mediums, such as an **invention,** the use of existing technology, the creation of new **infrastructure,** a social policy or program and many others (except, of course, for another theme park!).

Answers which are both **future-thinking** and original will score highest. While your solutions must be **realistic,** they do not have to be **immediately** or **certainly** achievable. Considering what **might** occur in future to address a problem such as this one is critical.

You will have **ninety (90) minutes** to complete the four components below.

Stimulus material to assist in your solution is attached at the end of this paper.

Please **carefully read** the marking criteria on the following pages for additional guidance on what to include in the answer templates provided, and where to do so.

The following components provide a structure for your work:

EMPATHISE (Ethical Decision-Making Framework) (15 marks)

This involves evaluating what 'ought to be done', through considering rights, obligations, fairness, the benefits and detriments for societies and other virtues. Reaching a final decision involves a degree of conviction and belief in what is 'the right thing to do'.

DEFINE (Design Brief) (15 marks)

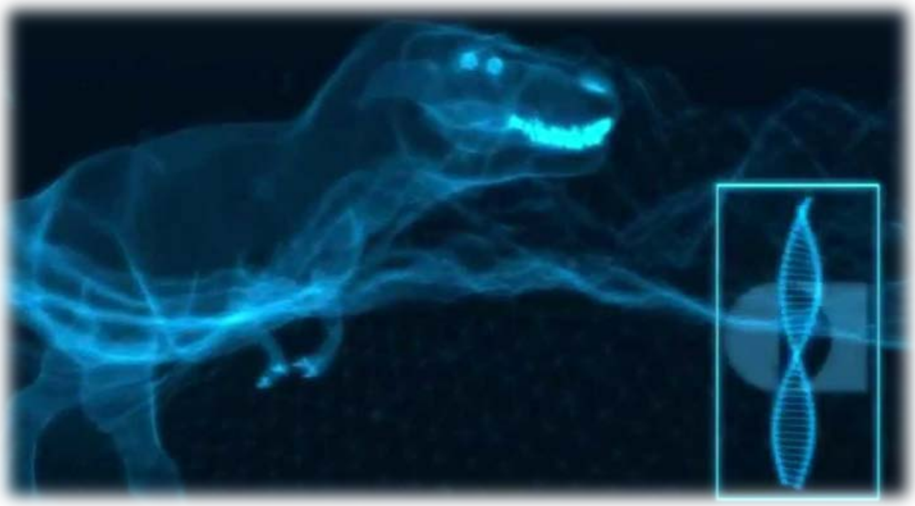
Here, you must identify the problem, outline the ethical issues, evaluate the challenges and research findings, and identify possible solutions.

IDEATE (Reflection) (15 marks)

You must then reflect on their solutions and whether they will be viable. A preferable solution should be identified, and any unanswered questions should be addressed. Issues of implementation are also crucial to reflect upon.

CREATE (Prototype) (15 marks)

Finally, a design for how your ideas and solution will be disseminated must be produced. This could be a story-board, mind-map, diagram, model, narrative or any other appropriate medium. Critically, an audience must be able to understand the process of dissemination by examining this prototype.



MARKING GUIDELINES

1. Ethical decision-making framework (15 marks)

QUESTIONS	LIMITED	SOUND	OUTSTANDING	TOTAL
1: At least two facts	0	1	2	
2: Identifies challenges	0	1-2	3	
3: States why it matters	0	1	2	
4: Identifies negative consequences	0	1	2	
5: Identifies positive consequences	0	1	2	
6: Demonstrates empathy	0	1	2	
7: Identifies impact on the wider community	0	1	2	
			TOTAL	/15

2. Design Brief (15 marks)

ASPECT	LIMITED	SOUND	EFFECTIVE	OUTSTANDING	TOTAL
Ideate: What – why it matters, challenges, ethical issues & the vision	0-1	2-3	4	5	
Research: Why - findings that support ideas & solutions	0-1	2-3	4	5	
Solutions: How – the question and possible solutions	0-1	2-3	4	5	
				TOTAL	/15

3. Reflection (15 marks)

ASPECT	LIMITED	SOUND	EFFECTIVE	OUTSTANDING	TOTAL
Ideation: Ideas	0-1	2-3	4	5	
Implementation: When, where & who?	0-1	2-3	4	5	
Dissemination: How to get the ideas adopted	0-1	2-3	4	5	
				TOTAL	/15

4. Prototype (15 marks)

ASPECT	LIMITED	SOUND	EFFECTIVE	OUTSTANDING	TOTAL
Originality and creativity	0-1	2-3	4	5	
Clarity and communication of ideas, audience appeal	0-1	2-3	4	5	
Idea is both realistic and future-thinking	0-1	2-3	4	5	
				TOTAL	/15

TOTAL: /60

ADDITIONAL STIMULUS

Should we bring extinct species back from the dead?

By David Shultz, published in Science, September 26 2016; available at http://www.sciencemag.org/news/2016/09/should-we-bring-extinct-species-back-dead

Earth is in the midst of its sixth mass extinction: Somewhere between 30 and 159 species disappear every day, thanks largely to humans, and more than 300 types of mammals, birds, reptiles, and amphibians have vanished since 1500. These rates do not bode well for the future of life on our planet, but what if extinction wasn't permanent? What if we could resurrect some of the species we've lost?

For decades the notion of "de-extinction" hovered on the scientific fringes, but new advances in genetic engineering, especially the **CRISPR-Cas9 revolution**, have researchers believing that it's time to start thinking seriously about which animals we might be able to bring back, and which ones would do the most good for the ecosystems they left behind. Indeed, earlier this month, ecologists at the University of California, Santa Barbara (UCSB), published guidelines for how to choose which species to revive if we want to do the most good for our planet's ecosystems.

The two animals at the forefront of this discussion are the **woolly mammoth**, a hairy, close relative of the elephant that lived in the Arctic, and the **passenger pigeon**, a small, gray bird with a pinkish red breast once extremely common in North America. The last mammoths died about 4000 years ago, and the passenger pigeon vanished around 1900. Research on reviving both species is well underway, and scientists close to the field think de-extinction for these animals is now a matter of "when," not "if."

With that prospect in mind, here's what we know so far about de-extinction:

Why bring back extinct animals?

As cool as it might be to visit a zoo filled with woolly mammoths, saber-toothed tigers, and giant tortoises, the best reasons for bringing back extinct animals have more to do with ecology than tourism. "If this is always going to be a zoo animal, then stop," says ecologist Ben Novak, the lead researcher on the passenger pigeon project at Revive & Restore—a foundation devoted to genetically rescuing endangered and extinct species in San Francisco, California. "The goals have to be about ecological restoration and function."

Every animal in an ecosystem has a function: Bats eat insects, fish clean algae from coral, grazers spread nutrient-rich dung across habitats. Some functions are redundant —shared among multiple different animals—but others are fulfilled by just one or two species.

Both the passenger pigeon and woolly mammoth were functionally unique species, and when they went extinct, their habitats changed dramatically. Harvard University's George Church, the lead researcher working to de-extinct the mammoth, says that bringing back the giants could help convert the Arctic tundra back to grasslands that existed during the last ice age. He points to research that shows that mammoths and other large herbivores trampling across the ancient Arctic ecosystems helped maintain the grasslands by knocking down trees and spreading grass seeds in the dung. When the large herbivores disappeared, the ecosystem transitioned to today's mossy tundra and taiga that is beginning to melt and release carbon dioxide into the atmosphere. Reviving the mammoth, Church says, could help slow climate change by shifting the landscape back toward the grasslands. “There’s twice as much carbon at risk in the tundra than in all the forests of the world put together.”

Likewise, the passenger pigeons, whose numbers are estimated to have reached nearly 5 billion at the start of the 19th century, played a dramatic role in shaping the forests they inhabited. Their numbers were so great and their droppings so prevalent and flammable that they destroyed trees and increased forest fires. After their extinction, these healthy natural disturbances ceased, white oaks lost their primary mode of seed dispersal (i.e., via bird droppings), and the forests have never been the same. “The passenger pigeon is a very important ecological species for the habitat that we want to restore,” Novak says.

How do you de-extinct an animal?

There are three main approaches to de-extinction scientists talk about. The first, called back-breeding, involves finding living species that have traits similar to the extinct species. Then scientists would selectively breed these animals to try to make a version that more closely resembles the extinct animal—**a process already underway for some extinct species like aurochs**. This isn’t really a true de-extinction, but it might still let us fill in missing ecological functions. In the case of mammoths, scientists might try to mate Asian elephants with more body hair than usual, for example.

A second option is cloning. Scientists would take a preserved cell from a recently extinct animal (ideally before the last of its kind died) and extract the nucleus. They would then swap this nucleus into an egg cell from the animal’s closest living relative and implant the egg into a surrogate host. (Researchers actually did this in 2007, and a common goat gave birth to an extinct species, the Pyrenean ibex. The infant lived only 7 minutes however, because of genetic problems with its lungs.) Cloning may eventually give us basically identical genetic copies of extinct species, but we’ll be restricted to animals that went extinct more recently and have well-preserved cells with intact nuclei. The mammoth and the passenger pigeon may never be cloned.

The newest option is genetic engineering. Here, researchers would line up the genome of an extinct animal with that of its closest living relative. They would then use CRISPR and other gene-editing tools to swap relevant genes from the extinct animal into the living species and implant the hybrid genome into a surrogate (or grow it in an artificial womb). This approach doesn’t produce genetically identical copies of extinct animals, but rather modern versions of an animal engineered to look and behave like its extinct relatives. This is the technology being used by the mammoth and passenger pigeon groups.

How close are we?

That depends on what you count as a true de-extinction, which is sort of a grey area. If scientists engineer an Asian elephant to have small ears, extra fur, and more body fat by swapping in mammoth DNA, is it still an Asian elephant?

“If you're willing to accept something that is an elephant that has a few mammoth genes inserted into its genome and therefore is able to make some proteins that mammoths might, we're probably closer to that,” says Beth Shapiro, author of How to Clone a Mammoth: The

Science of De-Extinction and an evolutionary biologist at UC Santa Cruz specializing in ancient DNA.

The passenger pigeons project faces similar questions. Novak wants to resurrect the bird using its closest living relative, the band-tailed pigeon, but how many genes need to be swapped to constitute success is somewhat arbitrary. “The two genomes are 97% the same. That 3% has built up over many millions of years and the majority of it is noise,” he says. “So, the actual differences are much likely a smaller portion—probably within the realm of several thousand mutations. What we want to find is the key 20 or 100 mutations that affect the traits that are most important.”

There’s also a divide as to what constitutes a de-extinction success for the scientists versus the public. Genetically coaxing to behave like their extinct relatives might restore the ecosystem’s lost function, Novak says. But is that good enough to count? “I don’t think anyone in the world is really going to call it de-extinction unless the bird looks right.”

Even if researchers can pinpoint and transfer those key mutations (a daunting task), DNA is only half the battle. From there it’s a matter of getting the hybrid cell to grow in a surrogate, hoping all the genes work harmoniously together, bringing the hybrid to term, and hoping it acts like the extinct species even though it was raised by a modern relative. If all that goes right, you still need the hybrids to mate and give birth to fertile offspring. “I think the hardest part is getting developmental biology to go,” says Philip Seddon, a conservation biologist at the University of Otago, Dunedin, in New Zealand and the lead author on a recent report by the International Union for Conservation of Nature (IUCN) that issued **guidelines** for de-extinction research.

It’s a monumental task, but Novak says that if his team can secure enough funding, “there’s no reason that we can’t have the first generations of passenger pigeons by something like 2022 to 2025. Everyone running these projects would very much like to be in 10-year time frames.”

How do we choose which animals to de-extinct?

In their recent publication, Douglas McCauley, an ecologist at UCSB, and his colleagues argue for **three criteria** to consider when choosing de-extinction candidates: Select target species with unique functions, concentrate on species that went extinct recently, and only work with species that can be restored to levels of abundance that meaningfully restore ecological function.

Although the mammoth and the passenger pigeon might pass McCauley’s first criterion, experts are sceptical about whether they’re truly the best animals to focus on. Shapiro points out that ecosystems are not static and have continued to change since these animals went extinct. “I worry about the dramatic changes to the forest in the eastern part of the North American continent,” she says. “I think there’s a lot we need to understand better about the passenger pigeon’s ecology and the effect that the passenger pigeon would have on that habitat before we can make a sufficiently educated decision.”

McCauley has similar worries: “Forests have fragmented, forests have expanded and contracted. A passenger pigeon that hits that forest again is going to be like a middle-aged guy who really wants to go back to high school and then he gets back there and he's like, 'Whoa I don't fit in anymore.'"

He thinks that de-extinction efforts should instead be focused on recently extinct animals like the Christmas Island pipistrelle bat (Pipistrellus murrayi), the Réunion giant tortoise (Cylindraspis indica), and the lesser stick-nest rat (Leporillus apicalis). Although not as charismatic as a woolly mammoth, he says these creatures still have habitats to return to and would restore a unique function in their ecosystems. The lesser stick-nest rat, for instance, did what its name implies and built large stick nests in central Australia that became hubs of biodiversity.

What are the risks?

The spread of genes can be difficult to control. We probably won't lose track of mammoths in Siberia, but what about rats? "It becomes hard to control those sorts of populations," Seddon says. "And there are the same fears one might have about genetically modified crops—the idea that a modification may move into relatives, may jump in and out, or may not be expressed in the way that you expect." Scientists are confident that there's a safe way to proceed, but mistakes may come at a high cost if we can't put the genie back into the bottle if something goes wrong. "If we lose sight of the true gravity of extinction and overzealously embrace de-extinction as a mitigation tool, it would be really easy to manufacture forests, savannas, and oceans full of Franken-species and Eco-zombies," McCauley says.

But in spite of any danger, McCauley says his biggest concern isn't a runaway genetic experiment wreaking havoc on a fragile ecosystem. "Honestly, the thing that scares me most is that the public absorbs the misimpression that extinction is no longer scary," he says. "That the mindset becomes: Deforest, no biggie, we can reforest. If we drive something extinct, no biggie, we can de-extinct it."

Introducing (or reintroducing) a new species to a habitat always comes with some risk, but de-extinction scientists point out that we've been able to manage that risk successfully with living animals like reintroducing wolves into Yellowstone National Park or beavers into the United Kingdom. There have also been disasters, like the poisonous **cane toad** in Australia, which was originally imported to help control the grey-backed cane beetles that were damaging sugar crops, but is now spreading across the continent and depleting native populations.

"De-extinction is just the next step in a progression that conservation has already been on," Novak says. "If you want to restore the ecological function of an extinct species, and you don't have any living species that will do that, you take the closest living species you can get and adapt it based on the genome of the extinct species."

IUCN has been dealing with these sorts of issues for years now, and so stands uniquely poised to help regulate de-extinction science's future. Still, there are no laws requiring that researchers take its advice. The only legal structures governing de-extinction are borrowed from genetically modified organism and cloning research—fields regulated by the U.S. Food and Drug Administration, Department of Agriculture, and Environmental Protection Agency.

Regardless, de-extinction is speeding closer to reality, and now is the time to start thinking about it, McCauley says. “For a long time it was easy to just put it aside because the technology wasn’t there,” he says. “But I don’t think we can do that anymore.”

Five reasons to bring back extinct animals (and five reasons not to)

By Breanna Draxler, published in Discover Magazine, April 4 2013; available at http://blogs.discovermagazine.com/d-brief/2013/04/04/5-reasons-to-bring-back-extinct-animals-and-5-reasons-not-to/#.Wlm7oqiWbDc

Would you like to see a real, live woolly mammoth? Or how about a Tasmanian tiger in the flesh? Scientists have already finagled a few ways to resurrect extinct species from their evolutionary graves. Even muckier than the scientific methods themselves, though, are the social, ethical and legal ramifications of so-called de-extinction.

In *Science* today, two Stanford researchers tackle this tricky topic to parse out exactly what we have to gain and lose from de-extinction technologies. Using the passenger pigeon as a thought experiment, another paper in the same issue looks at the fears and excitement of leaders in the field of genomics.

There are three main ways of bringing back extinct species, according to the Stanford researchers: back-breeding, genetic engineering, and cloning. With back-breeding, scientists use a living species that is genetically similar to the extinct species, and selectively breed it for the traits of the now-extinct species. Genetic engineering depends on existing DNA samples of the extinct species; scientists could bring them back to life by targeting and replacing specific genomic sequences in a closely-related living species. Finally, if viable cell nuclei from the extinct species are available, it can be cloned using a technique called somatic cell nuclear transfer—a tested but as-of-yet unsuccessful method for extinct species.

Based on the current state of the science, the Stanford researchers distil de-extinction down to five pros and five cons:

Benefits:

- Scientific knowledge: De-extinction could offer insights into evolution and natural resources that are currently unavailable to us.
- Technological advancement: De-extinction could be a big step forward for genetic engineering.
- Environmental benefits: Threatened or damaged ecosystems could be restored with the help of certain now-extinct species.
- Justice: If people pushed plant and animal species into extinction, perhaps we owe it to these species to try and bring them back.
- Wonder: How cool would it be to see extinct species alive and kicking again?

Objections:

- Animal welfare: People could be exploiting animals for solely human purposes, and may cause individuals of the de-extinct species harm.
- Health: Species could carry retroviruses or pathogens when brought back to life.
- Environment: De-extinct species would be alien and potentially invasive; their habitats and food sources have changed, so their roles in these changed ecosystems could be too.
- Political: De-extinction may change priorities in other fields of science, such as medical research and the conservation of currently endangered species.
- Moral: Is de-extinction playing god, or just plain wrong? It may also have unforeseen consequences.

If an extinct animal were brought back to life in the lab, the authors point out that it would still lack many of a species' key characteristics, such as epigenetics, environment and social groups. Plus, it would bring along with it a number of complicated legalities relating to the Endangered Species Act and patent laws. And that doesn't even get into the messy world of if and how such resurrections should be regulated.

In the end, both papers seem to draw open-ended conclusions. But if the practice is really as inevitable as it seems, the authors say the most interesting part will be seeing how humanity reacts.