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Emperor PENGUIN

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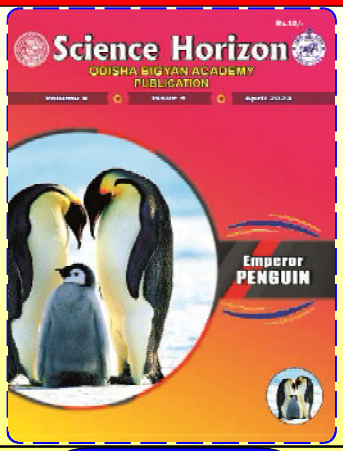

CONTENTS

	Subject	Author	Page
1.	Editorial : Lithium Discovery in India	◆ Er. Mayadhar Swain	146
2.	New Prefixes for Metric System of Units	◆ Dr. Bijay Kumar Parida	148
3.	Beach Erosion Threat in Odisha's Ganjam Coast	◆ Dr. Sundara Narayana Patro	155
4.	Fatherhood in Animal Kingdom	◆ Prof. B.C. Guru	160
5.	Give Earth a Chance!	◆ Dr. Bijay Ketan Patnaik	165
6.	Animal Chimera	◆ Prof. Prafulla Ku. Mohanty	170
7.	Need of Wildlife Census	◆ Sri Prakash Chandra Mishra	174
8.	Energy Engineering	◆ Dr. Nikhilananda Panigrahy	177
9.	Model Organisms in Bioscience Research	◆ Dr. Taranisen Panda Dr. Raj Ballav Mohanty	180
10.	Laws of Motion (Continued...)	◆ Dr. Chhatrapati Parida	185
11.	Recent News on Science & Technology		192

Cover Design : ***Kalakar Sahoo***

Editorial

LITHIUM DISCOVERY IN INDIA

1

Recently estimated deposit of 5.9 million tonnes of lithium has been discovered in the Salal-Haimana area of Reasi District of Jammu & Kashmir. It is also considered as one of the largest deposits of lithium in the world. The discovery is a significant achievement due to the reason that previously no deposit of lithium has been found in the country and its enormous use in battery manufacturing.

Chemically lithium is the lightest metal with atomic number 3 and atomic weight 6.941. The soft, white and lustrous metal has density of 0.534 g/cm^3. It is highly reactive and flammable. It remains in Group 1 of the Periodic Table of chemical elements along with other alkali metals. While other alkali metals were discovered from plant material, lithium was discovered from a mineral. It was discovered by Swedish chemist Johan August Arfwedson in 1817 from the mineral petalite. The name lithium is derived from the Greek word 'lithos' meaning stone.

The largest source of lithium is from mineral deposits such as spodumene, petalite and lepidolite. Extraction of lithium is very complex. It involves crushing the ore and then removing the impurities by various techniques such as froth flotation, magnetic separation and gravity separation. Another source of lithium is brine lakes from where it is extracted through evaporation and solar concentration. The major commercial form is lithium carbonate, produced from ores or brines by a number of processes. Addition of hydrochloric acid produces lithium chloride and this is the compound from which lithium is produced by electrolysis.

Lithium has many uses. Its main industrial applications is in metallurgy, where it is used to remove impurities in the refining of iron, nickel, copper and zinc and their alloys. It is used in production of special glass and ceramics, as it helps to reduce the melting point of these materials. This makes it possible to produce glass that is lighter and stronger, as well as ceramics that are more heat-resistant. It is used in aerospace and military industries for its high heat transfer and thermal conductivity properties. It is also used in space vehicles to cool the components. It is used as an ingredient in high temperature lubricating greases, due to

its ability to withstand high temperatures and provide long-lasting lubrication. It is used as a mood stabilizer in the treatment of disorder, depression and other mental health conditions.

Lithium has become important due to its use in manufacturing of batteries. It is a crucial component in the rechargeable lithium-ion batteries which are used in mobile phones, laptops, cameras and electronic vehicles among other devices. This battery is preferred over other types of batteries due to its lightweight, high energy density and low self-discharge rate.

The demand for lithium is increasing day by day, but it is available only in a few countries. The major deposits of lithium lie in Chile, Australia, China, Canada, Brazil, Bolivia and USA. The total lithium in the world is estimated to be 11,000,000 metric tons.

China is the leading supplier of lithium and lithium-ion batteries in the world market. Although it holds around 7.9 percent of the world's lithium reserve, it has 60 percent of the world's capacity for processing and refining lithium. It imports the ore and extracts the metal from it and supplies to different countries.

As per Paris Agreement and subsequent climate conferences, the nations have committed to reduce greenhouse gas emissions by 2030 and as the motor vehicles using fossil fuels are important sources of carbon emission, electric vehicles have gained momentum. Almost all countries are implementing schemes for electric vehicles.

India has committed to reduce greenhouse gas emissions by 30% by 2030 and to achieve zero net-carbon emission by 2070. Hence, it has planned for replacing the petroleum driven vehicles by electric vehicles by 2030. The main hurdle is battery as India is importing the battery as well as lithium for manufacturing battery in the country. In either case, we have to depend on other countries and cost is also being high. Now the discovery of large amount of lithium reserve in the country has given us the hope for our targeted progress of electric vehicles.

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Er. Mayadhar Swain
Editor

NEW PREFIXES FOR METRIC SYSTEM OF UNITS

2

Dr. Bijay Kumar Parida

Prefixes

We know that a prefix is usually a group of letters or a word put before another word to modify the latter. For example, a term familiar to students, such as "promotion" which means "moving ahead successfully", has a prefix 'pro-' added to the word 'motion'. This is an example of a qualitative prefix. There is a family of prefixes which are quantitative in nature or are linked with numbers. These are mostly used in association with metric units. For instance, when we say the distance between Bhubaneswar and Delhi is 1700 kilometers, we have used the prefix 'kilo' with the SI unit of distance 'meter'. The prefix kilo modifies the word 'meter' to make the word 'kilometer', where of course, kilo means the number one thousand (1,000 or 10^3). Kilo is just one of the several prefixes in use internationally. They are denoted by unique symbols and have specific names. For instance, k is the symbol for the prefix kilo and 'thousand' is its name. Whereas prefixes are normally affixed to units as per requirements, their names can be used to indicate numbers only. For example, the current population of India is about 1.39 billion, billion (10^9) being the name of the prefix giga (G). Note that the prefix giga is not used directly in such cases, i.e., we do not state that the population is 1.39 giga.

There is a family of metric prefixes, which has been expanded with four new members very recently, in November 2022. The family has 24 members now. The prefix-family has an interesting story like any other family. Here we shall take a look into this story after a quick glance at the metric system of units, with which these prefixes are normally associated.

The Metric System of Units

At school level the students are mostly introduced to the MKS system whose base units are metre (m), kilogram (kg), and second (s). Somewhat less common is the CGS system with base units centimeter (cm), gram (g), and second (s). The CGS system was formally introduced by the British Association for the Advancement of Science (BAAS) in 1874. Then, in 1889 the MKS system was formally approved by the world body called the General Conference on Weights and Measures (CGPM) for use internationally. This came as a consequence of the 1875 meeting of 17 nations at a conference called the Metre Convention. Interestingly, Britain, the profounder of the

CGS system, was not a participant at this convention. Initially both the MKS and CGS systems belonged to what is known as the 'metric system of units'. The term 'metric' is derived from the term 'meter' or 'metre', the unit of length. The International System of Units (SI) system was established in 1960 by the CGPM and has now become the gold standard of measurement worldwide. The SI system is an expanded form of the MKS system and is considered the modern version of the metric system. Hence, the terms SI and metric are sometimes used interchangeably.

However, the connection between the MKS and SI systems is worth keeping in mind. We know that the MKS system considers only three physical quantities namely length (m), mass (kg), and time (s). On the other hand, the SI system incorporates seven physical quantities such as length (m), mass (kg), time (s), electricity and magnetism (A or ampere for electric current, heat (K or kelvin for temperature), light (cd or candela for luminous intensity), and amount of substance (mol or mole) for the amount of substance. Thus, the SI system incorporates the MKS system and represents the metric system well. Therefore, the prefixes for metric system also apply to the SI units. The SI system has seen several revisions and upgradations over the years since its beginning in the era of the French Revolution (1789-1799), the latest coming with effect from 20 May 2019. Similarly, the prefix system has also seen a number of expansions, the latest happening in November 2022.

As an interesting point you may note the time unit s (second) remains the same in both the CGS and SI systems, 1 cm (centimetre) is equal to 10^{-2} m (metre) and 1 g (gram) is equal to 10^{-3} kg (kilogram). Thus, considering metre and gram as the names of the length and mass units respectively, the words "centi" and "kilo" become two of the metric or SI prefixes. We saw in the introduction above the role of the prefix kilo in the context of distance.

Significance of Prefixes

By adding prefixes to a SI unit, we may get multiples or submultiples of the unit. They are useful to denote bigger and smaller values of the corresponding physical quantities respectively, encountered in different fields of work. They cover the wide span between the microscopic world of particles constituting matter and the vast universe of which the earth and human beings are just a miniscule part. Actually, all the prefixes can be mathematically expressed as simple powers of 10, say $(10)^n$ where n is integer – positive for multiples and negative for submultiples. This way of denoting prefixes is easy for mathematicians and scientists. Then why give them names? Names are coined to express them in words instead of numbers, which may be easier to say or write down. For example, health experts say that an average adult needs 15 mcg (microgram or μg) of vitamin D daily. This amount is the same as 15×10^{-6} gram or 15×10^{-9} kilogram, both of which are lengthier and need careful presentation. The other equivalent form of mathematical representation such as 0.000015 gram or 0.000000015 kilogram is also cumbersome to write down and can hardly be

put in words. One has to worry about the appropriate number of zeros and the place of the decimal point. An additional inconvenience could be to whether leave a space or add a comma between groups of zeros in the decimal representation as followed in different conventions. In perhaps the easiest form the term microgram has the prefix 'micro' preceding the mass unit gram.

A History of the Prefixes

The practice of adding prefixes to units of measurement is quite old. Depending on necessity we have kept on coining more and more prefixes over time. A quick look at the prefix history is as follows.

- In 1795 the first eight SI prefixes were adopted. They were deca (da), hecto (h), kilo (k), and myria as multiples and deci (d), centi (c), milli (m), and myrio as submultiples. The number of multiples was balanced by the number of submultiples (four each). They were written as lowercase symbols. These prefixes were approved by the first CGPM in 1889.
- In 1960 the prefixes myria and myrio were removed and 3 more multiples (mega (M), giga (G), tera (T)) and 3 more submultiples (micro (ì), nano (n), pico (p)) were introduced, increasing the number of prefixes to 12.
- In 1964 two more submultiples (femto (f) and atto (a)) came in. This caused an imbalance between the numbers of submultiples and multiples even though the prefix number rose to 14.
- The multiple-submultiple balance was restored in 1975 by adding two multiple prefixes (peta (P) and exa (E)) thereby taking the total number prefixes to 16.
- In 1991 two more multiple prefixes (zetta (Z) and yotta (Y)) along with two more submultiple prefixes (zepto (z) and yocto (y)) were introduced so that the number of prefixes rose to 20.
- After a gap of 31 years the latest update came in November 2022, in which two more multiple prefixes (ronna (R) and quetta (Q)) and two more submultiple prefixes (ronto (r) and quecto (q)) were introduced thereby swelling the total number of SI prefixes to 24. The list is balanced between 12multiples and 12 submultiples.

The Latest Prefixes

In Table 1 we present the latest list of the 24 SI prefixes, along with the years of their introduction, symbols, equivalent mathematical factors, names, and the linguistic origins. The number 1 (one) or 10^0 has been placed midway between the multiples and submultiples just as a sort of passage between these two categories just as zero (0) separates the negative integers from positive integers.

Need For the Expansion

Needless to say, newer prefixes have become necessary from time to time in order to accommodate increasingly bigger and smaller numbers that appear thanks to continuous development in science and technology. These developments have enabled

Table- 1

Prefix	Year	Symbol	Factor	Name	Origin
quetta	2022	Q	10^{30}	nonillion	Latin: “ten” – $(10^3)^{10}$
ronna	2022	R	10^{27}	octillion	Greek: “nine” – $(10^3)^9$
yotta	1991	Y	10^{24}	septillion	Latin: “eight” – $(10^3)^8$
zetta	1991	Z	10^{21}	sextillion	Latin: “seven” – $(10^3)^7$
exa	1975	E	10^{18}	quintillion	Greek: “six” – $(10^3)^6$
peta	1975	P	10^{15}	quadrillion	Greek: “five” – $(10^3)^5$
tera	1960	T	10^{12}	trillion	Greek: “monster”
giga	1960	G	10^9	billion	Greek: “giant”
mega	1960	M	10^6	million	Greek: “big”
kilo	1795	k	10^3	thousand	Greek: “thousand”
hecto	1795	h	10^2	hundred	Greek: “hundred”
deca	1795	da	10^1	ten	Greek: “ten”
			10^0	one, unity	
deci	1795	d	10^{-1}	tenth	Latin: “tenth”
centi	1795	c	10^{-2}	hundredth	Latin: “hundredth”
milli	1795	m	10^{-3}	thousandth	Latin: “thousandth”
micro	1960	ì	10^{-6}	millionth	Greek: “small”
nano	1960	n	10^{-9}	billionth	Greek: “dwarf”
pico	1960	p	10^{-12}	trillionth	Spanish: “tiny bit”
femto	1964	f	10^{-15}	quadrillionth	Dano-Norwegian: “fifteen”
atto	1964	a	10^{-18}	quintillionth	Dano-Norwegian: “eighteen”
zepto	1991	z	10^{-21}	sextillionth	Latin: “seven” – $(10^3)^{-7}$
yocto	1991	y	10^{-24}	septillionth	Latin: “eight” – $(10^3)^{-8}$
ronto	2022	r	10^{-27}	octillionth	Greek: “nine” – $(10^3)^{-9}$
quecto	2022	q	10^{-30}	nonillionth	Latin: “ten” – $(10^3)^{-10}$

us to explore the microscopic world at lower and lower length scales on the one hand and the universe at increasingly higher length scales on the other. Without going back in time to seek out all the reasons for the expansions, let us simply look at the reasons the CGPM offered for introducing the latest update of the prefixes in 2022. They give two reasons as

follows.

(i) To accommodate the vast amount of digital information that is generated in data science.This has a tendency to grow exponentially and may soon go past yottabytes (10^{24} bytes), the largest multiple till 2022. To give an indication, on the global scale the accumulated data seems to have reached nearly 64 zettabytes (10^{21} bytes) in 2020 and is likely to reach 175 zettabytes by 2025.

(ii) The CGPM further apprehends that some other persons may whimsically introduce new prefixes without official approval, which may result in chaos. In fact, nonofficial and illogical prefixes like 'hella' (H) [perhaps from the phrase "hell of a big number"], and 'bronto' (B) [perhaps from the name of a big dinosaur called brontosaurus], were starting to be used in literature to indicate the factor 10^{27}. This has been pointed out by Richard Brown, a UK metrologist, who painstakingly coined the latest four names (ronna, quetta, ronto, and quecto) and spearheaded the move to introduce these prefixes through the 27th meeting of CGPM in November 2022. The new pair of submultiples are introduced to balance the number of multiples and make the system consistent though we

Things to Note

Several things may be noted from Table -1.

(a) The multiples and submultiples may be paired such that each is the inverse of the other and their product is 1 or 10^0, the middle member. Their names (like 'thousand' and 'thousandth') also corroborate this.

(b) The SI prefixes for submultiples are all denoted by lowercase symbols and those for multiples are denoted by uppercase symbols with the exception of kilo (k), hecto (h), and deca (deka in American English) (da).

(c) Compound prefixes are not permissible. Hence, as the SI base unit of mass "kilogram" contains the name "kilo" (the SI prefix for 10^3), multiples and submultiples of the unit of mass are made by attaching SI prefix symbols to g (gram) instead of kg (kilogram). Thus, one milligram is written as 1 mg and not as 1 μkg (1 microkilogram).

(d) It may further be noted that all the prefixes except for hecto, deca, deci, and centi follow the pattern of being multiples of 1000, i.e., of the form $(10^3)^n$ where n is an integer, positive or negative. Therefore, the above four prefixes are not used much.

(e) It may be observed that prefixes above kilo all end in the letter 'a' and those below milli all end in the letter 'o' as a sort of convention followed in coining the names.

(f) Though the prefixes may appear to be uncommon and arbitrary, their origins can be traced to some languages as noted in the table.

The Prefix Languages

A look at Table 1 shows that out of the 24 SI prefixes only one (pico) has a Spanish origin, two (femto and atto) are Dano-Norwegian in origin, nine are derived from Latin, and the rest twelve are from Greek. Historically, Latin was the classical language of the Roman Empire era from the 7th century BC to 18th century AD. The Latin or Roman alphabet is used to write English and other modern European languages. Greek is an Indo-European language in practice in Greece and some other European countries in different dialectical forms for over 3000 years. Dano-Norwegian is a mixed version of the Danish and Norwegian languages. It was the dominant language in the era 1536-1814 when Denmark and Norway were merged into one kingdom. Spanish of course is the language of Spain and several other countries.

may not feel the necessity of such small numbers in near future.

Some Practical Examples

Let us consider a few examples in which the latest prefixes are used to denote some familiar quantities in a way of justifying the prefixes.

Mass of electron $\approx 1 \times 10^{-27}$ g or, 1 rontogram or, 1 rg

Mass of Earth $\approx 6 \times 10^{27}$ g or, 6 ronnagrams or, 6 Rg

Mass of Jupiter $\approx 2 \times 10^{30}$ g or, 2 quettagrams or, 2 Qg

Mass of Sun $\approx 2 \times 10^{33}$ g or, 2000 quettagrams or, 2000 Qg

Diameter of the observable universe $\approx 10^{27}$ m or, 1 ronnameter or, 1 Rm

There are some speculated or hypothetical quantities which appear to need prefixes bigger than the biggest and smaller than the smallest currently available. They include the following:

Mass of the universe $\approx 10^{56}$ g

Planck length $\approx 2 \times 10^{-35}$ m

Planck time $\approx 5 \times 10^{-44}$ s

Mass value of the universe as above is a calculated result based on astrophysical reasonings. Planck length and Planck time are hypothetical values of what are called 'Planck units' deduced from the five fundamental constants of nature namely the universal gravitational constant (G), Boltzmann constant (k), speed of light in vacuum (c), Coulomb constant ($1/4\pi\varepsilon_0$) and the reduced Planck constant or h-bar or Dirac constant ($\hbar$), defined as $h/2\pi$ where h is Planck constant. *The Planck length and time are not likely to be reached through experiments in the near future. Therefore, it may be enough to be content with the largest and the smallest prefixes, quetta (10^{30}) and quecto (10^{-30}).*

Symbol Convention

Note that as per convention the symbols of the fundamental constants are to be printed in *italic* type whereas the unit symbols are to

be printed in roman ('upright') type. In handwriting such a distinction is of course difficult to maintain.

Summing up

From our discussion it is clear that prefixes have their own utility and history although they are not as important as the units they are often attached to. Though some of the prefixes have become common over time, the unfamiliar sounding newest ones hopefully will become familiar in time in their respective domains, if not in everyday life. Interestingly, some scientists do not seem to like the new crops of unfamiliar prefixes and are in hurry to give up the ones they are familiar with. For instance, radio astronomers are habituated to using a non-SI unit of spectral flux density or spectral irradiance called the jansky (Jy) which is equivalent to 10^{-26} watts per square metre per hertz and is named after the physicist K. G. Jansky, the discoverer of celestial radio waves. They may not like to switch over to the new SI prefix ronto (r) indicative of the small quantity 10^{-27}, just an order of magnitude less than the jansky. However, there may be others including science communicators and science fiction writers who may happily use such bizarre prefixes to convey their ideas.

It is only natural to wonder what new prefixes may have to be brought in after the presently defined upper and lower limits are crossed. Experts are of the opinion that the latest list of the SI (metric) prefixes is good enough to serve the current and immediate future needs of measurements and are not likely to need updating in the near future. Does this indicate that we are probably approaching the limits of human capabilities of measurement and data storage? Only time will tell!

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BEACH EROSION THREAT IN ODISHA'S GANJAM COAST

3

Dr. Sundara Narayana Patro

Introduction

Out of the total length of 480 km of the Odisha's coastline, 60-km is covered in the Ganjam district. As many as 28 villages are located along the coast in the district with at least eight villages facing the threat due to rapid beach erosion from the Bay of Bengal. Out of these, three are Podampeta, Gokhorokuda and Purunabandha in Ganjam Block, one is Aryapalli in Chatrapur Block, while the other four are Patisunapur, Anantaraipur, Rameyapatana and Katuru in Chikiti Block. All these are mostly fishermen villages. Podampeta is in the northern end at the Rushikulya mouth and Ramayapatna is in the southern end at Bahuda river mouth, close to Srikakulaum district of Andhra Pradesh. The beach was full of Casuarina, Cashew nut, Coconut and Kewda plants which have almost vanished because of rampant deforestation, cyclonic storms and sea ingression. Earlier there was also mangrove vegetation along the coast. The coast has been hit repeatedly by super-cyclone in 1999, phailin or super typhoon in 2013, hudhud in 2014, titli in 2018, fani in 2019, gulab in 2021 and recently by asani in May 2022. The process of erosion and sedimentation, periodic floods and cyclones and sea level changes continuously modify the shoreline.

Coastal Villagers Woe

Podampeta village with about 500 families is under Palibandha Panchayat near Rushikulya mouth. The villagers have been living in the dread of losing their land and livelihood as high tidal waves are fast creeping

Podampeta Village at Rushikulya River Mouth (Left) :: Ramayapatna Village near Bahuda RiverMouth (Right)

in towards the village eating the coast away.The sea surface always remains rough. Villagers on the coast are shifted to safer new locations at a distant place away from the sea. Even the Arjyapalli Marine Police Station and the Chhatrapur Police Station are likely to be shifted to new locations, because of the threat from the sea erosion.

The sea was far away from Podampeta. In 2010, the sea almost became close to the village, and now it is only a few metres away. It was observed that near Podampeta in 2005, the distance from shoreline to the road was 211 m whereas in 2009 it was 130 m and further decreased to 91 m in 2016. The study indicates that coast line is sifted 120 m towards landside during last 44 years. There have been several incidents of houses being washed away by the sea in recent years. The houses are crumbling like a pack of cards due to high tidal waves that are striking the village. In 2018 five families were put to sufferings after tidal waves washed away their houses. At least six houses were washed away by high tides recently on 30.07.2022 night. After the day's incident, many villagers fear that their localities will be submerged under the sea in the coming years.

Similarly, Rameyapatna, down south about 45 km away from Podampeta, which was about one km away from the coastline a few years ago is now shrunk to a few meters away due to rapid sea erosion. It was observed that near Ramayapatnam in 2005, the distance from shoreline from road was 163 m whereas in 2009 it decreased to 125 m and further decreased to 78 m in 2016. The study indicates that coast line is shifted 85 m towards landside during last 44 years. According to a news report, till September 2019, 27 families have been worst hit, and there is possibility of more houses being completely washed away if tidal waves hit the village further. In mid August 2022, 5 houses were collapsed, and 15 more houses are on the verge of collapse as high tidal waves lashed the village.

As the marauding sea was surging past the coastline the district administration has shifted villagers of Podampeta, mostly fishermen, to new location at a safer distance named as New Podampeta. Under the World Bank-aided Odisha Disaster Recovery Project (ODRP) cyclone-resilient houses have been provided to the villagers in two new sites named Podampeta ODRP-I and Podampeta ODRP-II. Under the said ODRP programme, villagers of Ramayapatna got houses at Chandbada Chowk, about one and half km away from their village. This fishermen village also has about 500 families. Some of them did not like to shift to the new colony and stayed back in their respective villages. They prefer to stay close to the sea shore for convenience of fishing activities. Pradhan Mantri Awas is another scheme that provides opportunity of providing houses to them. However, the rehabilitation scheme of the government is very much praise-worthy and timely intervention to rescue the affected villagers.

Among the measures, the State Government in Irrigation Department and also under the Integrated Coastal Zone Management Project (ICZMP) has come up with plans to

build boundary walls or dump stones to protect the coastal villages from high tides. Diversion of Bahuda river mouth is another reason of entry of water into the Ramayapatna village. Villagers of Surala and Patisunapur had diverted the river mouth of around one km from its original location for fish farming. The villagers of Ramayapatna have started digging and clearing the Bahuda river mouth, by hiring excavators.The Bahuda river mouth has shifted nearly 2 km towards north (near Katuru), while the Rushikulya River mouth (near Gokharkuda) has shifted nearly 1.5 km towards south (Palibandha), according to a study by the Department of Geography, Utkal University.

Purunabandha villagers blame that their village has become prone to erosion due to the construction of wave breakers of Gopalpur port a few years ago. However, port authorities claim that the construction of wave breakers has nothing to do with the erosion and a technical team which visited the area also stated the same in their report. Katuru panchayat villagers who are facing erosion threat are demanding a proper geomorphologic study of the sea erosion phenomenon, and to construct guard wall to protect the beach from erosion. But shoreline hardening or armouring (e.g., seawalls) can result in the complete loss of dry sand suitable for successful turtle nesting. A study conducted by the Department of Marine Sciences; Berhampur University indicates that geo-synthetic tubes laid down along the coast at Pentha (near Bhitarkanika in Kendrapada district) has not proved to be of complete success to mitigate coastal erosion. Ethically development of green belt with salt tolerant and cyclone resistant vegetation is best suited to protect the coast from erosion, in preference over engineering structures as long-term measure. The other plausible green solutions are beach nourishment (a process by which sediment lost through longshore drift or erosion is replaced from sources outside of the eroding beach), dune stabilisation, dune rehabilitation, dune fencing, dune thatching, dune grass planting, suitable coastal retreat, timber resentments, coastal wetland restoration, etc.

Olive Ridley Nesting Site in Peril

The beach at Rushikulya river mouth is the next preferable site for mass nesting of the Olive Ridley Sea turtles, after the Gahirmatha beach near Bhitarkanika estuary (Brahmani-Baitarani-Dhamra River mouths). Sporadic nesting is being observed near Bahuda river mouth also. The olive ridley gets its name from the olive-green colour of its heart-shaped shell. In 1993, the Odisha Forest Department and the Wildlife Institute of India discovered that large scale nesting of olive ridley sea turtles was taking place near the mouth of the Rushikulya river, recognised as one of the largest mass nesting (*arribada*-meaning arrival by sea) sites in India. The villages near the Rushikuya mouth are Podampeta, Gokharakuda, Palibandha, Purunabandha, and Kantiapada, where one can find the nesting sites. Except in 2006-07, 2015-16, 2018-19, regular mass nesting has been recorded here from 2003-04. A record number of over 4.92 lakh turtles have been

nested this year in last week of March 2022. In the previous years, the number was 3.23 lakh in 2019-20, 4.28 lakh in 2017-18, 3.70 lakh in 2016-17, 3.09 lakh in 2014-15, 0.59 lakh in 2013-14, 2.86 lakh in 2012-13, 1.01 lakh in 2011-12, 2.53 lakh in 2010-11, 1.56 lakh in 2009-10, 2.61 lakh in 2008-09, 1.80 lakh in 2007-08, 1.98 lakh in 2005-06, 0.89 lakh in 2004-05, 2.01 lakh in 2003-04.

The mating season of the turtles is between October to January and extends up to February some times. The mass nesting usually takes place from late December to April. The sea erosion usually takes place during July and August, and again the process of deposition starts from September and width of the coastline gets restored by December when olive ridleys visit the beach for nesting. Since 2007, the rate of deposition by the sea has decreased and the six-km stretch of beach is now reduced to around two km.

Nesting of Olive RidleyTurtles at Rushikulya in Odisha

The species is among the smallest of the world's sea turtles and listed under the Endangered Species. These turtles are found worldwide but primarily distributed in the tropical regions of the Pacific, Indian, and Atlantic oceans. In India three prominent arribada beaches occur in Odisha, namely Gahirmatha, Devi River mouth (a distributary of Mahanadi), and Rushikulya mouth). Two other sites in India are- one in Versova beach (Maharashtra) and the other in Marina beach of Chennai. More recently, a new mass nesting site was discovered in the Andaman Islands.

The olive ridley is omnivorous, meaning it feeds on a wide variety of food items, including algae, lobster, crabs, tunicates, and molluscs. They can dive to depths of 500 feet to forage on benthic invertebrates (those that live on the bottom).

A primary threat to sea turtles is their unintended capture (bycatch) in fishing gear. The primary types of gear that result in olive ridley by catch include trawls, longlines, gillnets, and purse seines. The other threats include collection of eggs for human consumption and mass killing of adult females on nesting beaches. Artificial lighting on and near nesting beaches can deter nesting females from coming ashore to nest and can disorient hatchlings trying to find the sea after emerging from their nests. The wild dogs, hyenas and

jackals are its predators.

Increasing pollution of nearshore and offshore marine habitats threaten sea turtles and degrades their habitats. A warming climate is likely to result in changes in beach morphology and higher sand temperatures, which can be lethal to their eggs or alter the ratio of male and female hatchlings produced. Changes in the temperature of the marine environment may very likely alter the abundance and distribution of food resources, leading to a shift in the migratory and foraging range and nesting season of olive ridleys. Rising seas and storm events cause beach erosion, which may flood nests or wash them away.

Happily, the local community including fishermen are conscious of the tranquil needed for the nesting of the turtles. Being very much aware of it they initiated cleaning of about 4 km-long beaches from Gokharkuda to Podampeta, making it free from debris, the famous mass nesting site for the endangered sea turtle. They involved local officials, activists, and hundreds of the students of nearby schools. The Forest Department has also taken steps to clean the beach and construct fences in Bateswar and Siddhantanagar, for safe turtle nesting.

Conclusion

Coastal areas are of enormous socio-economic importance, because of marine fish and other resources, coastal biodiversity, tourist potential, commercial and residential development, and of late the sources of wave energy, off-shore mining, port development activities, etc. But the areas are vulnerable to cyclone and other natural hazards, global warming and sea-level rise, beach pollution and various anthropogenic activities not compatible to protection of coastal ecosystem. International coordination and local community participation will go a longway in strengthening the government efforts towards beach protection, coastal biodiversity and sea turtle conservation.

Acknowledgement

The author acknowledges the help and cooperation extended by Dr. G.K. Panda, Emeritus Professor of Geography; Dr. P.K. Mohanty, Prof. of Marine Sciences; Mr. Tusar Kanta Sitha, Superintending Surveyor and Fisherman Raja Rao of Podampeta.

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.....To be Continued at Page No.-179

FATHERHOOD IN ANIMAL KINGDOM

4

Prof. B.C. Guru

The only person who loves us unconditionally even before we were born is our "Mother". The role of a father is often overlooked. But fathers, like mothers, are also pillars in the overall development of a child. Fathers provide a feeling of security, both physical and emotional to the children. Neither parent is more important, nor are both indispensable for a child's inner growth and strength through all stages of life.

It is not just in humans that fathers show such a wide degree of parenting styles, this is also true for the animal kingdom. In case of many animals fathers just do not deposit their sperm and leave the rest up to the females. Many birds and mammals do a lot of sacrifice and take care of the infants more than the mothers. Some incredible examples are described below:

Seahorses

A seahorse is a small marine fish in the genus Hippocampus which has unusual equine shape. Unlike most other fish, they are monogamous and mate for life. Rarer still, they are among the only animal species on Earth in which the male bears the unborn young. The female seahorse inserts her oviduct (about 50-1500 eggs) into the male's specially adapted brood pouch located on his abdomen. When the eggs are in place, the male fertilizes them and clings to a nearby plant and waits a few weeks for the eggs to mature. This offspring-carrying period ends with the male experiencing a series of contractions and expelling the newborns into the water.

Marmosets

Marmoset is a small tropical American monkey with a silky coat and a long tail, similar in appearance to squirrels that move in a quick jerky manner. The female of these little primates usually gives birth to twins. The suffering of pregnancy on the female is a

Marmosets

rough one, as the newborns can account for over 25 per cent of her body weight. Mother marmoset provides milk to the newborn, but almost immediately after birth, the father grooms and licks the newborn to give the female time to recuperate. This is extremely important, as female marmoset can become pregnant again only two weeks later.

Rheas

Ostriches

Ostriches are large flightless birds of Africa who lay the largest eggs. After a female lays her eggs, the parents take turn incubating them, the female during the day, and the male at night. Zoologists believe that the male gets the night shift because, with his darker coloring, he will be less visible to predators and therefore be able to protect the nest better than the female.Once the eggs hatch however, the male's job has only just begun. He will eagerly defend the hatchlings from predators, as well as teach them how to feed.

Rheas

Rhea is a large flightless bird of South American grasslands, resembling a small ostrich with grayish-brown plumage. Rhea eggs measure about 130 mm × 90 mm and weigh 600 g on average, they are thus less than half the size of an ostrich egg. These birds are superb fathers who do not need any help from the mother. In fact, the sole male in the family group of up to a dozen females will be the sole incubator of the over 50 eggs for up to 40 days. The male rhea will then chase anything, including females, away from the hatched chicks and raise them completely on his own.

Hornbills

Hornbills are birds found in tropical and subtropical Africa and Asia . They are characterized by a long, down-curved brightly colored bill The mother hornbill stays inside the tree, often molting her feathers to provide a soft nest. Hornbills will find a cavity or hole in a tree to make their home. The large hole is closed up with mud leaving only enough space to fit her beak. The

Hornbill

father hornbill then brings food to her and the chicks once they have hatched.

Red Foxes

The red fox is the largest of all foxes and one of the most widely distributed carnivorous animal. Red foxes reproduce once a year. When baby foxes are born they are blind for 12-14 days. During this time the mother stays by their side and keeps them warm. Male red foxes are very caring. For the first month after the birth of the pups, the male will provide food for the mother and young every four to six hours and will also frequently play with the pups. However, when fox pups are about three months old, father provides them with the means and skills to survive in the wild. The male fox begins to bury food close to the den and covers it with leaves and twigs to teach the pups to sniff out food and forage for themselves.

Red Fox

Emperor Penguins

The emperor penguin is the tallest and heaviest of all living penguin species and is endemic to Antarctica. Emperors are uniquely adapted to survive harsh conditions like -50°C temperature .They have two layers of feathers, a good reserve of fat and proportionally smaller beaks and flippers than other penguins to prevent heat loss. Female emperor penguins lay one egg at a time because it would require too much energy to produce more than one. At this point, most bird species set up a nest and sit on it for hours at a time, often with the male and female taking turns to incubate the developing embryo. But emperor penguins do not have a nest, they lay their egg on the cold Antarctic permafrost. After laying her egg, the female is exhausted and needs to feed. So, she carefully transfers the egg to the feet of her mate. This must be done with the finest precision, because if the egg slips onto the freezing ice or snow beneath them for too long, the unborn chick very likely would not survive. The female then walks off to the ocean to fill her belly,

Emperor Penguins

leaving the father with all the parental responsibility. The diligent father incubates his egg in his brooding pouch for the next 65 days, during which he does not eat. When the egg hatches, his job is to keep the near-featherless little chick warm since it cannot yet regulate its own body temperature. Therefore, in order to keep the newborn chick warm, all the fathers group together and form a giant phalanx of fathers like a rectangular mass military formation, and newborn chicks to try and conserve as much heat as possible. Eventually, the mother emperor penguin returns from sea, full of food and energy to devote to her newborn chick. She takes over from the father.

Gorillas

Gorillas are ground - dwelling, predominantly herbivorous great apes that inhabit the tropical forests of central Sub-Saharan Africa. Gorillas have broad chests and shoulders, large, human-like hands, and small eyes set into hairless faces. A typical gorilla father is in charge of a clan as large as 30 gorillas. He is responsible for finding food for his group, which is a big job seeing as gorillas typically eat up to 50 pounds of food per day! He is quite respectful of the mother of his children, always dining with her first before letting the kids join in on the meal. A gorilla dad is also very attentive, fending off threats by fiercely beating his chest and charging enemies. He often has to fight off other male gorillas that are known to kill baby gorillas when trying to take over the group. He spends a good deal of time with their young until they become teenagers, playing lovingly with his offspring and settling any arguments that arise between siblings

Flamingos

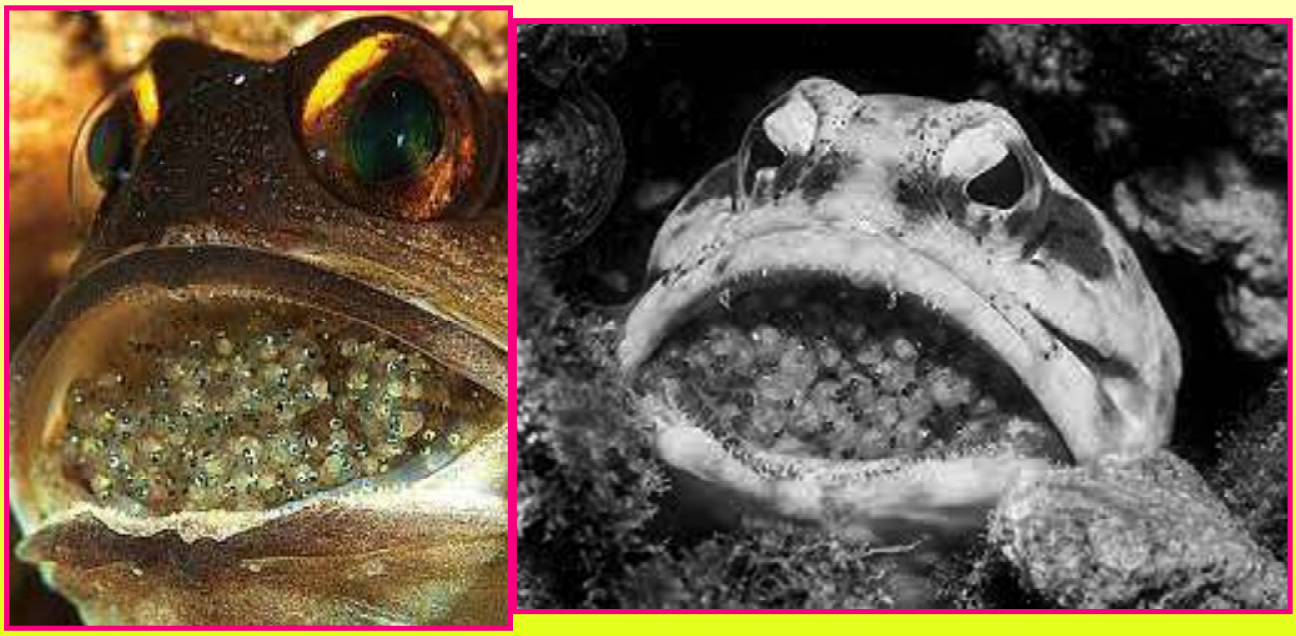
Greater flamingos are tall, pink bird with a long, lean, curved necks and black-tipped bills with a distinctive downward bend. Their bent bills allow them to feed on small organisms—plankton, tiny fish, fly, larvae, and the like. Flamingos have a famous habit of standing on one leg. Flamingo fathers defend their chick and nest from predators .They help feed the chicks with their crop milk, a fluid produced in their digestive systems. Both flamingo parents produce crop milk, which is not like mammal milk.

Flamingo

Jaw Fish

A male jaw fish attracts females to his burrow to lay her eggs so that he can brood them. The male will then quickly fertilize the eggs, which he then scoops up and holds in his mouth. During this time he does not eat, and his activities are restricted to juggling the eggs in his mouth to aerate them and remove waste and fouled eggs to keep them healthy. To accomplish this, he periodically spits all the eggs out and then quickly sucks them back in. A male can have up to 400 eggs in his mouth at one time. This is termed mouth brooding.

Interestingly, numerous animals provide parental care to their offspring, from fish and birds to non-human primates and humans. Care by fathers can have important consequences for survival and development of offspring in both humans and other species. Mechanisms underlying such effects may include protecting offspring from predators or environmental extremes (e.g., heat or cold), feeding them or, in some species, teaching skills.



Jawfish brooding eggs in mouth

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GIVE EARTH A CHANCE!

5

Dr. Bijay Ketan Patnaik

The 1972 United Nation's Conference on Environment was the first World Conference to make the Environment a major issue. The Stockholm Declaration placed environmental issues at the forefront of international concerns. One of the major outcome of the Stockholm Conference was the creation of the United Nation's Environment Programme (UNEP). It was agreed to hold World Environment Day every year on 5th June all over the world to encourage awareness amongst the people for protection of Environment. Accordingly the 1st World Environment Day (WED) was observed in 1973 with the theme "Only One World". During 2002, the theme for WED as decided by UN was "Give Earth A Chance". That year marked the 10th anniversary of Rio Earth Summit.

Choked with environmental pollution, our planet is dying a slow death. The theme therefore issues summons to every one of us to contribute to the healing of our ailing planet and give the planet a chance to recuperate by overcoming continuous assault on Earth's resources through environmental hazards and setbacks. Few years back, the then Ministry of Environment and Forest released a poster, where Earth is painted as a football with the subscribing slogan "Stop Juggling" that is to stop juggling or playing with Earth's Environment". Again 20 years later in June 2022, the original WED theme of 1973 was repeated i.e., "Only One World". This signifies that even after 50 years of observance of WED, we have still with us Only One World. The World scientists have not been able to discover another Earth like structure in the Universe having compatible living conditions,

If we view from a spacecraft, our Earth looks like a tiny green bulb of a very very small foot ball size and it is unique in this part of our galaxy. This greenness of our planet is not an optical illusion, rather an indication of life on earth surface. The blueness is because three fourth is blue sea water and one third of the balance land area is covered with green forest. Our earth is the only planet in the Universe, so far, which is known to sustain life and the human being is on the apex of the living pyramid. But paradoxically, a few years back, an evolutionary biologist Elisabet Sahtouris had candidly said, " If we had viewed Earth from space for thousands of years, we would describe humans as a desert-making species". It has been known from vedic times

that Nature and Mankind form an inseparable part of this life support system. The system has five components ie. air, water, soil, flora (plant kingdom) and fauna (animal kingdom). These are very much inter-connected, inter-related and inter dependant. This life support system which is responsible for sustaining life on Earth is what we term as "Environment". All these 5 constituents of environment are now showing signs of strain from their use, reuse and overuse. For the first time in an unequivocal term scientists have held human activities responsible for most of the warmings of Earth's atmosphere over the last 50 years or more. If such activities go unabated, a doom is predicted for our near and dear Earth by the end of 21st century.

Sustainable Development

In the United Nation's conference on Environment and Development at the Earth Summit at Rio (Brazil) in 1992, a slogan for Sustainable Development was adopted which advocated the idea of development that meets the needs of the present without compromising the ability of the future generation to meet their own needs. After the Earth Summit, the Govt of India announced the Environment action program, so as to fulfil the commitment made at the summit. India is one of the few countries of the world having constitutional sanction for environmental protection. Article 21 of the Constitution which is included as fundamental right, guarantees right to Life. Everyone has the right to live in a world free from toxic pollution and environmental degradation.

Environmental conditions play a vital role in establishing the extent to which the citizens get an opportunity to exercise their rights to life, health, adequate food, housing, livelihood and cultural set up. One must recognise that those who pollute or destroy the environment are not just committing a crime against nature but against the mankind by violating the human rights.

With the constantly increasing pressure on natural resources of earth and with unrestricted, unscientific use of available resources, the Biodiversity of the world that has come about over billion years of evolution is now under threat and struggle to survive amidst rapid catastrophic climatic changes, natural selection and adjustment to every conceivable habitat that were made available by climatic factors. This evolution process however, began to be influenced by man over the last tens of thousands of years. His weapons and tools_ wild fires, clearances of natural vegetation, grazing of domestic animals and habitat destruction _ all shape the present Biodiversity. In the present juncture, biodiversity is not only threatened but also getting destroyed at an alarming rate of 140 plant and animal species every day in the world scenario. According to State of Wides Tree Report 2021 nearly 40% forest of the world has been wiped away during last 300 years. Similarly from 60000 species available at present, around 30% species have been lost. This annihilation process has gained momentum in last 50 years period. The effect of vanishing bio diversity is manifested in unexpected climate change because of global

warming. The consequent natural calamity and disaster have increased five-fold during this period. World Meteorological report 2021, released by United Nations say that calamities like flash flood, catastrophic flood and cyclone, supercyclone occurred 70 times between 1970 to 1979. In sharp contrast, the frequency of occurrence of such type of events increased to 3500 between 2009 to 2019 (10 years). The financial loss increased 10 to 12 times. Serious thought need to be given to check further unnecessary and unwarranted loss by judicious use of available natural resources and thereby giving a chance to our mother earth to survive, to recuperate and regain its lost vigour.

Earth Overshoot Day

The concept of Earth Overshoot Day was first conceived by Andrew Simms of UK think tank .This is just as a bank statement that tracks income against expenditure. Income is represented by the term Bio capacity ie, the amount of natural resources generated sustainably by the Earth that year and expenditure is represented by the term Ecological Footprint which reflects the amount of humanity's consumption of Earth's natural resources for that year. Global Footprint Network, since 2006, is calculating Earth Overshoot Day by dividing World Bio capacity with World Ecological Footprint and multiplying it with 365 ie; number of days in a year. This day marks the date in a calendar year, when humanity's demand for ecological resources and services in a given year exceeds what Earth can regenerate during that year. During 2022 Earth Overshoot Day fall on 28th July. This means within 209 days, the Humanity has exhausted Nature's budget for the whole year. So for the rest of the year, we are maintaining for the ecological deficit by drawing from local resource stocks and accumulating carbon dioxide in the atmosphere and it is described as over shooting. Going by this way we will require 1.7 Earth for our safe and sustainable existence with present average life style. But unfortunately we have so far only one Earth with us.

LIFE Mission

Indian Prime Minister launched the LiFE campaign, i.e.; Life Style for Environment at COP 26, Glasgow climate conference 2021. It calls upon the global leaders to join this movement of safe guarding nature by adopting an environment friendly life style. This puts both individual and collective duty on every one to live a life that is in tune with Earth and not harm it. Our Indian life style perfectly suits this concept, because if we follow Indian life style, there will be no over shoot day. Whereas, if we follow American life style, the humanity will require almost 5 earths to sustain. The global community was to decide, what they should do. Whether to simplify their life style for sustenance of this planet or to adopt American life style and accelerate the pace of annihilation. Broadly our agenda should be to give a human face to all impending environmental issues, empower people to become active as well as willing agents of sustainable development, promote an understanding that communities are pivotal to

change individual mind set and advocate partnership which will ensure all nations and the people to enjoy a safer and more prosperous future.

Let us deliberate and decide, whether to give our Earth a chance to recuperate and survive or perish!

Ex Chief Editor, Bigyan Diganta
Mob: 9437000904

OBITUARY

Padma Shri Dr Prafulla Kumar Jena

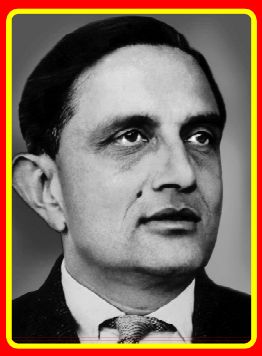
(27 December 1931 – 7 March 2023)

Eminent scientist Padma Shri Dr Prafulla Kumar Jena passed away at his residence in Bhubaneswar at the age of 92. Dr Jena was a genius scientist who encouraged, inspired scientific research, especially in metallurgy. He pioneered new waste management processes as well as metal value recovery processes from industrial and mining wastes. He was instrumental in popularising science among students and played a key role in establishment of several institutions of science and technology. He was an elected fellow of the Indian Academy of Sciences and the Institution of Engineers, India and a fellow of the Indian Institute of Metals. He was a life member and former president of the Indian Science Congress Association and a former member of the Planning Board of Odisha. He was President of Odisha Bigyan Academy from 25.10.1989 to 24.10.1991.

Azadi Ka Amrut Mahotsav

Scientists who Shaped Indian Science - 8

Vikram Sarabhai



Vikram.Sarabhai is considered as the Father of the Indian space program. He was a great institution builder and established or helped to establish a large number of institutions in diverse fields. He was born on August 12, 1919 in a family of industrialists. He attended Gujarat College, Ahmadabad, but later shifted to the University of Cambridge, England, where he took his Tripos in Natural Sciences in 1940. At the outbreak of the Second World War he returned to India and joined the Indian Institute of Science at Bangalore where he took up research in cosmic rays under the supervision of Sir C.V. Raman. He published his first research paper entitled "Time Distribution of Cosmic Rays" in the Proceedings of Indian Academy of Sciences. His work on cosmic rays during the period 1940-45 included the study of the time variations of cosmic rays with Geiger-Muller counters at Bangalore and at the high level station in the Kashmir Himalayas. After the war he returned to Cambridge to work for his PhD in cosmic ray physics. In 1947, he was awarded PhD by the Cambridge University for his thesis `Cosmic Ray Investigation in Tropical Latitudes'. After getting his PhD he returned to India and continued his research in cosmic ray physics. In India he studied interplanetary space, solar-terrestrial relationships and geomagnetism.

Sarabhai established the Indian National Committee for Space Research (INCOSPAR) in 1962 which was later renamed the Indian Space Research Organization (ISRO). He is credited for setting up the Thumba Equatorial Rocket Launching Station in Kerala. After the death of Homi Bhabha in 1966, Vikram Sarabhai was appointed as the Chairman of the Atomic Energy Commission of India. He also helped in developing indigenous nuclear technology for defense.

Vikram Sarabhai was very much interested in science education and founded the Community Science Centre at Ahmedabad in 1956. It is also called Vikram Sarabhai Community Science Centre (VASCSC). He also started a project for the fabrication and the launch of an Indian satellite.

Vikram Sarabhai died on December 30, 1971 at Kovalam, Kerala. He was awarded two of India's highest honours, the Padma Bhushan (1966) and the Padma Vibhushan (awarded posthumously in 1972). In 1974, the International Astronomical Union at Sydney has named a Moon Crater in the Sea of Serenity as the Sarabhai Crater.

- Editor

ANIMAL CHIMERA

6

Prof. Prafulla Kumar Mohanty

Concept from Mythology

In Greek mythology, chimera is a fire-breathing fabulous female monster, slain by Bellerophon with a lion's head, a goat's body, and a serpent's tail or a dragon's tail. This term is originated from old French *chimera* or directly from Mediaeval Latin *chimera*, from Latin *chimaera*_and from Greek *khimaira* which is a mythical creature. Only about 100 or so cases of chimerism have been recorded in modern medical literature. Chimera is composed of the parts of more than one animal (Fig.1).

What is Chimera?

A chimera is essentially a single organism that is made up of cells from two or more individuals, that is, it contains two sets of DNA , with the code to make to separate organisms.

It was one of the offsprings of Typhon (half lion and half goat) and *Echidna* (half human and half snake) and a sibling of monsters such as Cerberus and the Lernaean *Hydra*. In biology or zoology , a chimera is an individual composed of somatic and, in certain cases, germline tissues derived from more than one zygote. There are different ways to generate tissue chimerism, which includes mixing embryonic cells from two individuals, transplanting fetal or adult tissues from one individual in to another individual or grafting embryonic stem (ES) cell or their differentiated products into another individual.

Fig.1: Chimera

Modern chimeras are those which are genetically produced. In embryology, "chimera" refers to a combination of cells from different individuals (Fig. 2). In molecular genetics, "chimera" describes the combination of two DNA molecules from different individuals, or from different chromosomes of the same individual. "Chimera" may even refer to the grafting in a post implantation embryo of cells or tissues from another individual or species, such as the

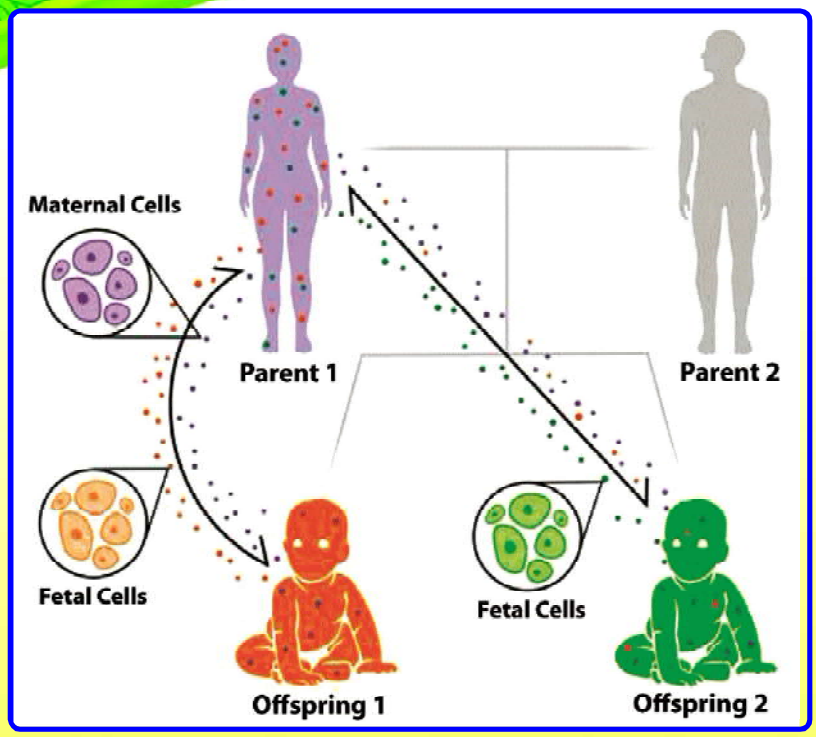


Fig.2: Fetal microchimerism

injection of hematopoietic stem cells intraperitoneally into a sheep's fetus to produce a chimeric sheep that expresses human myeloid and lymphoid lineages.

Types of Chimerism

Chimera is divided into two types namely (1) Natural and (2) Artificial (Fig.3). Natural is further grouped into five types such as (a) Microchimera (b) Tetragametic chimera (c) Parthogenetic chimera (d) Germline chimera and (e) Blood group chimera. Artificial chimera are classified into two types like (a) Intra- specific and (b) interspecific chimera.

1. Natural Microchimerism

The presence of a small number of cells, generally distinct from those of the host individual.

a. Tetragametic Chimera- It occurs through the fertilization of two ova by two sperms, followed by the fusion of the zygotes and the development of an organism with intermingled cell lines.

b. Parthenogenesis Chimera- This chimera generally arises from an oocyte undergoing parthenogenetic activation, giving rise to identical daughter cell which are then fertilized by two spermatozoa.

c. Germ line Chimera- Germ line chimerism is observed when the germ cells (sperm and egg cells) of an organism are not generally identical to its own.

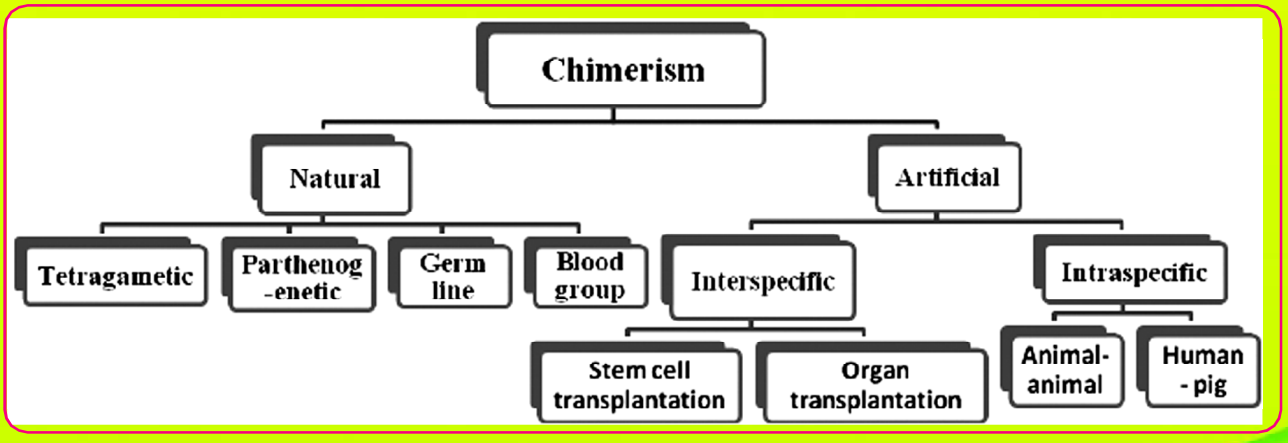


Fig. 3: Types of chimerism

d. Blood group Chimerism- Blood group chimerism means that in one organism two blood cell lines exist, from two genetically different zygotes.

2. Artificial

Artificial category is of two types like (a) intraspecific and (b) interspecific.

(a) **Intraspecific –** Intraspecific chimera is developed within same species . The examples of this type are (i) stem cell transplantation and (ii) organ transplantation .

i. **Stem cell transplantation -** It is referred to as bone marrow transplant. It is a procedure that replaces unhealthy blood-forming cells with healthy cells. Stem cell transplantation allows doctors to give large doses of chemotherapy or radiation therapy to increase the chances of eliminating blood cancer in the marrow and then restoring normal blood cell production (Fig. 4).

ii. **Organ transplantation -** Billingham, Brent, and Medawar showed that infused leukocytes obtained from a donor spleen were not rejected by the incompletely developed immune system of new born mice. Later scientists used adult mice instead of a naïve one . This condition of acceptance leads to leukocyte chimerism and the recipient system is called acquired donor specific tolerance.

b. Interspecific- Interspecific chimera is produced by the help of two different species. This includes (i) animal-animal chimera and (ii) human-pig chimera.

i. **Animal animal interspecific chimera** – First successful interspecific chimera was created in 1980 by Janet Rossant and William I. Frels between two species of albino mice namely *Mus musculus* and *Mus caroli*. The experiment involved creating of live chimeras by injecting the inner cell masses of *M. caroli* in to *M. musculus* blastocysts.

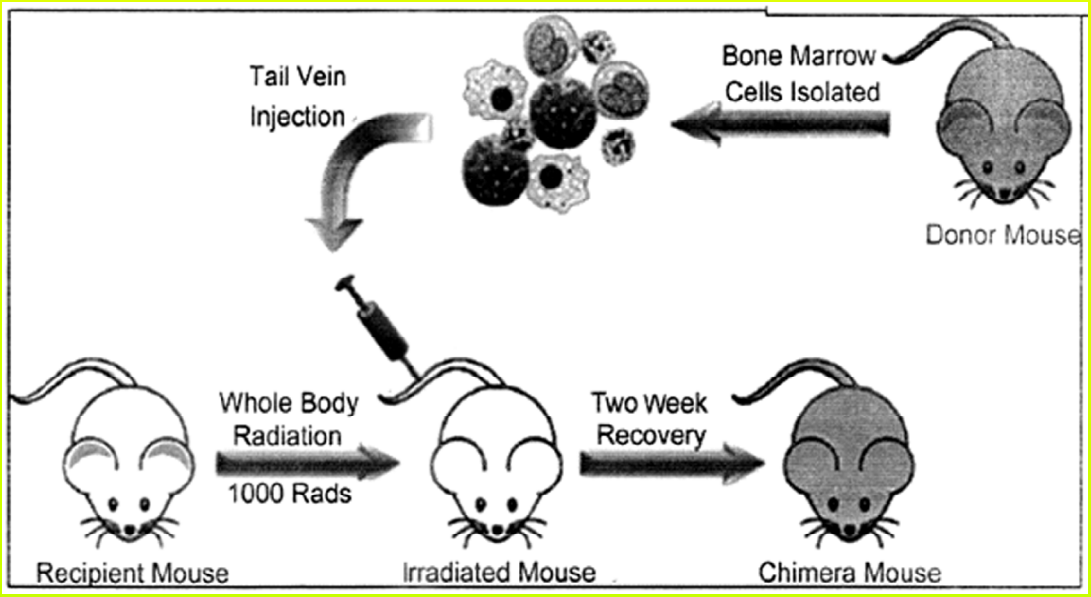


Fig.4: Chimerism due to stem cell transplantation

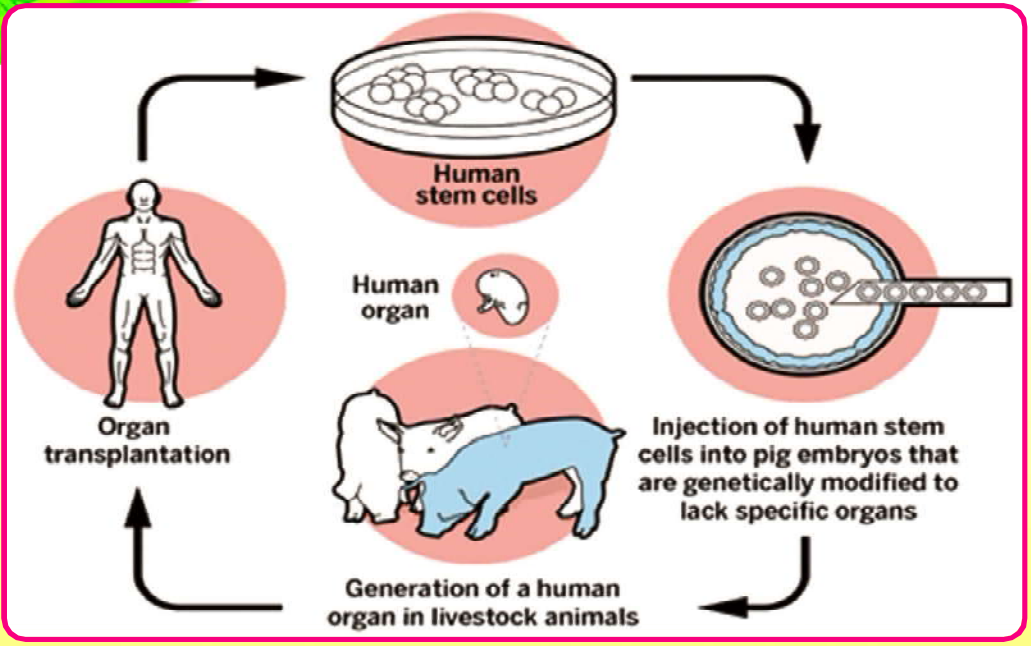


Fig.5: Process of human-pig chimera production

ii. Human pig interspecific Chimera – The primary goal of human-animal chimera research is to produce human cellular characters in animals (Fig.5).

Major Problems in Human Pig Chimera

The problems in human pig chimera are enlisted below.

(1) Xenograft rejection

(2) Hyperacute rejection and vascular rejection

(3) Complement system of human body

(4) Porcine endogenous retrovirus (PERV)

Advantages and Limitations

The advantages of chimera are as follows:

1. It is beneficial for organ and stem cell transplantation.
2. Growing human organs in pigs would allow addressing the chronic organ shortage and establishing a stock of available organs to avoid placing people on the waiting list for a suitable donor.
3. It can be useful for intrauterine diagnosis/ prognosis.
4. In future, it can be used in medical needs.

In spite of advantages, there are limitation as stated below:

1. It creates disputed maternity and ethical issues like normal status, independent identity etc.
2. It can cause blood typing and sex characteristic abnormalities.
3. It can induce immunologic tolerance and possibly promote autoimmunity.
4. It can cause medical and legal conundrums.

Conclusion

From time immemorial, chimera's had lived a fantasy life, but it is the developing technology today that has made it a dream come true.

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NEED OF WILDLIFE CENSUS

7

Sri Prakash Chandra Mishra

Census of human beings is being carried out regularly in India for more than a century at an interval of 10 years. It is an important operation to know increase or decrease of growth rate, sex ratio and other useful data for planning of the nation. Prior to declaring the result around 2 years is taken for preparation. It is one of the biggest manual operations in our country.

Wildlife Census is carried out in forest areas of the country from the year of scientific management of forests. Previously there were crude methods, but for the last 50 years advanced methods are adopted to carry out their census. Lot of people and our friends ask us repeatedly the need of Census for Wildlife. It is actually for their survival. Wild lives are quite different in nature to domestic ones, since they are free in nature, they can neither be caught nor medicated. The varieties of wild lives are terrestrial, flyers, aquatic ones for whose census are carried out every year, once in two years or once in four years by Forest Department. All the big terrestrial ones are lions, tigers, leopards, rhinos, bears, deer, bisons, boars, mongooses, ant eaters, pangolins, rabbits and snakes. Flyers are all birds, aquatic ones are salt water crocodiles, muggers, gharials, dolphins, turtles etc. Again birds may be residents or migratory. Census of lions, tigers includes all other terrestrial wild animals. Elephant, rhino and bird census are carried out separately. Census of dolphins, turtles, marsh/gharial crocodiles are done separately for their growth, sex ratio,

Crocodile

Indian Tiger

Dolphins

increase/decrease of their numbers for their very sustenance and to evaluate their scientific management by Forest Department. Census of muggers is done in river banks, ponds, marshy lands close to habitations, The season is important for carrying out the census. For tigers, lions, dolphins, crocodiles, turtles, all birds winter is the season, for rhino and elephants it is summer for maximum visibility for their counting. Migratory birds come from different parts of the Earth during winter, hence bird census is carried out in winter. Since water is the limiting factor for elephants, their movement is restricted to water sources for drinking and for taking bath and they are easily located from there and hence summer enumeration is done for them.

Census of tigers, lions, deer, sambar, bisons and other small herbivores are carried out in a group to ascertain their numbers, their growth pattern, availability of prey base (carnivores-herbivores ratio), occurrence of diseases, sex ratio, their occurrence of different localities of forests, need for treatment etc. The efficiency of Forest Department is also evaluated. It gives also an idea of measures to be taken for domestic cattle residing around the forests to treat them from any diseases, immunize them, cleanse the water reserves which act as common drinking source for wild and domestic animals so that diseases are restricted from domestic to wild animals. The prey base of tigers, leopards and herbivores depend on grass land and other forage. The census gives an idea about maintenance of prey base.

For elephants prey base is forage, bamboo forests and some fodder trees. If they are not

Elephants in Indian Forest

maintained as per census and water bodies are not sufficient, they come outside their habitats and migrate through different corridors threatening their lives. They also play havoc to human beings and cattle. To supplement the deficiencies, fodder plantations are raised in new areas, water bodies are either renovated or newly dug. For all types of birds, the prey base is aquatic flora and small faunas. From census, action is taken for more stringent protection measures for getting more aquatic flora and fauna for food of the resident and migratory birds.

Counting of dolphins, all types of crocodiles are done in winter considering their prey base. The census of turtles is done every year in winter when they come from oceans, seas to lay eggs in secluded sea coasts under the supervision of Forest Officers and go back to their natural habitats after hatching and growth. Their numbers are known from census.

Hence census of wild lives is an important tool for knowing their numbers, increase/ decrease, growth, prey base, disease, evaluation/monitoring of protection measures for their sustenance and other needs.

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ENERGY ENGINEERING

8

Dr. Nikhilanand Panigrahy

A daunting global problem at present is environmental preservation, that is, protecting natural environment. For this, it is essential to stop harmful human activities. In this context energy production and consumption plays a vital role.

Energy, defined as the ability to do work, can be viewed from different angles. One such distribution can be in the following manner :

(1) Green (2) Clean (3) Sustainable (4) Renewable energy.

1. Green Energy

Its use has an advantage that it is less polluting. Even though it emits green house gases and radiation, it is very small and restricted to the local area. Its examples are : solar energy, wind energy, geothermal energy, wave and tidal energy, hydropower, which is designed not to damage the environment.

2. Clean Energy

Zero-carbon energy sources are forms of clean energy. The amount of carbon dioxide, generated by it, is negligible. The energy due to sun and wind is of this type. But energy, produced by burning fossil fuel, is not clean as it pollutes the air.

The difference between the above two types can help combat our current climate crisis. (Ref : Impactful Ninja: clean energy v.s. Green energy, Grace Smoot)

3. Sustainable Energy

This type of energy renews itself. For example, solar and wind energy. The sun always produces light. Even though it is always used, its amount remains intact. So is the case with wind energy; as human beings have no role in increasing or decreasing the amount of wind.

In fact, it is a gift of nature. Solar energy is due to sun-shine. Wind energy is due to rotation of our planet. Now scientists have created many solar parks and wind farms to obtain sustainable energy.

4. Renewable Energy

Theoretically, it is exhaustible. Its example is ethanol. It is well known that ethanol comes from sugar cane. If we grow more sugar cane, we will get more ethanol. But if we don't cultivate sugar-cane, ethanol, being a renewable energy, will be nonexistent. Hence it depends on the source, as created by human beings. Another source of renewable energy is logs and wood chips. The amount of renewable energy from this depends on forestation. So protection and creation of jungle is vital for this. There are many other sources of renewable energy like biodiesels, biomass and municipal waste. Thus renewable energy is dependent on the mass and extent of its source, generated by us. Its source, as and when it is used, becomes depleted by the used amount. By adding fresh stock, then only the energy can be renewed. Otherwise it will gradually reduce to zero.

We have noted the importance of sustainable energy. This type of energy requires a special type of sustainable "energy engineers", who can handle global energy crisis. Its duty and motive will be to look into the problem of climate change and minimising pollution. For this to succeed, not only generation of sustainable energy but its supply matters most. It is estimated that seventy percent of carbon dioxide emissions can be reduced by 2050, if properly handled. (Ref: M Flint Now, Logan Mcgrady, 9 June 2022).

The work of an Energy Engineer can be illustrated by a simple example. We know that wind energy (a type of sustainable energy) is not produced everywhere. In India, Tamil Nadu leads the list in wind power output, followed by Gujarat, Maharastra, Karnataka and Rajasthan. The wind farms are located on-shore and also off-shore. Generation of wind power depends on factors like speed and density of air, hence, on location and climate.

The wind energy, so produced at a particular locality, should be distributed to different places, where energy is needed. So the initial problem is to store the energy safely at the place of its generation and then transmit the same to different places, with minimum energy loss and increased efficiency. The role of Energy Engineers comes at each step.

An energy engineer should have broad knowledge in physics, chemistry, mathematics and electrical and electronic systems "to design and moniter complex energy systems".

During Covid-19, there was a job-crisis in general. But according to International Energy Agency, in 2020", renewable sources of energy, such as wind and solar, continued to grow at their fastest rate in two decades." In fact, these engineers are specially required as Solar/Wind energy engineer, Energy Project Manager, Power Plant Operator, Renewal Energy Consultant and Environment Engineering Technologist. Just as now we have

mechanical/electrical/civil engineers etc, in future we will have a large number of Energy Engineers.

The Age of environmental engineers is fast approaching, because there is an urgent need for an alternative to fossil fuels. So solar, wind, hyproelectric and geothermal energy are becoming prominent. According to American Society of Mechanical Engineers, about twenty per cent of global electricity comes from energy sources, with use of fossil fuels at present. These fossil fuels are due to dead animals and plants, which are buried under the earth. After decomposition and millions of years inside earth, we get coal, oil and natural gas, which are called fossil fuels. It will be exhausted due to its rampant use, in not so distant future. Recently, on 16 Oct. 2022, our Finance Minister has announced that coal is going to be back, as gas has become unaffordable. For this she cited the example of an old thermal plant being now refurbished to produce electricity in UK. This is being considered as an emergency measure in various other countries. But unfortunately there will be more pollution, due to this.

In the mean time, it is causing disastrous climate change, putting mankind to health and safety risk.

So there is no other way except developing sustainable energy at great pace. Accordingly energy-engineers will have huge demand in future. For example, with this in mind, UM-Flint's College of Innovation and Technology has already started a course to help gain technical and soft skills, needed for Energy Industry.

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MODEL ORGANISMS IN BIOSCIENCE RESEARCH

9

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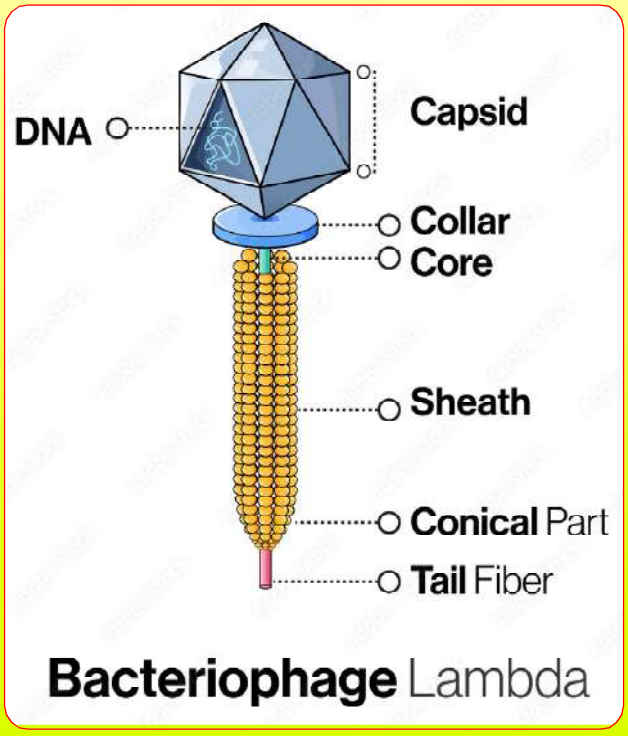
A model organism is a non-human species that is studied as an example in order to understand a range of biological phenomena. The hope is that data and theories generated through the use of the model will be applicable to other organisms, particularly humans. Further, it is often expected that the study of a single species will provide biological insights into many other species. This idea is grounded in evolutionary theory, according to which all life forms are related through a common evolutionary history and thus share a smaller or greater amount of genetic make-up and a number of developmental features. Model organism represents only a small fraction of the biodiversity that exists on Earth, although the research that has resulted from their study forms the core of biological knowledge to date. They are found among viruses, prokaryotes, protists, fungi, plants and animals. Some of the model organisms that are useful in bioscience research/experiments are given hereunder.

Virus (Lambda Bacteriophage)

A bacteriophage is a virus that infects bacteria. Lambda bacteriophage virus infects *Escherichia coli* cells. It has two options in its infectious cycle. It often chooses a lytic pathway in which many copies of the viral DNA are synthesized and packaged in

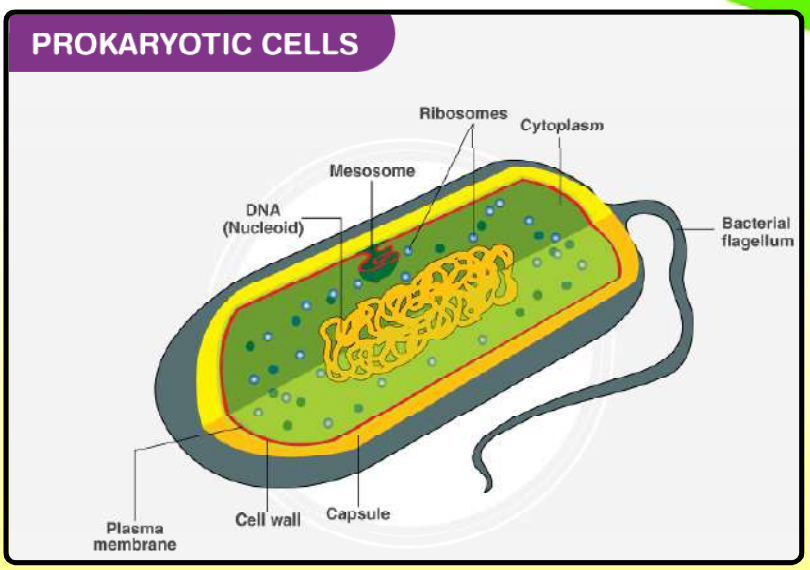


Structure of Lambda Bacteriophage

protein coats. The host cell bursts, releasing mature viral particles, which can then infect new host cells. Alternatively, the virus may choose a lysogenic cycle, where the lambda chromosome becomes inserted into a special region of the bacterial chromosome. The host cell does not lyse; rather it becomes immune to further viral infection and grows normally,

producing many cells, each of which carries an integrated copy of the lambda chromosome.

Lambda is very useful for the study of its host genetics and functions. When the viral DNA exits the host chromosome it occasionally will carry with it some *E. coli* chromosome material on either side of its insertion site, leaving behind some of its own DNA. Such a defective particle can infect and carry over the bacterial gene to a new host cell. This is called transduction, a process that has proved to be invaluable for analysing bacterial genes. It also plays a vital role in the molecular analysis of eukaryotic organisms. It is one of the vectors used to create molecular libraries of eukaryotic chromosomes. Eukaryotic DNA fragments can be cloned into modified lambda chromosomes, replacing some lambda genes not essential for infection and growth. Such libraries can be screened by molecular techniques to identify viruses containing a particular piece of the eukaryote's genome. Once having identified and isolated a desired virus, that virus can be grown to billions of copies to produce a large quantity of the eukaryotic DNA for analysis. This is a very useful way of molecularly purifying eukaryotic genes for mapping and sequencing.



Prokaryotes

Prokaryotes are organisms that lack both membrane bound organelles and a nucleus. They include the classical model of molecular biology, *Escherichia coli*, the spore-forming *Bacillus subtilis* (which is widely used in biotechnology) and notorious agents of disease, such as *Borrelia burgdorferi* (Lyme disease), *Mycobacterium tuberculosis* (tuberculosis), *Mycoplasma pneumonia* (pneumonia) and *Vibrio cholerae* (cholera). The discovery of sexual recombination in *E. coli* in 1947 vaulted this bacterium into the premier position of genetic analysis of prokaryotes. The single circular DNA chromosome of *E. coli*, only 4.6x106 base pairs, could then be mapped by matings. Complete nucleotide sequencing of the chromosome makes it possible to identify and determine the function of every gene in the *E. coli* genome. It is a super model organism to study transcription, translation, recombination, DNA repair and the regulation of gene activity.

Protists

Protists include all eukaryotes except plants, animals and fungi. They are predominantly unicellular, and span the entire eukaryotic tree of life. The ideal model organisms, such as *Chlamydomonas*,


Fungi

Dictyostelium and parasites of humans, such as *Plasmodium* (malaria), *Trypanosoma* (trypanosomiasis, Chagas disease), *Leishmania* (leishmaniasis), *Stentor coeruleus* and *Giardia* (giardiasis) have solved an enormous number of ecological and evolutionary challenges. *Chlamydomonas reinhardtii*, unicellular green alga has proven to be a powerful model for dissecting fundamental processes in biology. It is used to study photosynthesis, flagella and motility, regulation of metabolism, cell–cell recognition and adhesion, response to nutrient deprivation and many other topics including genetics. *Stentor coeruleus* is studied as a model of single-cell regeneration. *Dictyostelium discoideum*, is studied as an example of cell communication, differentiation, and programmed cell death.

Fungi

The fungi (Mycota) are eukaryotic organisms that have a mycelial structure formed from slender filaments or hyphae and are commonly multinucleate. Several models of fungi are of great importance for genetics like *Saccharomyces cerevisiae*, *Schizosaccharomyces pombe* and *Neurospora crassa*. Baker's yeast (*S. cerevisiae* 5,600 genes) was the first eukaryote genome to be fully sequenced. Another analytical tool is the use of retrotransposons, particularly Ty1 (The Ty1 element is the most abundant retrotransposon in *S. cerevisiae*. It targets very specific regions of the host genome upon integration, termed "integration windows," lying 52 of Pol III-transcribed genes, a set of genes principally consisting of the 275 nuclear tRNA genes), which can infect yeast cells. These are mobile elements capable of moving in and out of yeast chromosomes. They can create mutations by inserting into a gene, or by creating a deficiency when excising. Ty1 elements can also be engineered molecularly to contain selected yeast genes, which can then be transported into a host cell and integrated into one of its chromosomes. In this fashion, the yeast genome can be manipulated for precise molecular analysis. Yeast artificial chromosomes (YACs) are now being employed as vectors for cloning other eukaryotic DNAs.

Plants

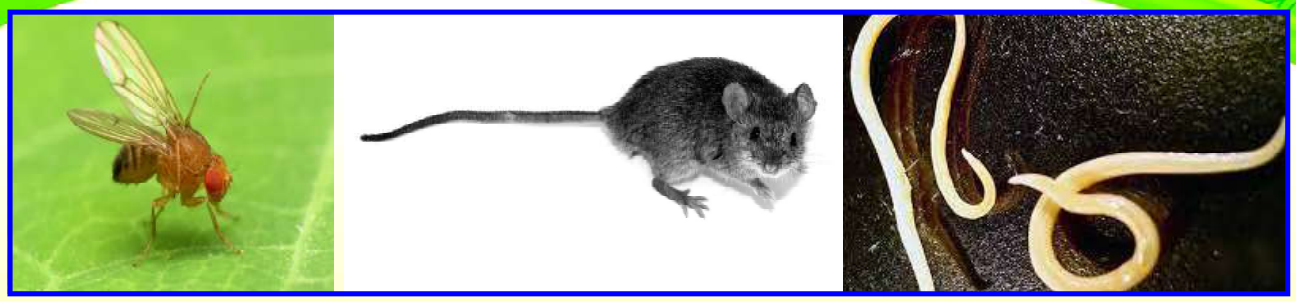
There are ~300,000 known species of land plants, but genomic models are only found in a handful of species and families. Pea


Pea

(*Pisum sativum* L.) was the model organism for Mendel´s discovery (1866) of the laws of inheritance, making it the foundation of modern plant genetics. The plant species used as model organisms include *Arabidipsis thaliana*, the classical model of plant genetics and development; grasses such as rice (*Oryza sativa*), corn (*Zea mays*), wheat (*Triticum aestivum*) and *Brachypodium dystachyon*, which is being promoted as an alternative model system to rice, for the temperate cereals and forage grasses; and other economically important crop plants, such as cotton (*Gossypium hirsutum*), soybean (*Glycine max*), tobacco (*Nicotiana tabaccum*). Beside these, which are well known plant models, other plant species have been proposed as models: *Antirrhinum majus* has been used as a model plant for the molecular analysis of transposons, asymmetric floral development and floral pigmentation; Micro-Tom (micro-tomato), a small tomato cultivar has been developed as a model plant for tomato genetics; *Nemesia strumosa* Benth, has many characteristics that make it a potential model plant for the study of asymmetric floral development; *Nicotiana attenuata*, has been proposed as a model ecological expression system; *Craterostigma plantagineum* has contributed significantly to our knowledge of the molecular regulation and physiology of dehydration tolerance in mature leaf tissue; *Medicago truncatula* and *Lotus japonicus* have been selected for molecular genetics analyses of legume biology; *Solanum nigrum* L., is presented as a model for ecological expression system; *Physcomitrella patens*, in which homologous recombination occurs naturally, has been used as a model system in mosses, for biotechnological aspects.

Animal

The most prominent animal model organisms are fruit flies (*Drosophila melanogaster*), mouse (*Mus musculus*), and the nematode *Caenorhabditis elegans*. T.H. Morgan chose *Drosophila* to study evolution. Together with his group, he showed that the mutations observed in the studied populations obeyed Mendel's rules. Other discoveries made at the time, such as sex linkage, crossing over, and the behaviour of the attached-X chromosomes, led to the final consolidation of the chromosome theory of inheritance. Before 1900, research on mouse breeding provided many traits for Mendelian analysis. To study many aspects of human biology and medicine, mouse was seen to become a model. *C. elegans* was chosen for its simplicity and experimental tractability, with the initial interest in the development of the nervous system. The research on animal models has



Fruit Flies, Mouse and Nematode

contributed to nearly all we know about cell biology. On the other hand, the choice of model organisms was not always crowned with success. Over time some organisms have fallen from grace. It is fair mentioning in here the rat (*Rattus norvegicus*) which was often an animal of choice two or three decades ago, but nowadays is less used because its genome cannot tolerate the insertion of foreign DNA near the extent of the mouse genome. Humans are not good model experimental organisms. However, medical practices demand investigations into human health and the basis of human diseases. Genetic characteristics of humans are best worked out through family pedigrees because there are very few direct experimental manipulations that can be applied.

Conclusion

The phylogeny and timescale of life are becoming better understood as the analysis of genomic data from model organisms continues to grow. As a result, discoveries are being made about the early history of life and the origin and development of complex multicellular life. The benefits have extended beyond medicine, industry and agriculture, to systematics and evolutionary biology. Therefore, the model organisms are a wealth of biological data that will continue to be productive for the biological community.

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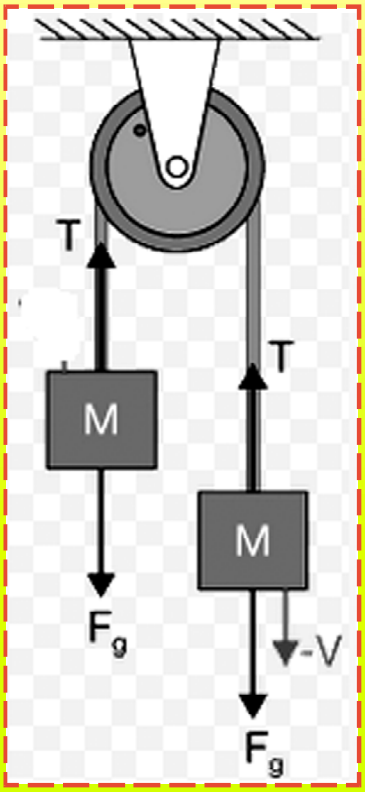
LAWS OF MOTION (Continued....)

10

Dr. Chhatrapati Parida

1.13 Misconceptions

1. Imagine an object lying stationary on a table. Normally we say that there is no intermediate force acting on the stationary object on a table since the object will remain in its stationary state.



But in reality, two forces are acting on the stationary object. Gravity is pulling it downwards and the reaction force of the table is exerted upwards.The resultant of forces on a stationary object on the table is equal to zero since there are two forces present and they are equal in magnitude and acting in the opposing directions.

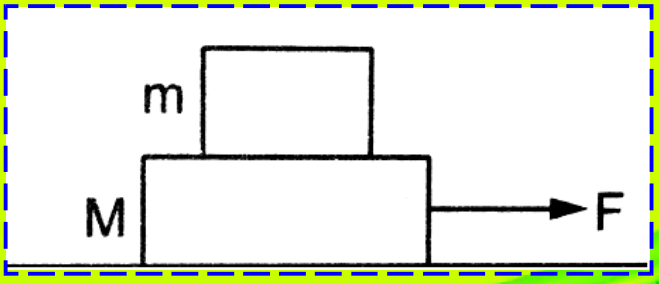
2. Consider a pulley system with identical mass at both ends. The system is at rest.What will happen if a vertical force is applied on one mass.

Most of the students will answer that the body will perform simple harmonic motion because the mass is displaced from the equilibrium position. However, in accordance with the Newton's first law, the displaced body will continue to move downward unless an external force is applied to stop its motion.

3. Two bodies are considered with smaller mass m kept over larger mass M. If a force F is applied on lower body M, then we guess that the same force will act on the upper body m.

However , If the contact surface between the two masses is frictionless, then no force will act upon the upper body. If the contact surface is rough , then there will be frictional force on the upper body.

4. In the expression $\vec{F} = \overrightarrow{ma}$, a is normally thought as the acceleration of any point of the body.



If a body slides along a particular direction, then acceleration of all points of the body are same and is equal to acceleration of center of mass of the body. However if a rolling body is acted upon by a force, then acceleration of the body will be different at different points of the body.

5. $\overrightarrow{ma}$ is chosen as a force acting upon the body by many students.

It is not a force that acts on a body. Rather the net force acting on a body is equal to $m\vec{a}$

6. Many students assume that the normal force acts through the center of the body.

Normal force doesn't act always through the center of the body. Rather it shifts depending upon the nature and direction of external force acting on the body.

7. It is always thought that the normal force is equal to the gravitational force.But this is not always true .

If a body is at rest, only then the normal force is equal to the gravitational force or weight of the body.

N = mg

If a body is kept inside a lift and the lift is accelerating upwards then

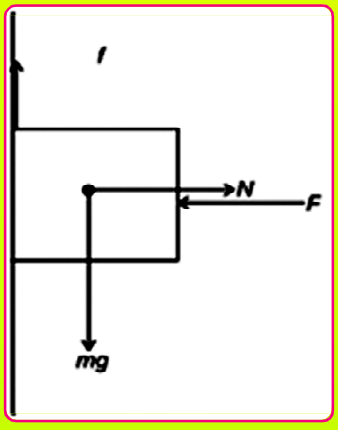
N - mg = ma or N = mg + ma

8. We always assume that the actual weight and weight we feel are same

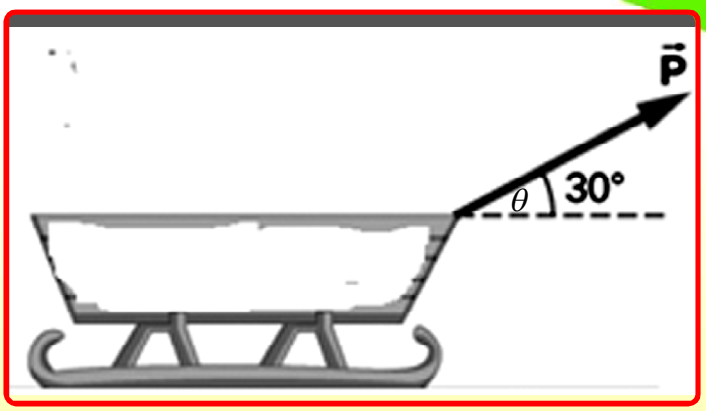
Actual weight of your body is the force exerted by Earth on you.The weight you feel is measured by the force that counterbalances the force exerted by earth on you. Suppose you are standing at rest inside a stationary lift, then the downward pull of the earth on you is balanced by the normal reaction of the surface exerted on you. So, here the actual weight of you is same as the weight you feel. When the lift starts accelerating upwards, the normal reaction force exerted by the surface is greater than the downward pull of the earth. In this case the weight you feel is more than your actual weight. When the lift falls downward with an acceleration, the downward pull of the earth is greater than the actual weight of you and in this case, the weight you feel is less than the actual weight. The counterbalancing force is the normal force provided by the surface which the object is in contact. When the lift falls downward with an acceleration exactly same as g, the counterbalancing force becomes zero and the body feels weightlessness.

9. Only one normal force acts on a body

The number of normal forces acting on a body depends on the number of surfaces in contact. The more the number of contact surfaces, the more will be number of normal forces. If there is no contact or when the body loses contact, normal forces become zero.



In the figure shown, the body is held against the wall by an applied force.The normal force F is due to the contact between the body and the vertical wall and acts in the horizontal direction. If the body will be in contact with the horizontal, there will be another normal force acting against the weight of the body.



10. Force is needed to keep an object in motion

When an object is in motion, it will continue to move with same speed and same direction without any need of force. Sustained motion doesn't need any force.

11. Is walking push or pull?

While walking, we exert a **push force** against the earth. As per Newton's third law of motion, for every action, there is an equal and opposite reaction. The counterforce exerted by the ground in the opposite direction is called the force of friction. Due to this frictional force, we are able to walk.

12. Pushing is harder than pulling

In pushing **frictional force is greater than that of in case of pulling**. When you push some object, the normal reaction increases, so friction also increases but in case of pulling at the time you are pulling you decrease the normal reaction, so friction is reduced and & it becomes easier.

In the figure shown, a boat is pulled by a pulling force P at an angle 30^0 with horizontal. P is resolved into two components along horizontal and along vertical. As the body is in equilibrium along vertical we can write

$$P\sin 30^\circ + N = mg \Rightarrow N = mg - P\sin 30^\circ$$

Here N is decreased from mg to $mg - P\sin 30^\circ$ during pulling. However N will increase from mg to $mg + P\sin 30^\circ$ during pushing. As the normal force decreased during pulling, it is easier to pull the boat.

13.Newtons laws of motion are applicable universally.

When motion of an object is observed from an inertial frame (the frame which is at rest or moving with constant speed), the laws of motion are valid. Suppose a mass tied to a string is whirling in a horizontal circle. For an inertial observer standing at rest, the net force acting on the object will be tension along the string towards the center of the circle.For an inertial frame, the path of the object is circular and the net force acting on the object is centripetal force. We can write $F_{net} = ma = m\frac{v^2}{r}$. But if the whirling of the object is observed by another observer which is also whirling in the same circular path as the original object, the circular motion can't be observed by the observer .The observer moving along the circular path will find the object at rest. There is no net force acting on the object for these observers which are also moving in

the same circular paths. These observers are accelerating frame and known as non-inertial frame. From non-inertial frame we can't write $F_{net} = ma = m\frac{v^2}{r}$. The object is in equilibrium from non inertial frame and the inward tension force is balanced by outward centrifugal force. Therefore as no net force is acting on the object when it is observed from non-inertial frame, the Newton's laws of motion are normally written in the inertial frame.

14.Centrifugal Forces are Real Forces

Just imagine a car taking a turn on a curved road. The persons standing on the curved road will observe the circular motion of the car and for them the friction between the tire of the car and the road is the net force acting on the car towards the center. This net frictional force is the centripetal force which is a real force. Now imagine yourself as driver inside the car driving the vehicle. You as a driver inside the car can't observe the circular motion of the car. You are a non-inertial frame or rotating frame. You will be in equilibrium under the effect of an inward frictional force and outward centrifugal force. You will feel an outward jerk while taking a turn. That outward jerk can be felt only inside the vehicle and not by inertial observer outside the vehicle. This outward jerk is not a real force but named as pseudo force which is felt only by non-inertial observers.

15. **The Horse Cart Paradox**

Think of a horse-drawn cart system. The force the horse applies causes the cart to advance. According to Newton's third Law, there is an equal and opposite reaction to every action. Consider a scenario in which the horse pulls the cart ahead with force F_h, and the cart subsequently pulls it back with force F_c, which is equal to and the opposite of F_h.The net force acting on the horse-cart system should be 0 if both forces are equal and in the opposing directions. So how does the horse-drawn carriage proceed?

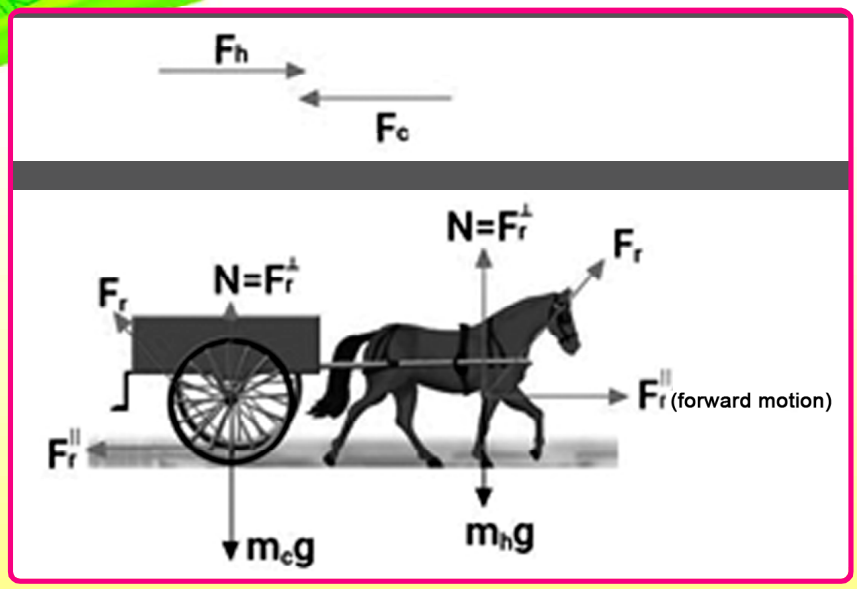
This issue results from widespread errors in understanding how to apply Newton's Third Law.Despite being equal and opposite, the forces F_c and F_h do not balance each other out because they are not acting on the same object. Two independent systems - the horse and cart - are joined by a harness. Let's analyse the forces affecting the horse and the waggon independently and create free-body diagrams for each. Forces acting on the horse are,

1. Weight of the horse, acting downward (m_h g)
2. Reaction force exerted by the ground on the horse (F_r)

The horse exerts an inclined force on the ground. It can be shown by Newton's Third Law that the ground exerts an equal and opposite force on it, which is taken into account here.

3. Backward force exerted by the cart on the horse (F_c)

The force exerted by the road (F_r) is resolved into parallel and perpendicular components. The perpendicular component of the reaction force balances the weight of the horse. If the parallel component of the reaction is greater than the backward force exerted by the cart, the horse can move forward.



The forces acting on the cart are,

1. Weight of the cart, downward force, ($m_c g$)
2. Reaction force exerted by the ground on the cart, (F_{r2})
3. Forward force exerted by the horse, (F_h)

The reaction force can be resolved to parallel and perpendicular components as before. The perpendicular component balances the weight of the cart. The parallel component opposes the forward force exerted by horse. If forward force (F_h) is higher than this parallel component, then there is an unbalanced force on the cart and it moves forward.

1.14 Think yourself and answer the following questions

1. Explain the need of seatbelts in vehicles based upon Newton's first law.
2. Explain the role of inertia when you throw a basketball .
3. You are lying on the beach after a bath in the sea, where the water waves hit you. Can you say that no forces are acting on you?
4. A dog swims in the sea and then shakes himself for drying.Which laws of Newton helps the dog drying?
5. When a car begins to move forward, what external force is present there for its motion? All internal forces inside thae car is zero. Explain the role of engine as the driving force?
6. Two cars moving towards each other collide .Will the rear ends of both cars come to rest at the same time as the front ends of the car?
7. Does a man weigh more at the top of the mount Everest or at the base of the mountain?
8. Two objects having different crossectional area are falling with same speed.Will the drag force exerted by air be same for both objects?
9. Explain why the drag force on a falling object increases as the speed of the object increases.
10. You are pulling a suitcase in the airport at constant speed.The handle of the suitcase makes an angle 60^0 with respect to the horizontal.If the pulling force exerted by you is 25 N, then find the force exerted by the floor on the suitcase and the weight of the suitcase.

1.15 Answer to the motivational problem

For take off the aircraft must attain a same speed all the times after covering certain distance on the runway. Here the aircraft will

attain the same speed without carrying the glider and with carrying the glider. Let the velocity at the time of take off is v. If a_1, s_1 and m_1 are the acceleration, distance travelled and mass of the aircraft, then we can write

$$v^2 - u^2 = 2a_1s_1 \Rightarrow v^2 = 2a_1s_1 \Rightarrow s_1 = \frac{v^2}{2a_1}$$

If s_2 is the distance travelled by the aircraft with the glider and a_2 is the acceleration of the aircraft with the glider, then $s_2 = \frac{v^2}{2a_2}$

Now $\frac{s_1}{s_2} = \frac{a_2}{a_1}$

But acceleration is inversely proportional to masses. So,

$$\frac{s_1}{s_2} = \frac{a_2}{a_1} = \frac{m_1}{m_1 + m_2}$$

$$s_2 = \frac{m_1 + m_2}{m_1} s_1 = \frac{m_1 + m_2}{m_1} 150\text{m} > 150\text{m}$$

So the distance covered by the aircraft + glider system for take off is more than 150m.

1.16: Choose the most appropriate answer

1. Consider a particle moving on a straight line with constant velocity. Which of these will not be affected if a force is applied to it?

a. For the particle to move with constant velocity.

b. For it to increase its speed.

c. For it to change its momentum.

d. For it to change its direction.

2. A bus is moving in a straight line, and suddenly, it takes a right turn. The passengers are seen to be thrown towards the left. Why is that?

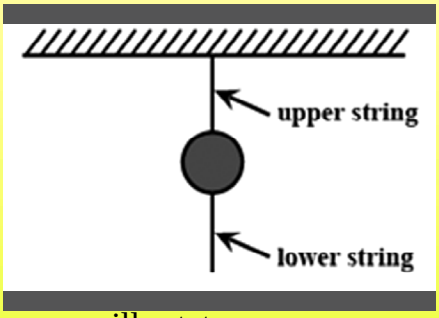
a. Acceleration of motion

b. Speed of motion

c. Inertia of motion

d. None of the above

3. A mass of 1kg is hanging from a ceiling suspended by a string. Another string is tied to the lower end of the mass. What will happen if someone suddenly jerks the string below?



a. The mass will rotate.

b. The lower part of the string will break.

c. The upper part of the string will break.

d. The whole system will fall down.

4. When you get down from a running bus, you seem to fall forward. Why is that?

a. Due to inertia of rest, the road remains static, and the bus continues to move.

b. Due to inertia of motion, your feet come to a rest, but your upper body part continues to stay in motion.

c. It is just your habit.

d. All of the above

5. The mass of a body is 2 kg, and it is moving on a horizontal surface with a velocity of 4 m/s, but comes to rest after 2 seconds. What will be the force to be applied to it if one wants the body to

move with the same initial velocity?

a.0 N b.2 N c. 4 N d.8 N

6. A plane is inclined at an angle of 30 degrees from the horizontal surface. A mass of 5 kg is kept on the inclined surface and suspended from a spring balance. What will be the balance reading if g = 10 m/s^2?

a.25 N b.50 N

c.100 N d. Inconclusive reading

7. If two balls of same masses are dropped on sand, the depths of penetration is same if;

a. Heavier ball is dropped faster than lighter ball

b. Lighter ball is dropped faster than heavier ball

c. The product 'mv' is same for both bodies

d. None of these

8. A monkey is climbibg up a rope with an positive acceleration.The tension along the rope is

a. equal to weight of the monkey

b. greater than weight of the monkey

c. Less than weight of the monkey

d. None of the above

9. When a force is called a normal force, it is

a. the usual force expected from the arrangement of the system

b. a force that is perpendicular to the surface of earth at any given location

c. a force that is always vertical

d. a contact force that is perpendicular to the contact surfaces between two solid objects.

10. A 70.0 kg man stands on a bathroom scale in an elevator.What does the scale read if the elevator is slowing down at a rate of 3.00 m/sec^2 while descending?

a.70 kg b.476 N c.700 N d.896 N

Answers to MCQs

1) **a.** motion will be sustained in the absence of any unbalanced force.

2) **c.** Inertia of direction of motion

3) **b.** The lower string will break because the impulsive force is given to the lower string and the upper string does not stretch much as compared to the lower string.

4) **b.**

5) **c.** $F = ma = m\frac{u}{t} = 2kg\frac{4m/sec}{2sec} = 4N$

6) **a.** Downward pulling force along the inclined plane is

$$mg\sin\theta = mg\sin 30^0 = \frac{mg}{2} = \frac{50}{2} = 25N$$

7) **c.** When a body is dropped from a certain height, it attains a momentum while reaching the sand.The depth of penetration depends upon the momentum imparted to the sand.

8) **b.** T - mg = ma or T = mg + ma

9) **d.**

10. **d** $mg - N = m(-a) \Rightarrow N = mg + ma = 70g + 210 = 896N$

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RECENT NEWS ON SCIENCE & TECHNOLOGY

USA is Planning to Boost Floating Wind Power Plant

USA has announced initiatives on February 22, 2023 to prepare states for floating offshore wind - a young but fast-emerging type of power that some say could revolutionize renewables on the West Coast. The plans include a 20-month study on how to build out transmission networks that would link the West Coast's grid to first-of-their-kind floating wind projects. The Pacific Northwest National Laboratory also released a major report assessing how to build transmission for floating offshore wind on the West Coast, where deep waters make traditional offshore wind prohibitive.

Asteroid lost 1 million Kilograms after Collision with DART Spacecraft

Last September, NASA's Double Asteroid Redirection Test (DART) spacecraft smashed into an asteroid, deliberately altering the rock's trajectory through space in a first test of planetary defence. Now scientists have deconstructed the collision and its aftermath - and learnt just how successful humanity's punch at the cosmos really was.

DART, which was the size of a golf cart, collided with a Great Pyramid-sized asteroid called Dimorphos. The impact caused the asteroid's orbit around another space rock to shrink - Dimorphos now completes an orbit 33 minutes faster than before the impact, researchers reported on March 2, 2023 in *Nature*. This means that if a dangerous asteroid were ever detected heading for Earth, a mission to smash into it would probably be able to divert it away from the planet.

The impact ejected at least one million kilograms of rock from Dimorphos's 4.3-billion-kilogram mass. The debris formed a tail that stretched for tens of thousands of kilometres behind the asteroid. Various telescopes watched over weeks as the tail shifted and evolved under the pressure of the Sun's rays; the Hubble Space Telescope even detected a second tail, which had disappeared by 18 days after the impact.

Dimorphos is 151 metres wide and orbits the larger asteroid Didymos. NASA's goal was to alter Dimorphos's orbit enough for astronomers to spot the changes by monitoring the brightness of the pair over time using ground-based telescopes. Neither asteroid is, or will ever be, a threat to Earth.

Compiled by
EDITOR

GUIDELINES FOR CONTRIBUTING ARTICLES FOR THE MAGAZINE

1 "SCIENCE HORIZON" aims at developing the scientific outlook of students as well as the general people and seeks to give them information on scientific developments. It is published as a monthly magazine.

2. The authors desirous of writing and contributing articles to the magazine should first assimilate the ideas of the theme and present it in simple language and popular style.

3. The authors are requested to send their articles by typing (in MS Word) to avoid errors in reading handwritten article and send it through e-mail given below.

4. The authors are requested to write clearly on one side of A/4 size paper. The relevant pictures in 4cm X 6 cm size are welcome. Photo copies of manuscripts are not accepted for consideration.

5. Each article will be ordinarily of two to three printed pages in A/4 size papers.

6. The article shall be profusely illustrated with pictures.

7. At the end of the article the author should give the references and suggestions for further reading.

8. The reference of books, journals, sources, ideas and essential points collected by the writer should be mentioned in the bibliography. This will enhance the quality and fidelity of the writing and give the reader an opportunity for making further studies.

9. Matter translated from other languages and illustrations should indicate the original sources otherwise those would not be accepted. The articles which are not published, can not be returned to the authors.

10. As far as practicable the articles should be based on contemporary science and must be easily comprehensible to students at the secondary level.

11. The writers should present difficult concepts of science through stories of everyday life, heart-rendering songs, pictures, satirical cartoons or attractive dramas.

12. All units in the articles should be given in the metric system.

13. The title of the article should be brief and attractive. Moreover, subtitles may be given in long articles. The writings should be coherent and cohesive.

14. There should not be repetition of specific words. While ensuring the contemporary spirit of the writing, it should reflect some valuable lesson for the society. It is also necessary to avoid mistakes in spelling, language use and factual details.

15. The Editor & the Editorial Board of "Science Horizon", Secretary of the Academy or Odisha Bigyan Academy shall not be responsible for the views of the authors.

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