

1. Below is a diagram showing basic processes of photosynthesis. Based on the information provided, please rearrange the sentences in the following table to form a scientific abstract. You will be graded based on the structural flow and readability. (30 points)

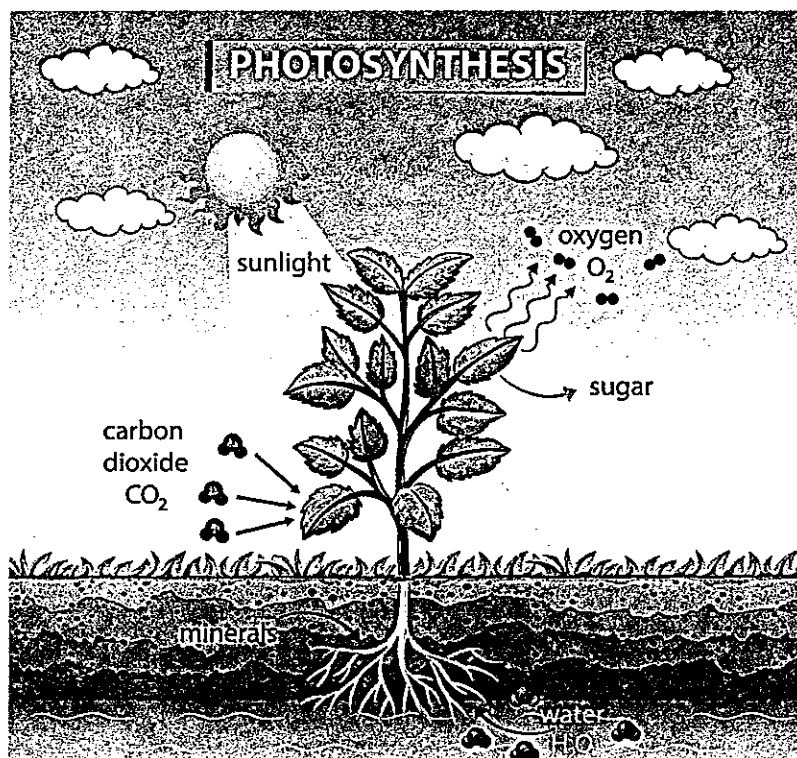


Figure adapted from https://www.freepik.com/free-vector/diagram-showing-process-photosynthesis-plant_14014147.htm

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| <ul style="list-style-type: none"> • This energy is used to split water molecules (H₂O) into hydrogen and oxygen. • The second stage is the light-independent reactions, or the Calvin cycle. • Moreover, photosynthesis is a prime example of energy conversion – transforming solar energy into chemical energy. • Photosynthesis also plays a key role in the Earth's climate. • This process is vital for the survival of almost all life forms on our planet. • Here's a more in-depth look: Photosynthesis occurs in two main stages. • Understanding this process gives us insight into the delicate balance of life and the importance of conserving our natural environment. • Oxygen is then released into the atmosphere – yes, this is the very oxygen we breathe! • Plants absorb carbon dioxide, a greenhouse gas that contributes to global warming. | <ul style="list-style-type: none"> • This sugar provides energy for growth, development, and other essential functions of the plant. • This phase doesn't require direct sunlight but uses the energy absorbed during the light-dependent reactions. • It's a fascinating phenomenon where plants, algae, and some bacteria convert sunlight, water, and carbon dioxide into food and oxygen. • The first stage is the light-dependent reactions. • Photosynthesis is a critical biological process that fuels life on Earth. • In this phase, chlorophyll, a green pigment in the leaves, captures sunlight. • By converting CO₂ into oxygen, photosynthesis helps regulate the levels of these gases in the atmosphere, maintaining a balance essential for life. • Here, carbon dioxide (CO₂) from the air is used to produce glucose (C₆H₁₂O₆), a type of sugar that serves as food for the plant. • In summary, photosynthesis is much more than just a plant process. |
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2. Read the following article and answer the questions below. (20 points)

Taiwan's Real Estate Odyssey: A 30-Year Economic Perspective

In the ever-evolving tapestry of Taiwan's economy, the real estate market stands out as a dynamic and telling narrative. Over the past 30 years, this market has not only mirrored the island's economic fortunes but has also been a crucible where various social, political, and global factors have interplayed to shape its course. This column examines key periods, revealing how Taiwan's real estate market reflects its resilience and adaptability amid various challenges. We will explore the intricate connections between economic policies, global events, and societal changes, shedding light on the complexities of this dynamic market.

The 1990s in Taiwan were marked by robust industrialization, which fueled urban migration. The burgeoning demand for urban housing from a workforce transitioning from rural to urban areas was a significant catalyst for the rise in property prices. This period saw the genesis of Taiwan's modern urban landscape, with cities expanding both vertically and horizontally. The Asian Financial Crisis of 1997 tested the resilience of Taiwan's economy. The real estate sector, not immune to these shocks, experienced a downturn. The crisis led to a reduction in foreign investments, a slowdown in industrial growth, and increased unemployment, all of which negatively impacted the housing market.

Entering the millennium, Taiwan's economy pivoted towards technology, leading to the growth of sectors like semiconductor manufacturing and electronics. This shift didn't just bolster the economy; it transformed the real estate sector. Higher incomes and job security led to increased demand for quality housing, pushing prices upward. The SARS outbreak in 2003 brought to light the interconnectedness of health and economics. The epidemic's impact, though short-lived, was significant, leading to cautious spending and a temporary lull in the housing market. The 2008 Global Financial Crisis, originating from the U.S. housing market meltdown, had a cascading effect worldwide. Taiwan's real estate market experienced a period of uncertainty, with a slowing in the growth of house prices. This period highlighted the vulnerability of local markets to global economic tremors.

In response to the global financial crisis, Taiwan, like many countries, adopted a low-interest-rate policy. This policy made mortgages more affordable, leading to increased borrowing for home purchases and a consequent rise in housing prices. The period from 2010 to 2015 witnessed some of the highest increases in property prices in Taiwan's history. Another factor contributing to the housing boom was the influx of investments from Mainland China. This period saw heightened cross-strait economic activities, with real estate being a key sector for Chinese investments in Taiwan. This led to concerns about housing affordability for local residents and prompted discussions on regulatory measures. The 2010s also saw an increase in real estate speculation. Investors bought properties, not for residential purposes, but as assets expected to appreciate in value. This speculative buying contributed to the rapid escalation of housing prices, leading to fears of a property bubble.

The onset of the COVID-19 pandemic in 2020 initially led to a slowdown in the real estate market, mirroring the global economic uncertainty. However, as the pandemic progressed, it brought about a shift in living preferences. The demand for larger, more comfortable homes suitable for remote work and living outside densely populated urban centers increased, leading to a surprising resilience and growth in the housing market.

Faced with rising housing affordability concerns, the Taiwanese government has implemented various measures. These include higher property taxes on speculative investments and increased supply of affordable housing. These efforts aim to stabilize the market and ensure housing affordability for the general population.

The past 30 years have seen Taiwan's real estate market undergo significant transformations. The journey from rapid urbanization to technological advancements, from global crises to pandemics, has been marked by periods of both turbulence and growth. As Taiwan continues to navigate these challenges, the real estate market remains a key indicator of its broader economic health.

- 2-a. Please create a line graph showing the trend of housing price in Taiwan over the past 30 years. (8 points)
- 2-b. What are the factors causing the drop in housing prices? (8 points)
- 2-c. How did the 2008 Global Financial Crisis affect Taiwan's real estate market? (2 points)
- (A) It caused a significant and long-lasting crash in housing prices.
 - (B) There was a substantial increase in housing prices.
 - (C) It led to a temporary stabilization and slight decrease in housing prices.
 - (D) It had no impact on the real estate market.
- 2-d. What is a key factor that consistently influences housing prices in urban areas of Taiwan? (2 points)
- (A) Urban migration and population density.
 - (B) Changes in agricultural policies.
 - (C) The popularity of rural living.
 - (D) The availability of recreational facilities.

3. Please read the following article and answer the questions accordingly. (30 points)

We finally know the cause of severe morning sickness. A remedy could be next.

The debilitating, sometimes fatal condition called hyperemesis gravidarum has received scant funding and little acknowledgment, but new research may soon yield drugs to treat it.

Sam Jones

During her first pregnancy, Marlena Fejzo experienced nausea and vomiting so severe it landed her in the emergency room twice before giving birth. But her second pregnancy “was so much worse. I didn’t even think it could be worse, but it was,” recalls Fejzo, who is now a women’s health researcher at the Keck School of Medicine of USC.

During the second pregnancy, Fejzo was given IV fluids, seven different medications, and placed on a feeding tube. Nothing worked. At % she was so weak that she couldn’t speak, was bedridden, and needed round-the-clock care. Fejzo’s doctor told her he thought she was just trying to get attention from her husband. At 15 weeks, she miscarried.

Fejzo suffered from hyperemesis gravidarum (HG), a condition experienced by around 2 percent of pregnant individuals and characterized by severe, persistent nausea and vomiting that can be life-threatening. Despite that, HG research is consistently underfunded and those experiencing it are often dismissed. Fejzo’s miscarriage was in 1999. Shortly after, she returned to her postdoctoral researcher position at UCLA motivated to learn everything she could about HG.

Last month, Fejzo and her colleagues published breakthrough work on how the hormone GDF15 impacts a mother’s risk of developing HG. The work could lead to several effective treatments whose availability, some researchers say, feels imminent. But lack of awareness and acknowledgment of the severity of HG could stand in the way.

Morning sickness is an unpleasant pregnancy experience, but when HG—a far more extreme condition—is lumped together with morning sickness, the women suffering from it feel gaslit, says Kimber Wakefield MacGibbon, one of the study authors and the co-founder and executive director of the Hyperemesis Education and Research (HER) Foundation. HG feels like food poisoning, but with a very important difference: vomiting does not lead to relief. “It’s a continuous feeling that something’s in your stomach that shouldn’t be there,” says MacGibbon, a registered nurse who experienced HG in both of her pregnancies.

Dehydration and weight loss are common symptoms of HG, but the most severe cases can lead to miscarriage and conditions in the mother such as Wernicke’s encephalopathy, a neurological disorder caused by vitamin B1(thiamine) deficiency that can be fatal. A number of studies have shown that babies born to mothers with HG are at increased risk for preterm birth, low birth weight, and neurodevelopmental disorders including speech and language delay.

“It really is a dangerous exposure in pregnancy, and it should be considered that,” says Fejzo. “Unfortunately, it just isn’t.”

First-line treatments for HG, including anti-vomiting and nausea medications, are not effective for many women, says physician Jone Trovik, a professor in the department of clinical science at the University of Bergen who was not involved in Fejzo and MacGibbon’s study. And, even if a patient is given intravenous fluids to help relieve dehydration and electrolyte depletion or—in the most dire circumstances—is hooked up to a feeding tube, they may still need to terminate their pregnancy to survive.

“As a doctor I feel very incompetent when I do not manage to help these women avoid termination in an otherwise wanted pregnancy,” says Trovik.

Despite its severity, HG is overlooked, even by the medical community. Obstetrics and gynecology physician and HER Foundation medical advisor Aimee Brecht-Doscher will never forget the American College of Obstetricians and Gynecologists annual meeting she attended alongside thousands of other physicians in 2017, where only two presentations were given about HG, one by Fejzo. And as Brecht-Doscher and a few other attendees sat discussing the neglected condition, a male physician joined the conversation and announced: ‘I know what causes hyperemesis: it's hysteria.’ “And if you believe that,” says Brecht-Doscher, “then you don't believe that you really need to do anything to treat people.”

Brecht-Doscher, who also was not involved in Fejzo and MacGibbon’s study, suffered from HG in two pregnancies, one of which led to a miscarriage. “The knee jerk reaction as a physician—especially to women who don't respond to standard therapies—is to assume that there's a psychological component and that's why they're not responding,” she says. “And I had learned that bias myself as a physician prior to having hyperemesis.” Brecht-Doscher says that, once she got HG, “I realized there was really nothing I could do to make myself better.”

Building an HG community

Following her miscarriage, one of the first things Fejzo did was create an online survey to get a sense of HG’s prevalence and the variables that influenced it. She was shocked by how many responses she received, including one from MacGibbon, who Fejzo remembers writing, “after I’m done with this pregnancy, I’m going to make a website on hyperemesis because there’s nothing out there.”

What began as a website became the HER Foundation in 2002, a non-profit that collaborates with universities and research studies; offers support to families; and provides resources on HG to patients and providers—such as information on medications and management strategies. MacGibbon says she has spoken to around 10,000 families across the globe since she launched the foundation.

Fejzo’s survey was soon posted on the HER website and, with that data, she, MacGibbon, and colleagues showed that HG was likely heritable. Fejzo then applied for NIH funding to study which gene(s) may be responsible but was denied. In 2010, her brother gave her a 23andMe genetic testing kit as a birthday gift. In addition to providing genetic information, 23andMe customers have the option of filling out health surveys. Fejzo had an idea. “I contacted them and asked them if they could include questions about hyperemesis, which they did.”

In 2018, using genetic and health survey data from 23andMe participants, Fejzo, MacGibbon, and colleagues were the first to show a link between hyperemesis and a hormone called GDF15. GDF15 levels were already known to increase in the first two trimesters of pregnancy and to be a driver of cachexia, a wasting syndrome often seen in cancer patients.

Around the same time, studies showed that GDF15 binds to cells in the brain stem, a structure responsible for basic functions like breathing and consciousness as well as vomiting, which reinforced its likely role in HG. But Fejzo was still perplexed as to why some people have HG in one pregnancy and not another.

What causes HG?

In the recent study, Fejzo and colleagues discovered that the majority of the GDF15 hormone comes from the baby, not the mother, and the amount produced can change from one pregnancy to the next, depending on the genetics of the baby, which is why mothers don't always experience HG with all pregnancies. In addition, a mother's level of nausea and vomiting during pregnancy is determined by her sensitivity to GDF15.

The researchers found that women who produce below average amounts of GDF15 before becoming pregnant are at higher risk for developing HG because they are hypersensitive to the typical rise of the GDF15 protein in early pregnancy. By comparison, women who produce high levels of GDF15 before becoming pregnant report very little nausea or vomiting.

To test the hypothesis that sensitivity to GDF15 influences risk of HG, researchers exposed mice to either a small dose of GDF15 followed by a high dose of GDF15—comparable to levels in women with HG—or to only a single high dose of GDF15. Mice given only one high dose began eating less and lost weight; by contrast, the mice given a small dose of GDF15 first, and thereby desensitized, were not impacted when given the larger dose.

Promising drugs in the pipeline

Brecht-Doscher believes these findings will soon lead to treatments. But, she says, there is still valid concern about giving drugs to pregnant women. "There's a lot of history there, with other medications that were used specifically for nausea and pregnancy that did cause harm." One of those was thalidomide which, in the early 1960s, was found to cause severe limb deformities in the children of mothers who took it to relieve nausea during pregnancy.

But Fejzo and others are optimistic because drugs that appear promising are already being tested, albeit for other conditions. Fejzo is hoping to evaluate drugs that increase GDF15 levels prior to pregnancy, preventing HG, as well as drugs that decrease GDF15 during pregnancy, further staving off or mitigating symptoms.

Fejzo is currently applying for a grant to test the diabetes drug metformin, which increases levels of GDF15 in the blood and is already used to increase fertility in patients with polycystic ovary syndrome (PCOS) and in some cases of gestational diabetes. There are also GDF15 blocking drugs in clinical trials for cancer patients with cachexia. Fejzo hopes that, once those drugs are shown to be safe in those trials as well as in pregnant animal models, they can be tested in pregnant women as well. On January 9, San Francisco biotech company

NGM Bio announced that they are talking with the FDA about beginning clinical trials in HG patients with their GDF15-blocking drug, NGM120. Fejzo will serve as an advisor to NGM Bio in the process.

3-a. Please describe what HG is, and why it is neglected. (10 points)

3-b. Why are the two factors underlying HG? (10 points) Drug development was based on one of the factors. Please explain how it works in your own words and contemplate on why the route based on the other factor was not taken. (10 points)

4. Please read the following article and answer the questions accordingly. (20 points)

It Turns Out We Were Born To Groove

The evolution of beat perception likely unfolded gradually among primates, reaching its pinnacle in humans

Henkjan Honing

In 2009, my research group in Amsterdam, in collaboration with colleagues at the HUN-REN Research Center in Hungary, found that newborns possess the ability to discern a regular pulse — the beat — in music. It's a skill that might seem trivial to most of us but that's fundamental to the creation and appreciation of music. The discovery sparked a profound curiosity in me, leading to an exploration of the biological underpinnings of our innate capacity for music, commonly referred to as "musicality."

In a nutshell, the experiment involved playing drum rhythms, occasionally omitting a beat, and observing the newborns' responses. Astonishingly, these tiny participants displayed an anticipation of the missing beat, as their brains exhibited a distinct spike, signaling a violation of their expectations when a note was omitted. This discovery not only unveiled the musical prowess of newborns but also helped lay the foundation for a burgeoning field dedicated to studying the origins of musicality.

Yet, as with any discovery, skepticism emerged (as it should). Some colleagues challenged our interpretation of the results, suggesting alternate explanations rooted in the acoustic nature of the stimuli we employed. Others argued that the observed reactions were a result of statistical learning, questioning the validity of beat perception being a separate mechanism essential to our musical capacity. Infants actively engage in statistical learning as they acquire a new language, enabling them to grasp elements such as word order and common accent structures in their native language. Why would music perception be any different?

To address these challenges, in 2015, our group decided to revisit and overhaul our earlier beat perception study, expanding its scope, method and scale, and, once more, decided to include, next to newborns, adults (musicians and non-musicians) and macaque monkeys.

The results, published last month in *Cognition*, unequivocally confirm that beat perception is a distinct mechanism, separate from statistical learning. The study provides converging evidence on newborns' beat perception capabilities. In other words, the study was not simply a replication but utilized an alternative paradigm leading to the same conclusion, and, as such, it succeeded in dispelling any lingering doubts.

When we employed the same paradigm with macaque monkeys in 2018, we found no evidence for beat processing, only a sensitivity to the isochrony (i.e., regularity) of the rhythms. This suggests that the evolution of beat perception unfolded gradually among primates, reaching its pinnacle in humans and manifesting with limitations in other species like chimpanzees and various other nonhuman primates. It provides further empirical support for the Gradual Audiomotor Evolution (GAE) hypothesis I outlined in my 2019 book "The Evolving Animal Orchestra," a hypothesis that addresses the similarities and differences that are found in rhythm perception (and production) between human and nonhuman primates. It suggests the connection

between the motor and auditory brain areas to be stronger wired in humans as opposed to chimpanzees or gibbons, while mostly lacking in macaques.

What does this study say about the origins of music, and why does it matter? When we integrate the findings of the new study with our previous work, we now have converging evidence from two distinct paradigms indicating the functionality of beat processing in newborn infants. This adds weight to the argument for a biological foundation of beat perception itself. The study not only contributes to our understanding of the biological underpinnings of musicality but also underscores the intricate and multifaceted nature of our capacity to perceive and engage with rhythmic elements in the auditory environment. As such, music is not solely a cultural phenomenon but also possesses deep biological roots, apparently offering an evolutionary advantage to our species.

The exciting prospect of placing the study of the evolutionary origins of musicality at the forefront of international research is currently witnessing a surge in interest. Previously relegated to mere speculation, this field explores the biological processes that were set in motion millions of years ago, potentially shaping human nature over the last millennia. Despite the challenges posed by the fact that music doesn't fossilize, and our musical brain doesn't leave physical traces, a paradigm shift has taken place in recent decades, steering the field toward empirical inquiry.

Alongside psychology and neuroscience, the realms of biology and genomics now offer effective toolkits for empirically testing theories on the origins of music in the present day. Consequently, musicality research is gaining scientific respectability, coherence, and maturity. The once-speculative nature of the origins of musicality research is giving way to a more concrete and scientifically rigorous approach, making it an exciting and promising avenue for those delving into the mysteries of our musical evolution.

4-a. Please write a 200-word summary of the article. (10 points)

4-b. Please surmise on how the findings in this article could apply to language. (10 points)