

# Topics

- (PraVaHa)
- Hydroxyurea
- Green beard genes
- JAMES WEB TELESCOPE
- The Preston curve
- InviTs
- Mains



By saurabh Pandey



# Target Mains -2024/25 -

**Q What role economic changes has on life expectancy and per capita income in a country ??**

**Q किसी देश में जीवन प्रत्याशा और प्रति व्यक्ति आय पर आर्थिक परिवर्तनों की क्या भूमिका है ??**

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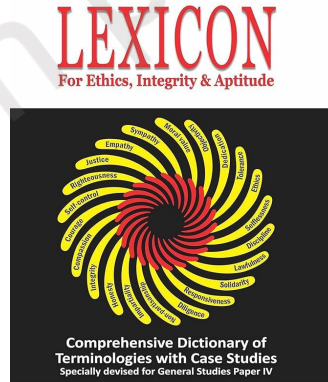
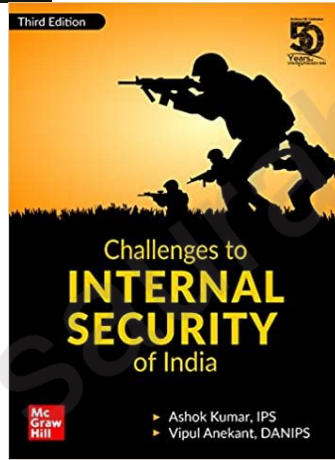
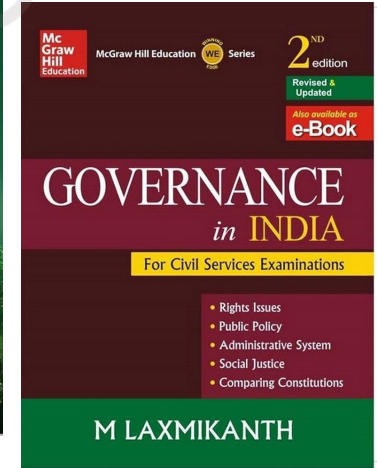
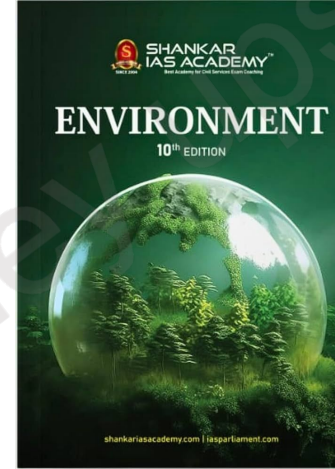
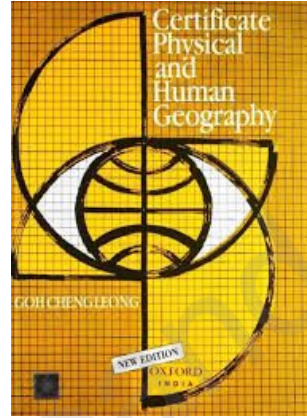
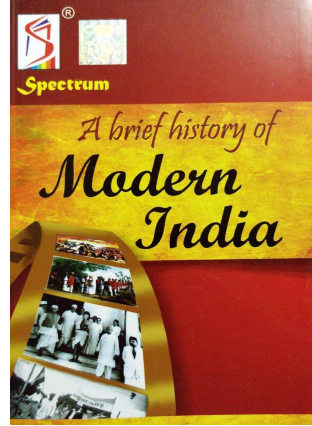
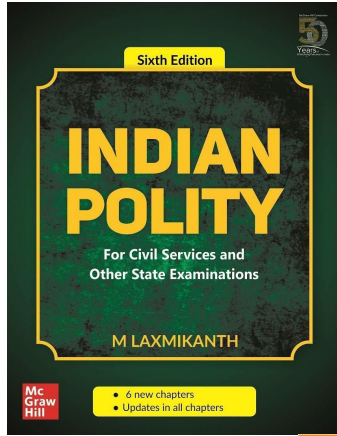
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ISRO's Launch Vehicle Mark-III M4 carrying 'Chandrayaan-3' lifts off on July 14, 2023. ISRO says initial aerodynamic design studies for launch vehicles demand evaluation of many configurations.

## ISRO develops new PraVaHa software for aerodynamic design

**The Hindu Bureau**

BENGALURU

The Indian Space Research Organisation (ISRO) has developed Computational Fluid Dynamics (CFD) software named Parallel RANS Solver for Aerospace Vehicle Aero-thermo-dynamic Analysis (PraVaHa).

This software was developed in ISRO's Vikram Sarabhai Space Centre (VSSC). It can simulate external and internal flows on launch vehicles, winged and non winged re-entry vehicles. According to ISRO, initial aerodynamic design studies for launch vehicles demand evaluation of a large number of configurations.

Any aerospace vehicle while moving through the Earth's atmosphere during launch or re-entry is subjected to severe aerodynamic and aerothermal loads in terms of external pressure and heat flux.

Understanding the airflow around aircraft, rocket bodies, or Crew Module (CM) during earth re-entry is essential to design the

shape, structure, and Thermal Protection System (TPS) required for these bodies.

The unsteady part of aerodynamics contributes to serious flow issues around such rocket bodies and creates significant acoustic noise during the mission. Computational Fluid Dynamics (CFD) is one such tool to predict the aerodynamic and aerothermal loads which solve numerically the equations of conservation of mass, momentum, and energy along with the equation of state.

PraVaHa has been used extensively in the Gaganyaan program for aerodynamic analysis of human-rated launch vehicles, viz, HLV M3, Crew Escape System (CES), and CM.

Currently, the PraVaHa code is operational to simulate airflow for Perfect Gas & Real Gas conditions. Validations of the code are under way for simulating the effect of chemical reactions that occur during air dissociation upon 'earth re-entry' and 'combustion' as in scramjet vehicles.

# (PraVaHa)



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# ICMR seeks to provide oral formulation of hydroxyurea to treat sickle cell disease

**Bindu Shajan Perappadan**  
NEW DELHI

The Indian Council of Medical Research (ICMR) has invited Expressions of Interest (EoI) from eligible organisations for the “joint development and commercialisation” of a low dose or paediatric oral formulation of hydroxyurea to treat sickle cell disease in India.

India has the highest prevalence of sickle cell disease in South Asia. Over 20 million people with the disease live in the country. While most pharmaceutical companies in India market 500-mg capsules or 200-mg tablets of hydroxyurea, the biggest challenge in treatment is that it is not available in the suspension form for effective use in the case of paediatric patients, the ICMR said.

Sickle cell disease is one



Over 20 million people with sickle cell disease are residing in India. AP

of the most common monogenic disorders of haemoglobin, and hydroxyurea, a myelosuppressive agent, is an effective drug for treating patients of sickle cell disease, and thalassemia.

## **Risk of low dose**

The ICMR said that since only high-dosage hydroxyurea tablets are available, initiating a low-dose treatment becomes a tedious

task for service providers, as the capsule or tablet has to be broken down appropriately to be administered in accordance with body weight, risking the efficacy available with measured doses.

“Thus, there is a need for paediatric formulation of HU (hydroxyurea), considering the number of SCD cases in India and in view of the launch of the National Mission to eliminate Sickle Cell Anaemia/SCD (by 2047),” it said.

The ICMR, which is the apex biomedical research body in the country, also said that in India, according to the National Health Mission’s guidelines, healthcare providers initiate hydroxyurea therapy to only symptomatic sickle cell disease patients among children both because of the lack of availability of paediatric doses as well as the fear of toxicity.

In children, the prescribed dose is 10 mg to 15 mg per kilogram of body weight after two years of age. This titration of dose is difficult, and currently, it is carried out by using a fraction of the broken capsules, which is not an appropriate method because it can lead to less accurate administration of the drug, which has five dose-related side-effects.

## **Titration of drug**

With the availability of a formulation, the titration of the drug can be better, and its dose-related side effects can be reduced.

The council said that it could enter into any form of exclusive or non-exclusive agreement with eligible manufacturing companies for joint development and commercialisation of paediatric oral formulations of hydroxyurea for sickle cell disease.



## Hydroxyurea

- **Hydroxyurea helps the body make a type of hemoglobin that helps keep red blood cells round. Hemoglobin is the protein inside red blood cells that carries oxygen to the body.**
- **Round and flexible red blood cells work better and last longer.**

## What are Sickle Cell Disorders?

- A group of disorders that cause red blood cells to become misshapen and break down.
- The cells die early, leaving a short age of healthy red blood cells and can block blood flow causing pain.



### Types:

#### Sickle Cell Anaemia

Dysfunctional red cells due to abnormal haemoglobin

#### Sickle Cell Crisis

Blockage of blood vessels causing severe pain or organ damage



Healthy

Sickle cell anaemia



Normal red blood cell



Sickle red blood cell



unrestricted blood flow



sickle cells blocking  
blood flow

## SICKLE CELL TRAIT



NORMAL HbA



SICKLE HbS



**parent 1**

HAS THE SICKLE CELL TRAIT



**parent 2**

HAS THE SICKLE CELL TRAIT

**child**



**25%**

CHANCE TO NOT HAVE  
SICKLE CELL DISEASE OR TRAIT



**50%**

CHANCE TO HAVE SICKLE CELL TRAIT  
BUT NOT SICKLE CELL DISEASE



**25%**

CHANCE TO HAVE  
SICKLE CELL DISEASE

# 'Green-beard' genes could explain how altruism arose in nature

Amoebae don't use rational numbers. Instead, they use genes to estimate kinship with other amoebae. If the genes have not diverged at all, or have diverged very little, there is kinship and it is good to cooperate. If they have diverged significantly, there is less kinship and hence cooperation is risky

D.P. Kashekar

**A**ltruism is widespread in nature. Worker honey bees devote their entire life to foraging and caring for their sister, the queen, and her offspring, but do not themselves reproduce. In widow spiders, a male allows a female fertilised by him to eat him, and thus nourish herself and her offspring. A meerkat, a mongoose found in Africa, assumes the role of a sentinel, perching itself on a mound or rock, keeping a lookout for predators, instead of foraging for food, while the rest of the clan is feeding. If a predator is sighted, it alerts the others.

Many humans themselves have agreed that "greater love has no man than he who lays down his life for his friends".

How can the emergence of altruism in all these diverse forms be explained?

## A genetic switch

Most of the progress in answering this question has come from studies of a simpler organism that has been easier for researchers to study: the social amoeba *Dictyostelium discoideum*. The take-home message of these studies is that if a gene makes a worker bee altruistic, it also helps the copy of the gene in the queen and her offspring to be passed on to the next generation, even if the worker herself does not reproduce.

Such so-called 'green-beard' genes allow the individuals bearing them to recognise and preferentially cooperate with each other.

Alternatively, a green-beard gene could provoke individuals to behave harmfully towards those carrying a different version of the gene.

Thus, scientists have postulated, green-beard genes encode some kind of tag that helps the genome to know their identity (i.e. self-recognition).

## Altruistic amoeba

*Dictyostelium discoideum* is a free-living, fast-growing, unicellular amoeba. In the wild, it feeds on bacteria that grow on decaying vegetation. In the laboratory, researchers have been known to feed them a bacterial 'lawn' grown in a Petri dish. When the bacteria run out, the amoebae stop multiplying and gather in the hundreds of thousands to form multicellular aggregates visible to the naked eye.

The aggregates then transform into fruiting bodies, each a few millimetres tall. A fruiting body is composed of a slender stalk made of dead cells, and it holds aloft a droplet of spores. About 20% of the amoebae in an aggregate altruistically sacrifice themselves to form the stalk. The remaining 80% become the spores.

Small fauna, such as ants and earthworms, disperse the spores to new food sources where they germinate to release amoebae. The newly released amoebae then go on to repeat the cycle of growth, division, and dispersal.

## Beware of cheaters

Not all the amoebae in an aggregate necessarily share kinship: some could be only distantly related, so the aggregates can potentially be genetic chimeras – structures in which not all amoebae have the exact same genome. And when the



A view of *Dictyostelium discoideum* bacteria aggregating under a microscope. PUBLIC DOMAIN

genome differs, there is a risk that some strains may have found a way to 'cheat' and avoid becoming stalk cells, and as a result become represented in more than their fair share among the spores.

How does *D. discoideum* ensure that cheaters do not prosper?

In 2017, researchers from the University of Manchester, in the U.K., reported that two genes in the *D. discoideum* genome – called *tgtrB* and *tgtrC* – displayed all the properties one would expect in a green-beard gene. On May 11 this year, researchers at the Baylor College of Medicine in the U.S. reported evidence that *D. discoideum* amoebae use these genes to navigate the risk of chimerism.

Their findings demonstrate how sophisticated genetic machinery can confer these deceptively simple life-forms the ability to express a universal virtue. Both these studies were published in the journal *Nature Communications*.

## Separating kith from kin

The *tgtrB* and *tgtrC* genes are located next to each other in the *D. discoideum* genome, and are expressed together (so if one isn't expressed, the other isn't either). They contain information for cells to make two cell surface proteins called TgtrB and TgtrC. The TgtrB protein on one cell binds to the TgtrC protein on another. If the binding is strong, the TgtrB protein is activated, and confers altruistic behaviour – manifesting as the amoeba's willingness to form the stalk.

The binding between the TgtrB and the TgtrC proteins of cells of the same strain



The study demonstrated the logic that green-beard genes use to produce altruism plus the corresponding ability to keep altruistic amoebae from being exploited by greedy ones

is strong, and leads to self-recognition and cell-cell cooperation. Pure cultures of cells that lack the *tgtrB* and *tgtrC* genes fail to develop because they are unable to recognise each other as being alike.

The *tgtrB* and *tgtrC* genes are also very polymorphic within the same population of *D. discoideum* amoebae, they have multiple variants. In fact, they are among the most variable genes in the *Dictyostelium* genome. When the researchers in the 2017 study examined 20 strains of the amoeba isolated from a common location, they found 18 different variants of each gene.

The researchers were able to correlate differences in the *tgtr* gene sequences between two strains to the efficiency with which their cells segregated from each other in mixed aggregates and formed separate fruiting bodies. Specifically, when the binding of TgtrB and TgtrC proteins across the cells of diverged strains was weak, TgtrB failed to be activated, and the cells split away from each other instead of cooperating.

When the researchers deleted the *tgtrB* gene but left the *tgtrC* gene intact, the

amoeba did not cheat on 'non-self' amoebae that carried a different *tgtrC*. Instead, it cheated those with the same *tgtrC* variant as itself – i.e. its kin. Every family has its black sheep!

## From Haldane to Voltaire

On the other hand, amoebae in which the researchers activated the *tgtrB* gene alone (by introducing a mutation) were relegated to the stalk when mixed with their kin.

These findings demonstrate the logic that green-beard genes use to produce altruism plus the corresponding ability to keep altruistic amoebae from being exploited by greedy ones.

The British-Indian geneticist J.B.S. Haldane (1892-1964) is reputed to have said that he would jump into a river to save eight cousins but not seven – but also that he would jump in to save two brothers, yet not one. His quip highlights the fact that we share one-half of our genes with a sibling and one-eighth with a first cousin.

As far as we know, amoebae do not use rational numbers. Instead, they use their rapidly evolving genes to estimate kinship with other amoebae. If the genes have not diverged at all, or have diverged very little, there is kinship and it is good to cooperate. If they have diverged significantly, there is less kinship and hence cooperation is risky.

To paraphrase the philosopher Voltaire (1694-1778), if *tgtr* genes did not exist, it would be necessary for the amoeba to invent them.

(D.P. Kashekar is a retired scientist.)

# Green beard genes



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JADES-GS-z14-0, shown in the pulsar, is the new record-holder for the earliest known galaxy.  
NASA/ESA/STScI

## JWST spots oldest galaxy yet, from cosmic dawn

### Reuters

NASA's James Webb Space Telescope (JWST) has spotted the earliest known galaxy, one that is surprisingly bright and big considering it formed during the universe's infancy - at only 2% its current age.

By peering across vast cosmic distances, JWST is looking way back in time, observed the galaxy as it existed about 280 million years after the Big Bang event that initiated the universe roughly 13.8 billion years ago, the researchers said. This period spanning the universe's first few hundred million years is called cosmic dawn.

The telescope has revolutionised the understanding of the early universe since becoming operational in 2022. The new discovery was made by the JWST Advanced Deep Extragalactic Survey (JADES) research team.

This galaxy, called JADES-GS-z14-0, measures about 1,700 light-years across. It has a mass equivalent to 500 million stars the size of our Sun and was rapidly forming new stars, about 20 every year.

Before JWST's observations, scientists didn't know galaxies could exist so early and certainly not luminous ones like this.

"The early universe has surprise after surprise for us," said astrophysicist Kevin Haiman of Stanford Observatory at the University of Arizona, one of the leaders of the study published online this week ahead of formal peer review.

"I think everyone's jaw dropped," added astrophysicist and study co-author Francesco D'Agulo of the Kavli Institute

**JWST observed the galaxy as it existed about 280 million years after the Big Bang event that initiated the universe roughly 13.8 billion years ago.**

for Cosmology at the University of Cambridge. "JWST is showing that galaxies in the early universe were much more luminous than we had anticipated."

Until now, the earliest known galaxy dated to about 520 million years after the Big Bang, as announced by the JADES team last year.

"It makes sense to call the galaxy big, because it's significantly larger than other galaxies that the JADES team has measured at these distances, and it's going to be challenging to understand just how something this large could form in only a few hundred million years," Mr. Haiman said.

While it is quite big for such an early galaxy, it is dwarfed by some present-day galaxies. Our Milky Way is about 100,000 light years across, with the mass equivalent to about 10 billion sun-sized stars.

Star formation in the early universe was more violent than today, with massive hot stars forming and dying quickly, and releasing tremendous amount of energy through ultraviolet light, stellar winds and supernova explosions, Mr. D'Agulo said.

Three main hypotheses have been advanced to explain the luminosity of early galaxies. The first attributed it to supermassive black holes in these galaxies gobbling up material. That appears to have been ruled out by the new findings because the light observed is spread over an area wider than would be expected from black hole gluttony.

# JAMES WEB TELESCOPE

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# JAMES WEBB SPACE TELESCOPE

## ENGLISH

Will be the premier space observatory for astronomers worldwide, extending the tantalizing discoveries of the Hubble Space Telescope.

An international collaboration among NASA, the European Space Agency, and the Canadian Space Agency.

The largest telescope ever placed in space; 100 times more powerful than Hubble.

So big it has to fold origami-style to fit in the rocket and will unfold like a "Transformer" in space.

Has a 5-layer sunshield that protects the telescope from the infrared radiation of the Sun, Earth, and Moon; like having sun protection of SPF 1 million.

With unprecedented infrared sensitivity, it will peer back in time over 13.5 billion years to see the first galaxies born after the Big Bang.

Will orbit the Sun 1.5 million kilometers or 1 million miles from the Earth. (Hubble orbits 560 kilometers above the Earth.)

**Proposed  
Launch Date:**

Webb will be  
launched in 2021

**Launch  
Vehicle:**

Ariane 5 ECA

**Mission  
Duration:**

5 - 10 years

**Diameter  
of primary  
Mirror:**

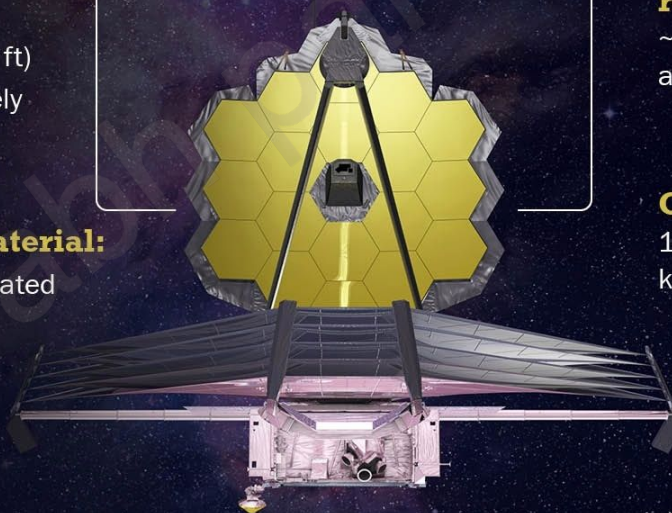
6.5 m (21.3 ft)  
approximately

**Primary  
mirror material:**

beryllium coated  
with gold

# JAMES WEBB TELESCOPE

A window into cosmos

**Focal  
length:**

131.4 meters

**Optical  
resolution:**

~0.1  
arc-seconds

**Orbit:**

1.5 million  
km from Earth



JADES-GS-z14-0, shown in the pulsar, is the new record-holder for the earliest known galaxy.  
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# The Preston curve

- The Preston curve refers to a certain empirical relationship that is witnessed between life expectancy and per capita income in a country.
- It was first proposed by American sociologist Samuel H. Preston in his 1975 paper “The changing relation between mortality and level of economic development”.
- Preston found that people living in richer countries generally had longer life spans when compared with people living in poorer countries.



- **This is likely because people in wealthier countries have better access to healthcare, are better educated, live in cleaner surroundings, enjoy better nutrition etc.**
- **When a poor country begins to grow, its per capita income rises and causes a significant increase in life expectancy initially as people are able to consume more than just subsistence calories, enjoy better healthcare etc.**

# More road projects, higher toll revenue boost the introduction of InvITs

**Janaki Krishnan**  
MUMBAI

The faster pace of development of highways in FY25 alongside increased revenue from tolls and toll hikes are attracting road developers, private equity and pension funds to float road infrastructure investment trusts, assets under which are expected to more than double in the next three years creating a ₹1 lakh crore incremental lending opportunity.

In FY24 road InvITs controlled more than 10,000 km of road length and this is expected to cross 22,500 km by FY28, according to SBI Caps.

## Major buyers

"InvITs have emerged as one of the major buyers of operational road assets in India in recent years, and it has also facilitated the unlocking of capital for road developers once their road projects become operational," said Vinay Kumar G., Vice President and Sector Head - Corporate Ratings at ICRA.

There are more than half a dozen road InvITs already in operation while more are in the pipeline. At the moment, PE firm Actis-backed NXT Infra Trust and Roadstar Infra Pvt. Ltd.'s (a subsidiary of IL&FS Transportation Networks) InvIT is awaiting regulatory approval.

In the current fiscal year, the awarding of road projects by the Ministry of Road Transport and Highways is expected to be better than the 8,551 km seen last year, while execution is expected to be 5-8% higher at 12,500-13,000 km, ac-



**Patient capital:** Key investors in InvITs were pension funds and sovereign funds who invested for the long term. THE HINDU

## ICRA projects NHAI's asset monetisation in FY25 could fetch it up to ₹60,000 cr. via sale of 33 road assets

cording to Mr. Kumar.

Fastag revenue spiked in FY24 to ₹65,000 crore and it is expected to reach ₹77,000 crore in the current fiscal year and to surpass ₹1 lakh crore annually by FY28, SBI Caps estimated. On Sunday, National Highways Authority of India announced a 5% raise in toll rates, giving further boost to revenue visibility.

## Patient capital

The road sector, due to the long-term concession periods and elongated payback periods requires patient capital with a long-term investment horizon, pointed out Mr. Kumar. He added that key investors in InvITs were pension funds and sovereign funds who invested

for the long term.

Canada's CDPQ and CPPIB are pension funds that have taken stakes in road InvITs in India.

Anything which generates revenue is InvIT-able, said Prateek Jawar, Head, Infrastructure & Real Assets at Avendus.

He added that more InvITs were in the pipeline, especially with a new monetisation programme of NHAI's assets expected.

ICRA had recently estimated that NHAI's asset monetisation in FY25 could fetch it up to ₹60,000 crore from the sale of 33 road assets through toll-operate-transfer and InvIT mode; this could translate into ₹38,000-43,000 crore funding opportunity.

"We expect InvITs will continue to acquire operational road assets and grow their asset base further in the coming years," said Mr. Kumar.

*(The writer is with The Hindu businessline)*

# InviTs

- InviTs are a type of investment vehicle that allows investors to invest in infrastructure projects.
- The main objective of InviTs is to provide retail investors with access to investment opportunities in infrastructure projects that were previously only available to large institutional investors.
- InviTs offer investors the opportunity to invest in a diversified portfolio of infrastructure projects, which can provide stable income streams and potential capital appreciation over the long term. At the same time, it helps infrastructure projects tap into household savings

- **InvITs are similar to mutual funds or REITs, but they invest in infrastructure assets like toll roads, power transmission lines, and pipelines.**

## **Structure**

- **InvITs are created by sponsors, who are typically infrastructure companies or private equity firms.**
- **The sponsor sets up the InvIT and transfers ownership of the underlying infrastructure assets to the trust.**
- **The trust then issues units to investors, which represent an ownership stake in the trust and thus the underlying assets**

# What are Infrastructure Investment Trusts ?

It is a trust which raises money from individuals, companies & institutions to invest in infra. projects.



The money raised is used to construct highways, dams, power & energy farms, towers etc.



Revenue generated from these projects are distributed to shareholders as dividends.



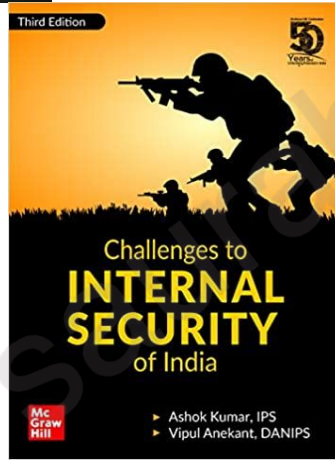
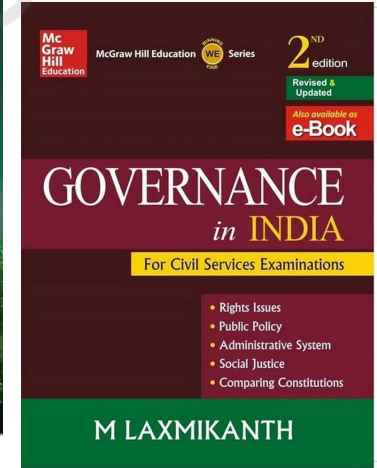
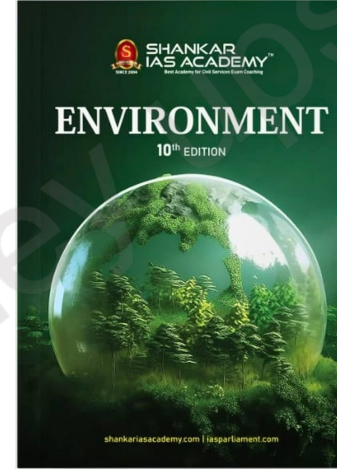
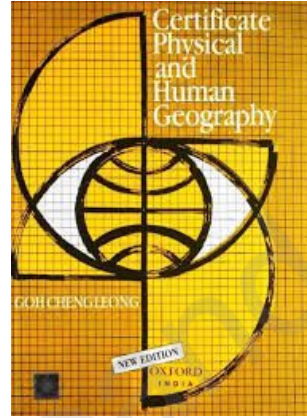
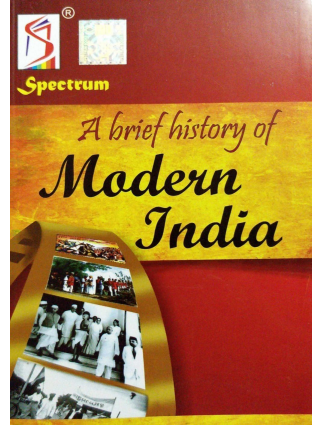
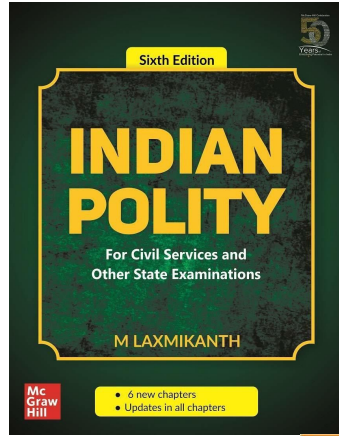
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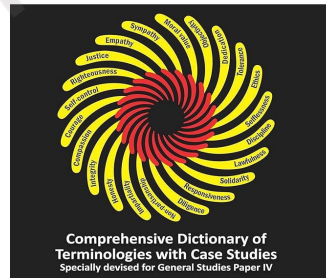




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