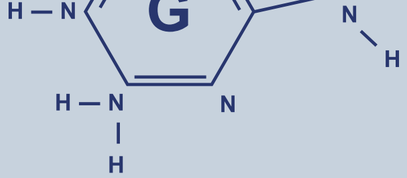
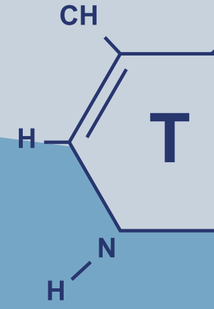


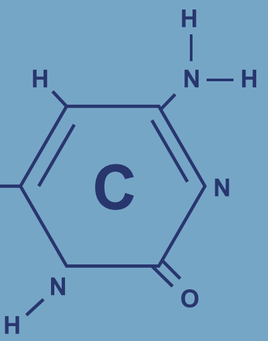
STANFORD SUMMER MINI FELLOWSHIP

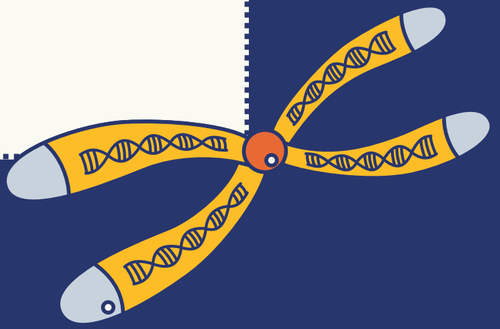
AKWESI N. DUODU

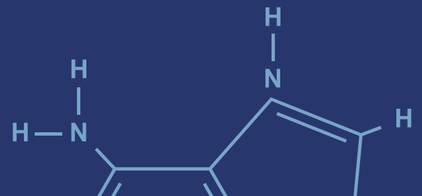
JULY 2025

AI FOR MOLECULAR IMAGING APPLICATIONS

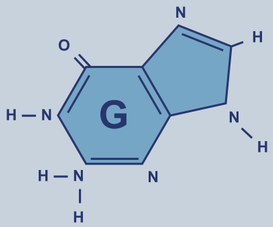








Introduction

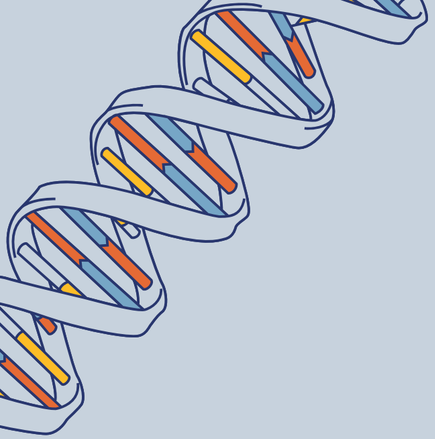


- Molecular imaging is a rapidly evolving field that enables visualising and quantifying biological processes at the molecular and cellular levels.

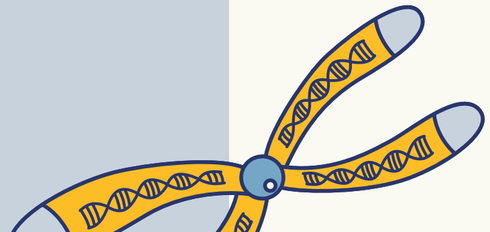
- Techniques such as PET, Single-Photon Emission Computed Tomography (SPECT), MRIs and Optical Imaging play a crucial role in disease diagnosis, drug development, and medicine prescription.

- Interpreting molecular imaging data is complex due to noise, low resolution, and vast datasets.

- Artificial Intelligence (AI), which appears in recent times to be "attracting attention" in clinical molecular imaging, is revolutionising molecular imaging by enhancing image reconstruction, segmentation, quantification, and predictive analytics[1].



APPLICATIONS OF AI IN MOLECULAR IMAGING



Applications of AI in Molecular Imaging

1. Image Reconstruction & Enhancement

- Problem: Traditional reconstruction methods (e.g., filtered back projection, iterative reconstruction) are computationally intensive and suffer from noise [2].
- AI Solution:
  - Deep learning (DL) models (e.g., CNNs, GANs) improve image quality by reducing noise via model training and artifacts[3].

2. Automated Segmentation & Quantification

- Problem: Manual segmentation of tumors or organs is time-consuming and prone to inter-observer variability[4].
- AI Solution:
- Convolutional Neural Networks (CNNs) automate tumor detection in PET/CT scans with high precision.

Challenges & Future Directions

Interpretability: Black-box AI models lack transparency in clinical decision-making since research is largely novel in this field.

- **Regulatory Hurdles**: FDA/EMA approvals for AI-based imaging tools are still evolving.

Federated Learning: Enables multi-institutional AI training without sharing sensitive patient data. AI is transforming molecular imaging by improving accuracy, efficiency, and predictive capabilities. While challenges like data privacy and model interpretability persist, advancements in deep learning, federated AI, and quantum computing will further integrate AI into clinical workflows.

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