BIOTECHNOLOGICAL INNOVATION IN SNAKE VENOM RESEARCH:

Addressing Affordability and Accessibility in Modern Medicine

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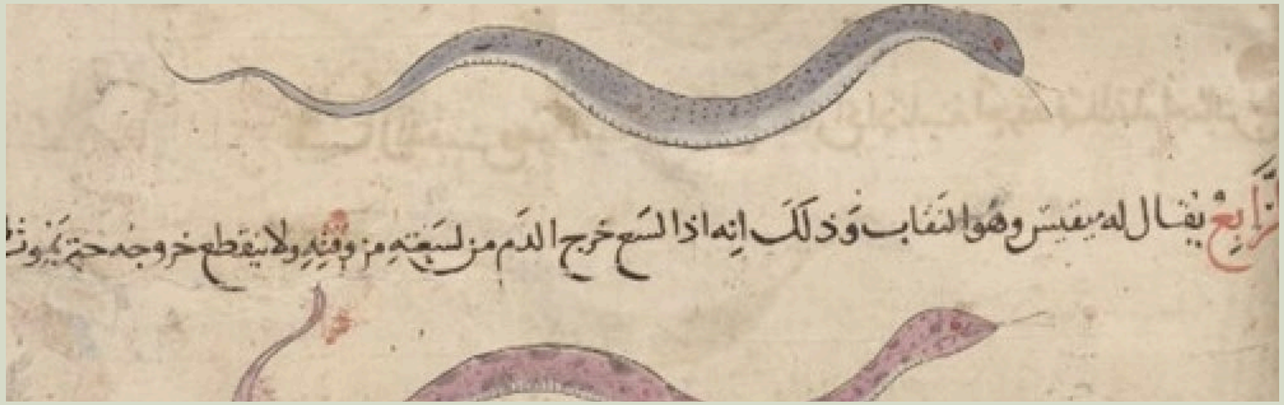
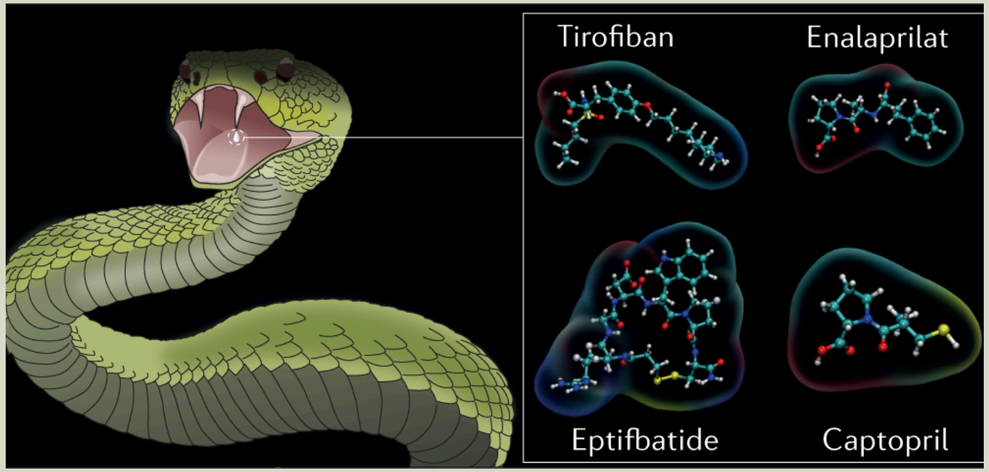
BACKGROUND OF THE STUDY



- Over centuries (Chinese + Ayurvedic)
- First medical breakthrough: antivenom in late 1800s



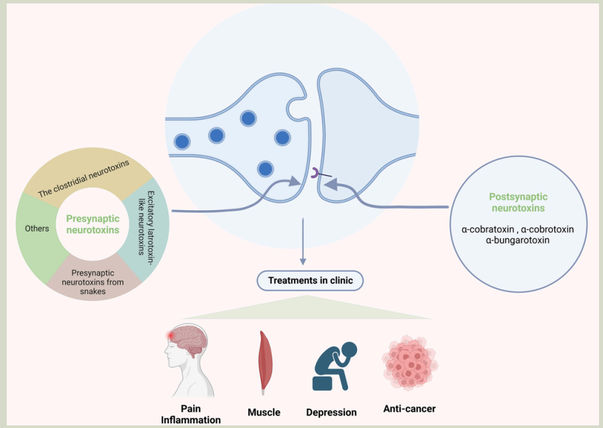
Modern Research

Venom proteins into new medications:

- Painkillers
- Blood pressure & heart drugs (Captopril)
- Clot prevention meds (Tirofibin)

Harrison et al., 2009
NTD, 2019
Lewis & Garcia, 2003
Harvey, 2014

TYPES OF VENOM: NEUROTOXIC



Source:

- **Elapid** snakes: Indian cobra (*Naja naja*) + black mamba (*Dendroaspis polylepis*)

Mechanism

- Contains α-neurotoxins & dendrotoxins
- Binds to acetylcholine receptors + ion channels
- Disrupt synaptic transmission --> paralysis

Application

- Pain relief: Cobrotoxin --> non-opioid analgesic potential
- Alzheimer's Disease: Cholinergic paths
- Parkinson's Disease: Target potassium channels/stabilize neuron activity

Lewis & Garcia, 2003
Kalita et al., 2022
Harvey, 2014
Dutertre & Lewis, 2010

TYPES OF VENOM: CARDIOTOXIC

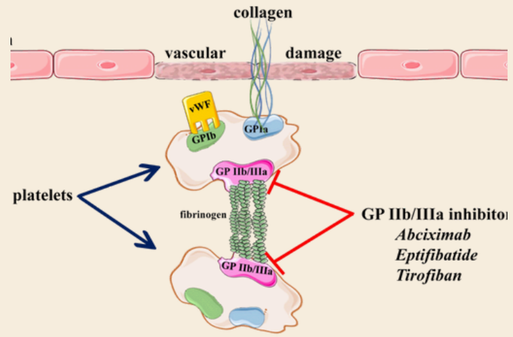
Common Source:
Russell's viper (*Daboia russelii*) → near human habitats

Active Venom Proteins:

- Disintegrins
- Phospholipase A2 enzymes
- Serine proteases → regulate clotting, vascular tone

Mechanism:
Kills cardiac muscle cells
Arrhythmias, cardiac arrest

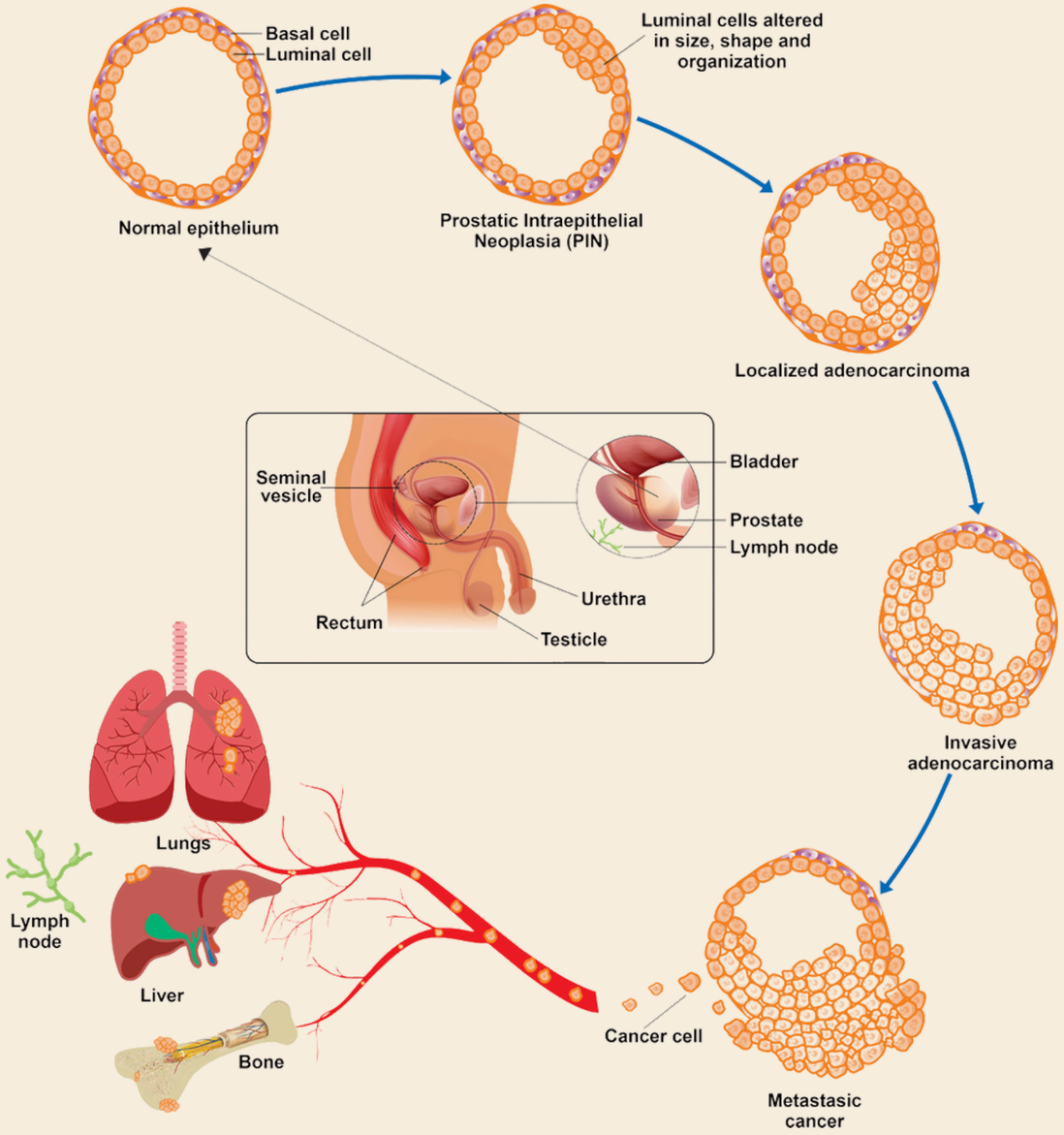
Pharmaceutical Insight:
Tirofiban: antiplatelet drug from viper disintegrin
Targets glycoprotein IIb/IIIa to prevent clotting



Gutiérrez et al., 2017
Koh & Kini, 2012
Markland, 1998

TYPES OF VENOM: CYTOTOXIC

- **Source:** cobra, viper, rattlesnake
- **Mechanism:** destroy cells (membranes) → apoptosis (programmed cell death)
- **Usage in Cancer:**
  - Melittin (bee venom) = suppresses tumor growth
  - Disintegrins (viper venom) = tumor metastasis
- **Ongoing Research:** leukemia



Bittenbinder et al., 2024
Haddoub et al., 2020

LIMITATIONS

Challenge: Deliver safe, ethical, affordable venom-based drugs at scale.

Cost

- Sterile environments + large amounts of yield to create **1 vial (up to 50 snakes)**
- Developing countries: imports required

Toxicity/Stability

- **Narrow** therapeutic windows
- Peptides/proteins are **unstable** --> efficacy

Ethical Concerns

- Conditions in **venom harvesting**
- Techniques: electrostimulation
- Unnatural diet
- Butantan Institute w/ ethical committees

Impacts Accessibility (low-income)

Grego et al., 2021
Harrison et al., 2009
NTD, 2019

RESEARCH QUESTION

How can **biotechnology** be leveraged to develop cost-effective and accessible therapeutic applications from snake venom for the treatment of common diseases?

Common Diseases: Alzheimer's + Parkinson's, Cardiovascular disorders, Chronic pain, & Cancer

1: RECOMBINANT PROTEIN PRODUCTION

What it is:

- Isolates + clones specific venom toxin genes
- Uses fast-growing organisms (E. coli, yeast, CHO cells)

Why it matters:

- Mass production **without live snakes**
- Higher purity, consistency, scalability → reduces waste

Impact:

- Reduces production costs by **90%**
- Ex: $14,000 → reduces to **$1,354** (polyvalent version)

Jenkins & Laustsen, 2020

2: RNA INTERFACE (RNAI)

What it is:

- Silences specific genes
- Mitigates toxicity/drug resistance

Why it matters:

- Precision: selectively blocking harmful pathways
- Immune system diseases

↓

Impact:

- Reduces side effects (by specificity)
- Lower HC costs by therapeutic safety + effectiveness

Lüddecke et al., 2023

3: CRISPR-BASED GENE EDITING

What it is:

- Gene-editing tool that changes/disables genes
- Stops gene expression via mutations → early stop codon

Application in Venom Study:

- Reveals how venom affects the body at genetic level
- Repurpose existing treatments

Impact:

- Accelerates therapeutic target discovery
- Drug repurposing
- **Reduces** time + cost of development

Coddington et al. 2024

SOLUTION CONT: ECONOMIC ACCESS

1: Scalability

- Using **existing infrastructure**
- Adaptable to regional biotech hubs
- Job Growth
- Ex: India's Serum Institute

2: Policy + HC System

- Eligible for Organ Drug Benefits (tax credits, FDA fast-tracking)
- Subsidize **R&D** in exchange for price controls
- National essential medicine lists

Potet et al., 2021
Yadav, 2024

SOLUTION CONT: ECONOMIC ACCESS

3: Global Health Accessibility

- WHO’s existing snakebite treatment plan
- NGO collaborations
- Ex: Montiviperia treatments tested in sub-saharan clinics

4: Integration

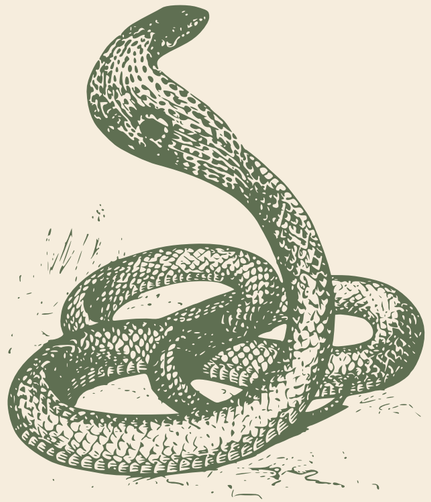
- **Compatible** with current CRO/CMO pipelines
- Reduces dependency on rare raw materials
- Aligns with global bioeconomy strategies (**sustainability**)

Lüddecke et al., 2023
Matlani, 2024
Matthews et al., 2017

CONCLUSION

Objective: Equitable Healthcare

- **Biotech:** lowers cost + enables scalability
- **Economy:** logistically viable + accessible



QUESTIONS?

Lit Review:

References:

Thank You To:

GHP

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