

# **Graphene Oxide@Gold Nanorods Conjugate for Controlled Release of Doxorubicin in tumor**

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# NANO

# TECHNOLOGY

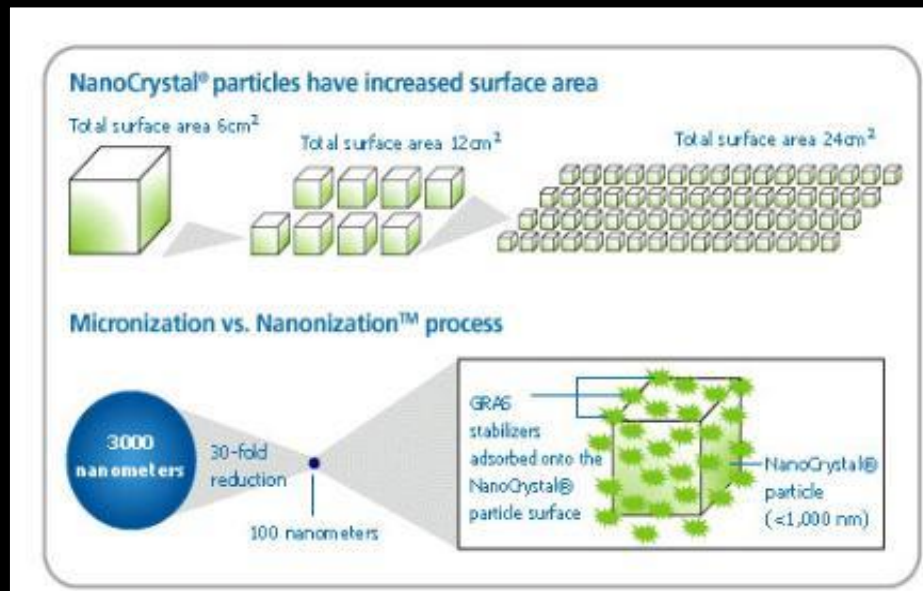
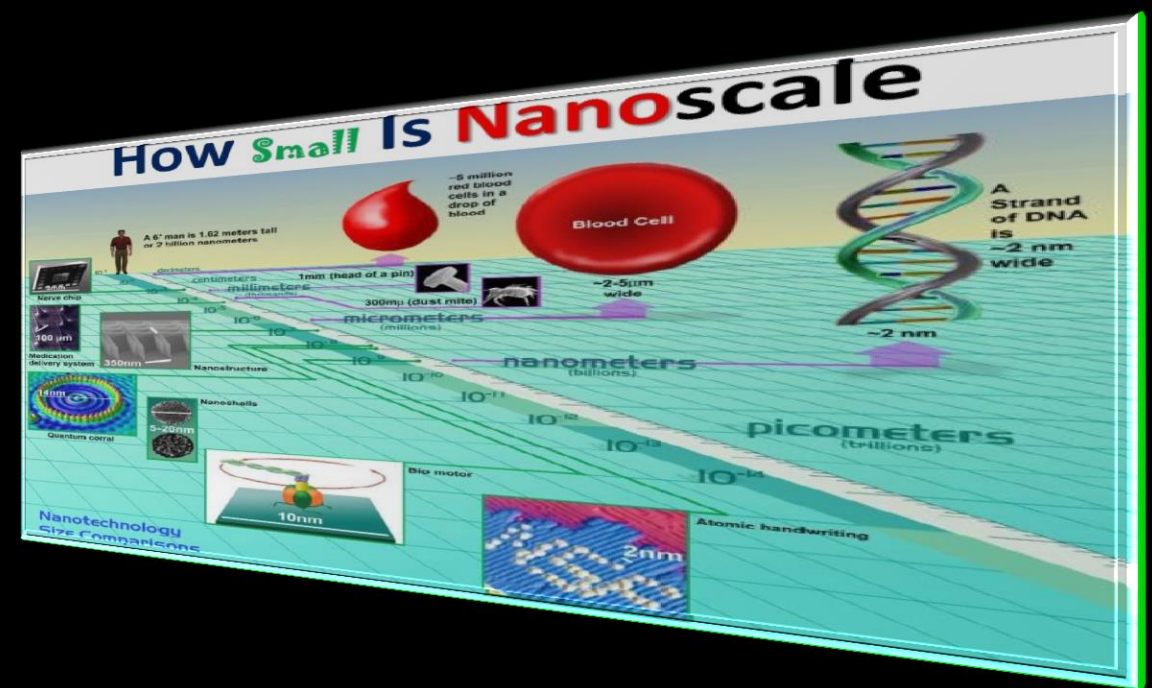
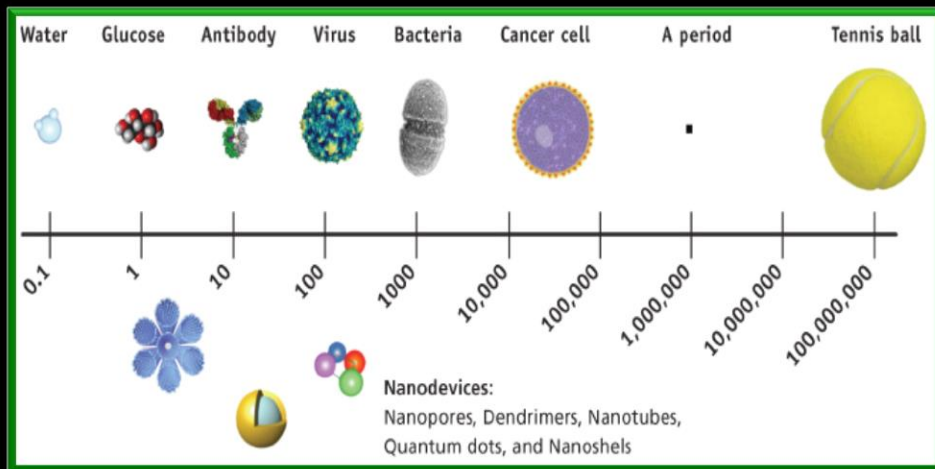
*the power  
of*

# Small

*“There's Plenty of Room at the Bottom”*

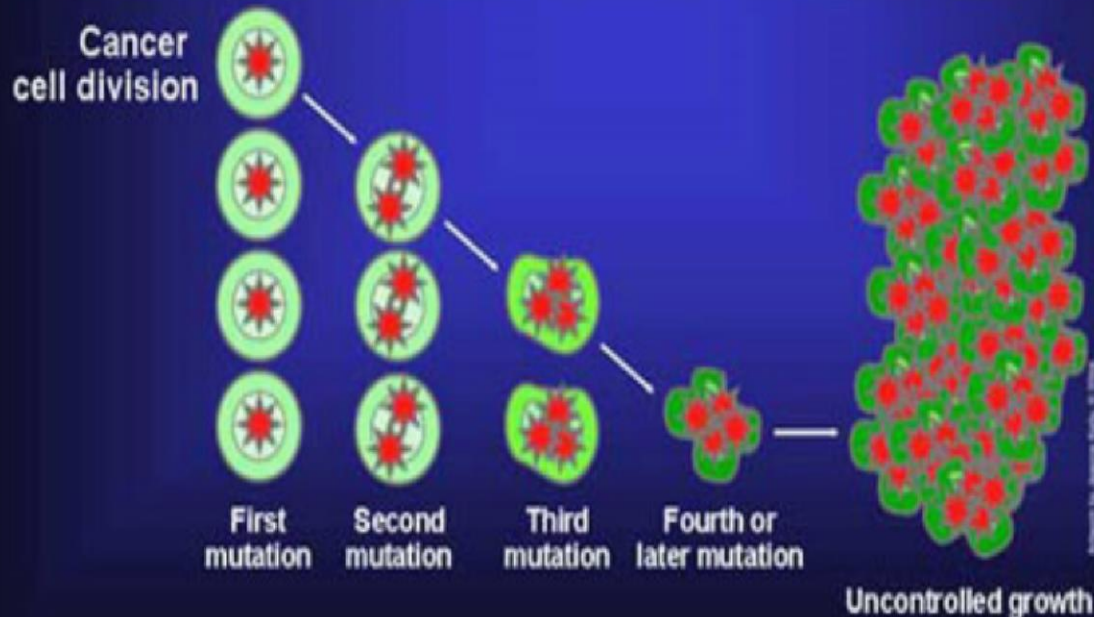
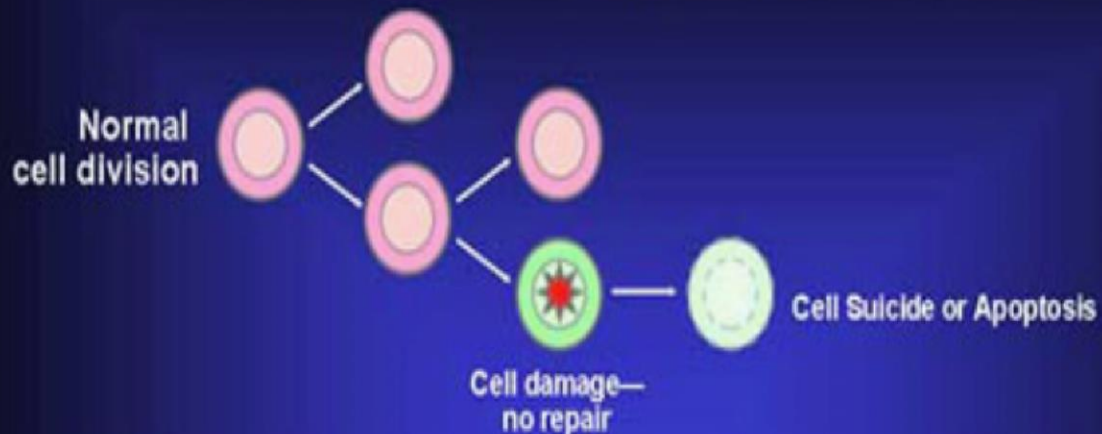
Richard Feynman





# Cancer ?

## Loss of Normal Growth Control



NATIONAL  
CANCER  
INSTITUTE

## Estimated Cancer Deaths in the US in 2013

**Men 306,920**

**Women 273,430**

Lung & Bronchus

28%

26%

Lung & Bronchus

Prostate

10%

14%

Breast

Colon & Rectum

9%

9%

Colon & Rectum

Pancreas

6%

7%

Pancreas

Liver

5%

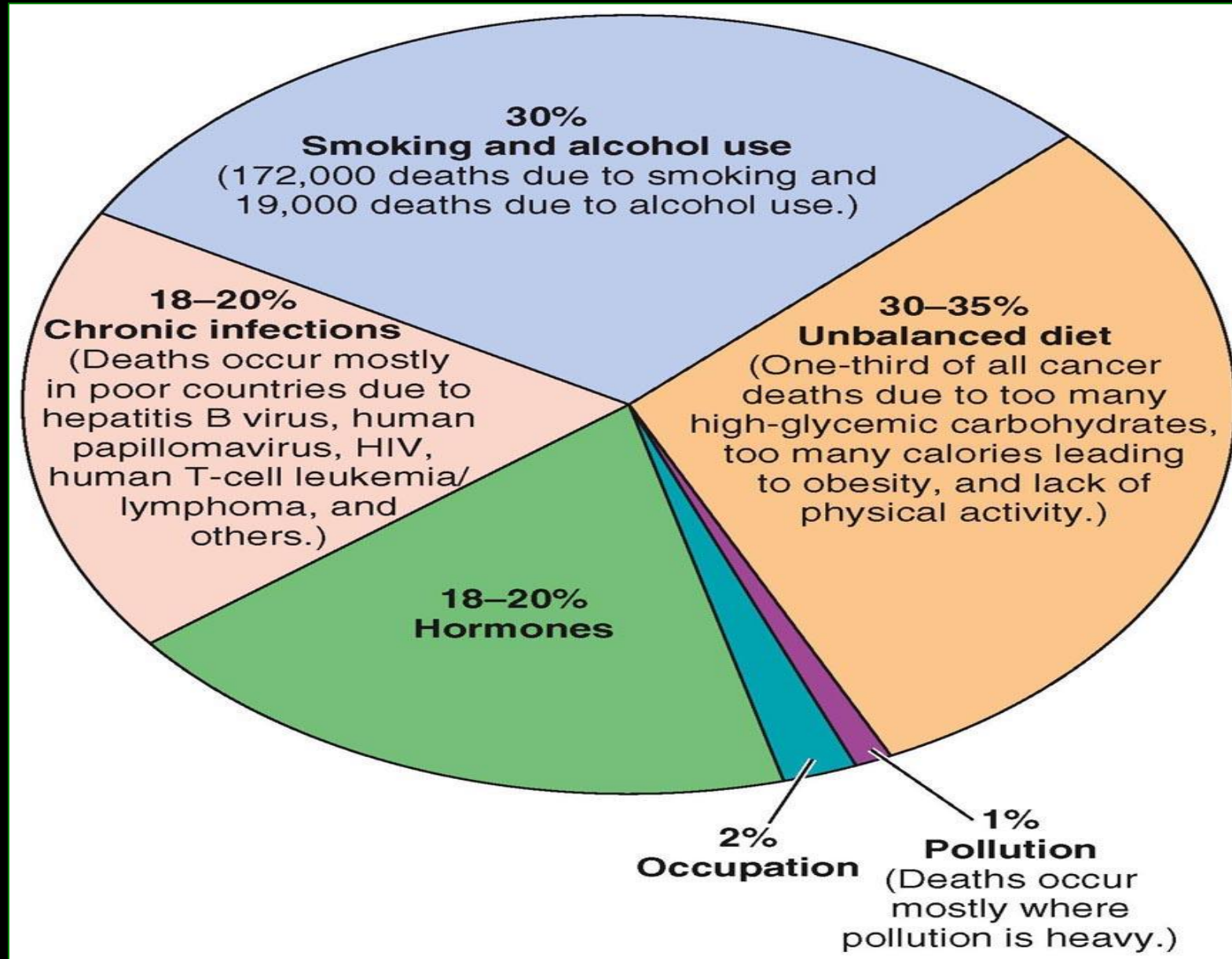
5%

Ovary

- American Cancer Society



# Factors Believed to Contribute to Global Causes of Cancer

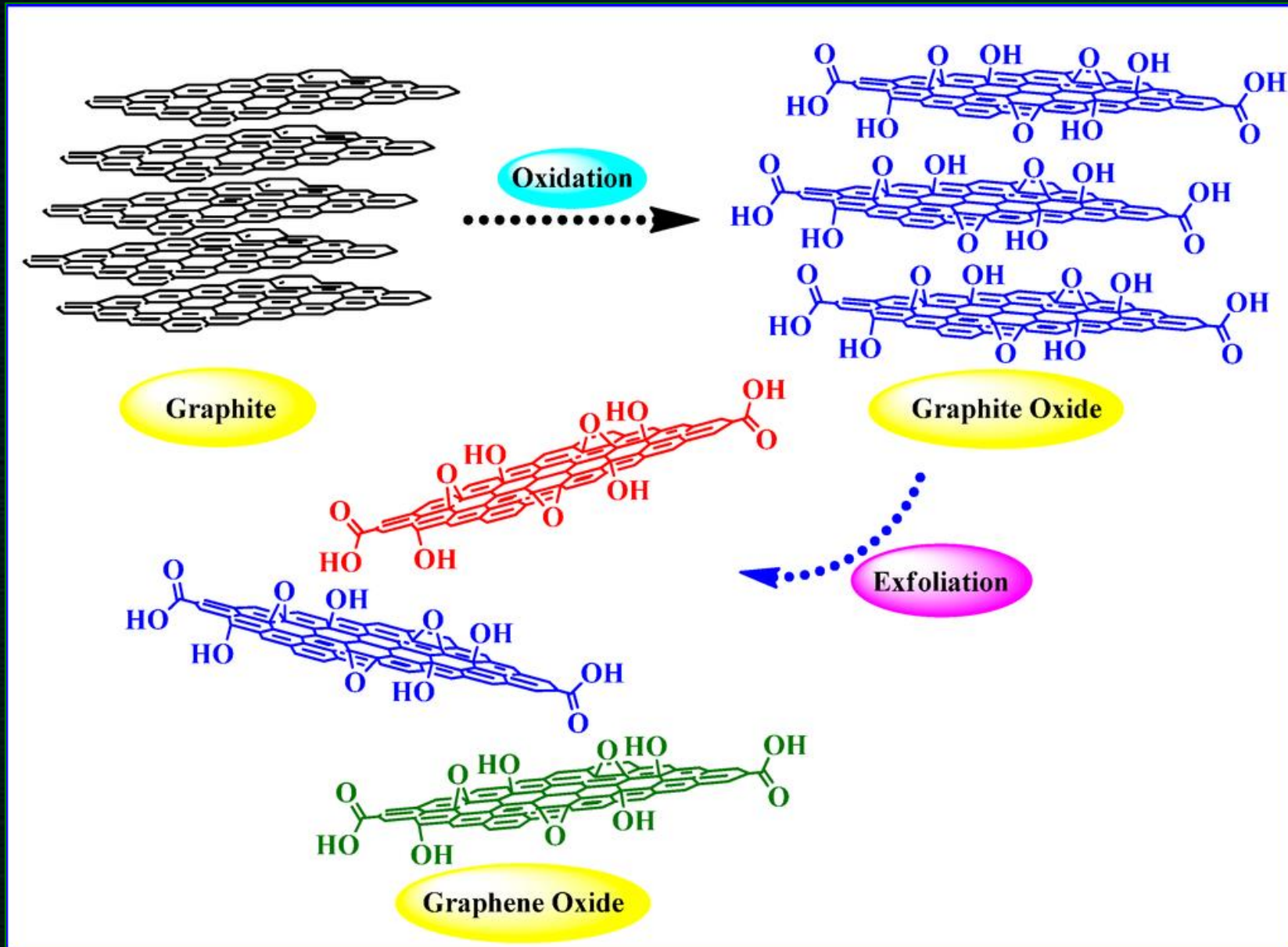


# The flow...

- ❑ Synthesis of Graphene Oxide and Gold nanorods
- ❑ Characterization
- ❑ Photothermal property
- ❑ Application

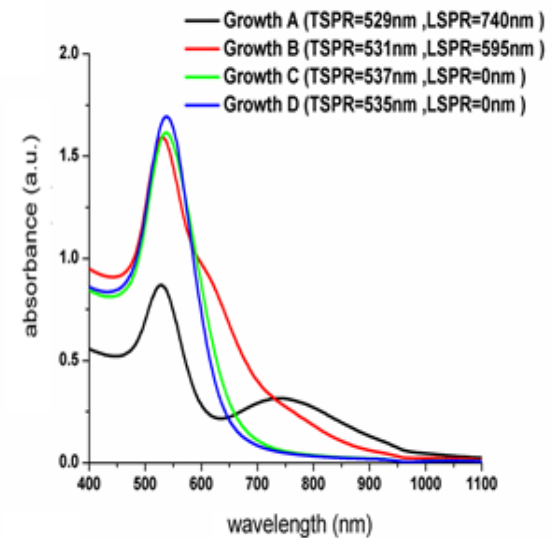
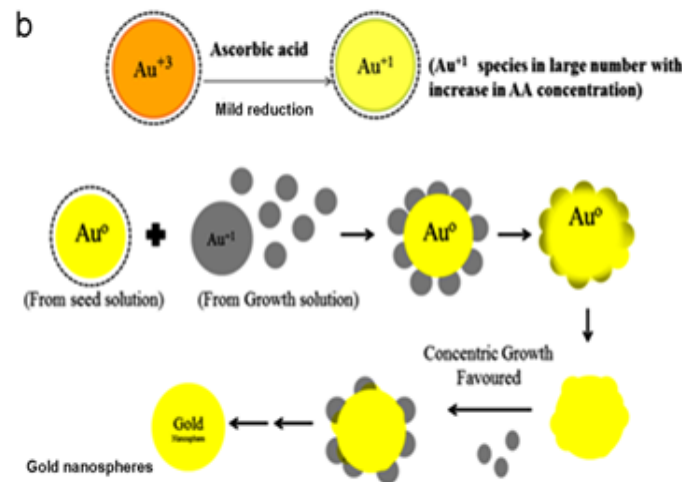
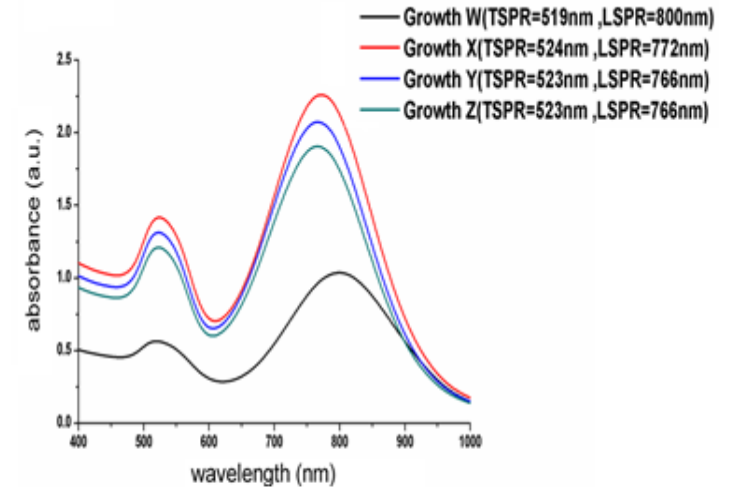
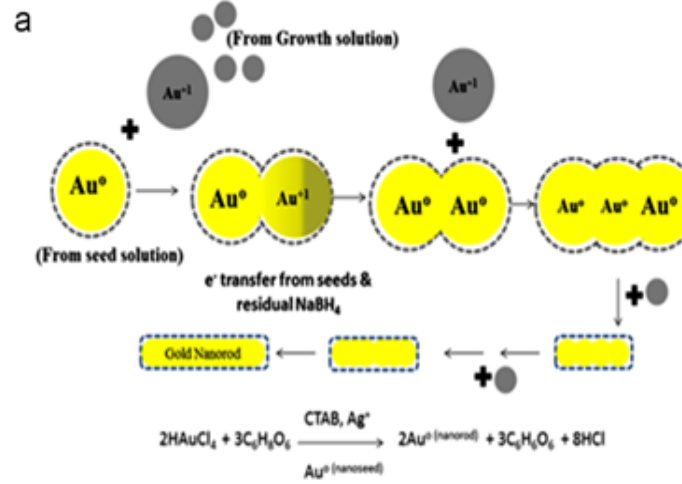
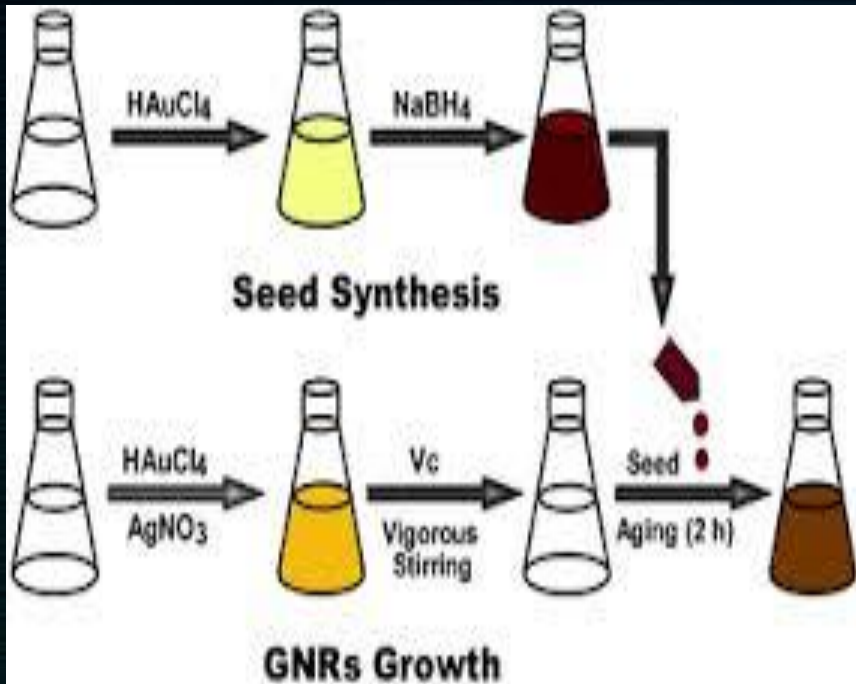


# Synthesis of Graphene oxide



Functionalisation with  
*Arabica acacia*

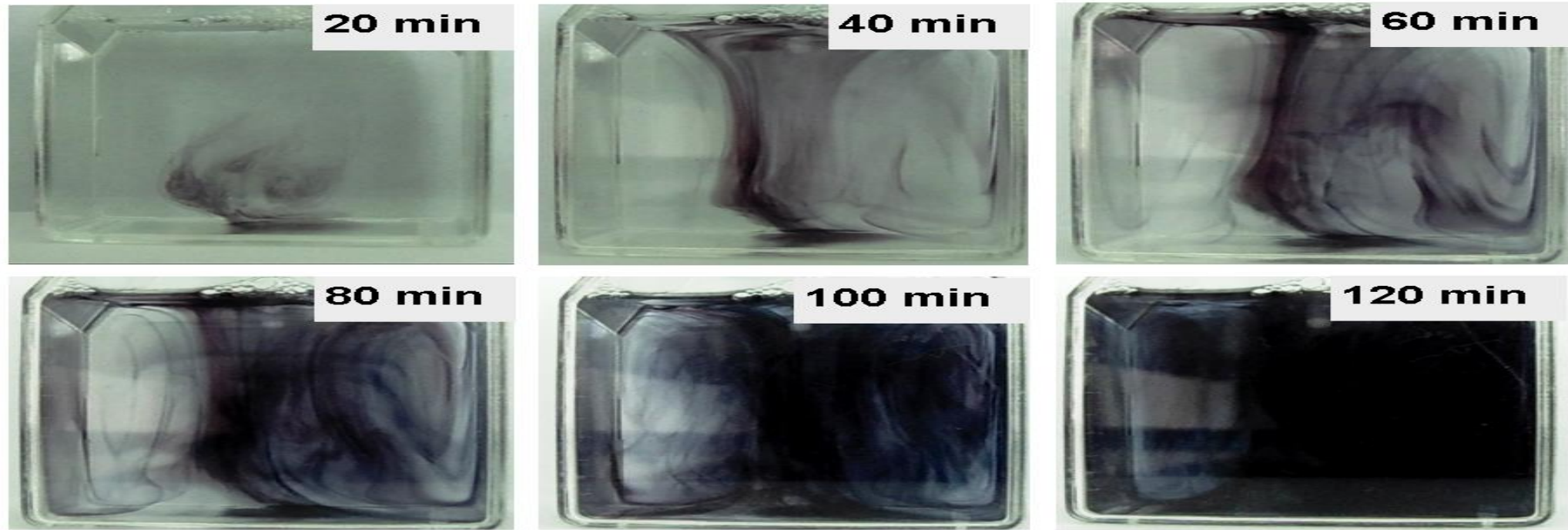
# Synthesis Gold Nanorod



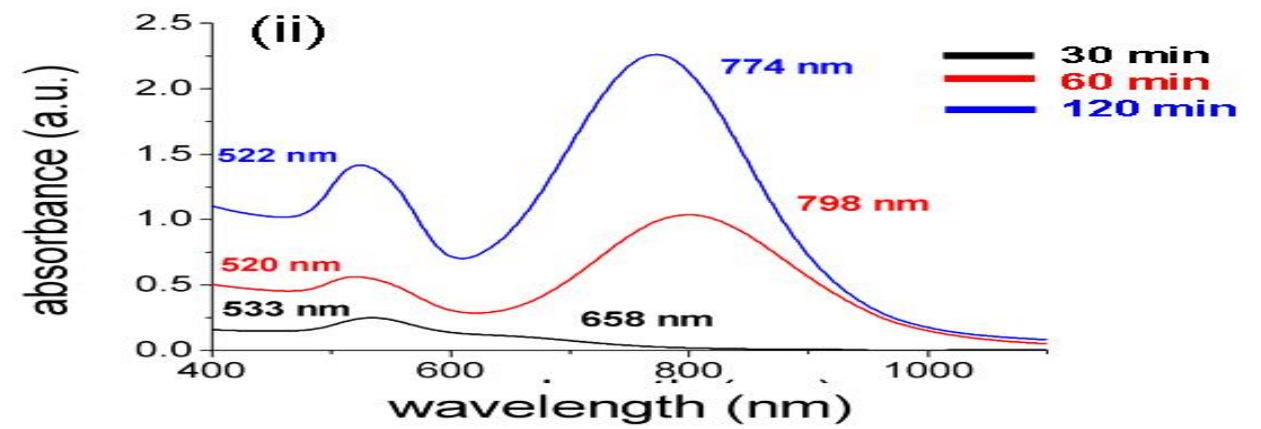
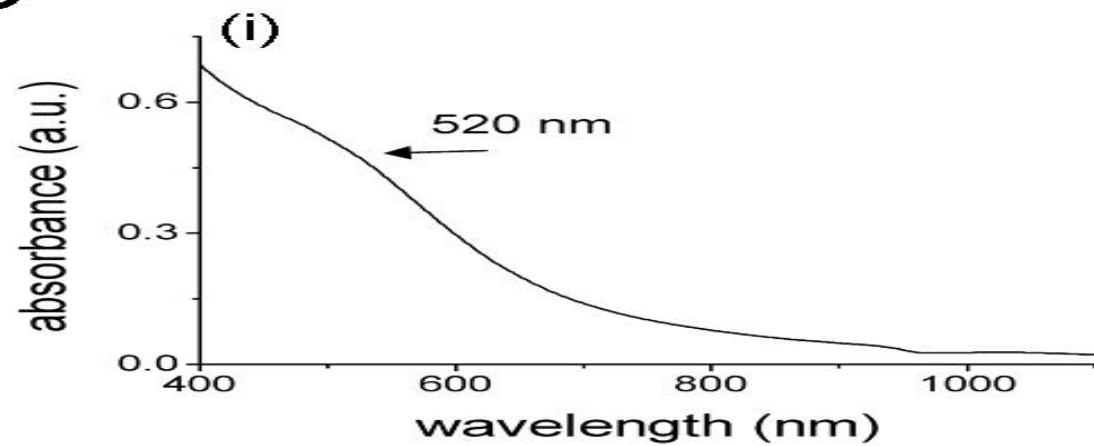


# Formation of Gold Nanorod

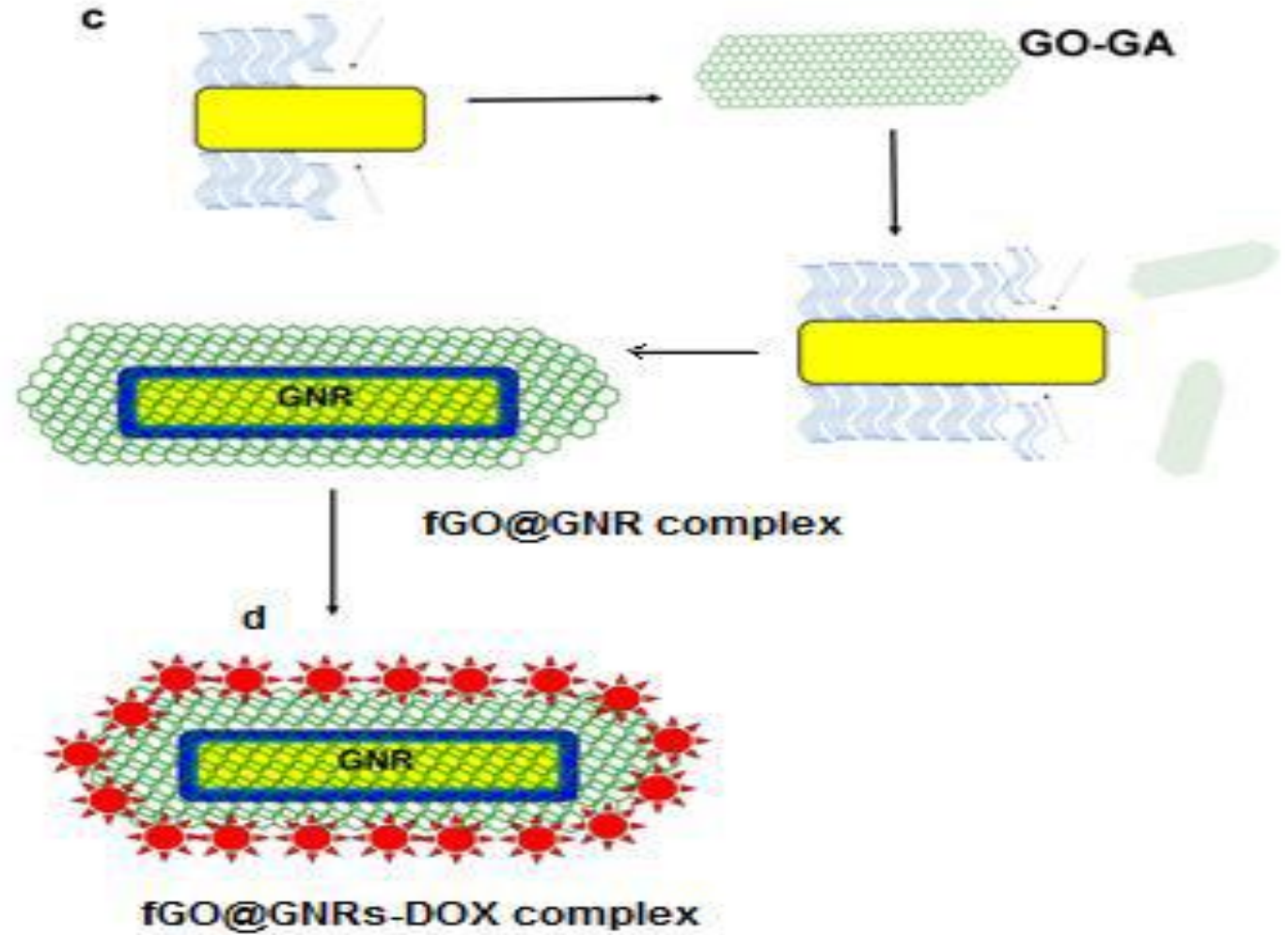
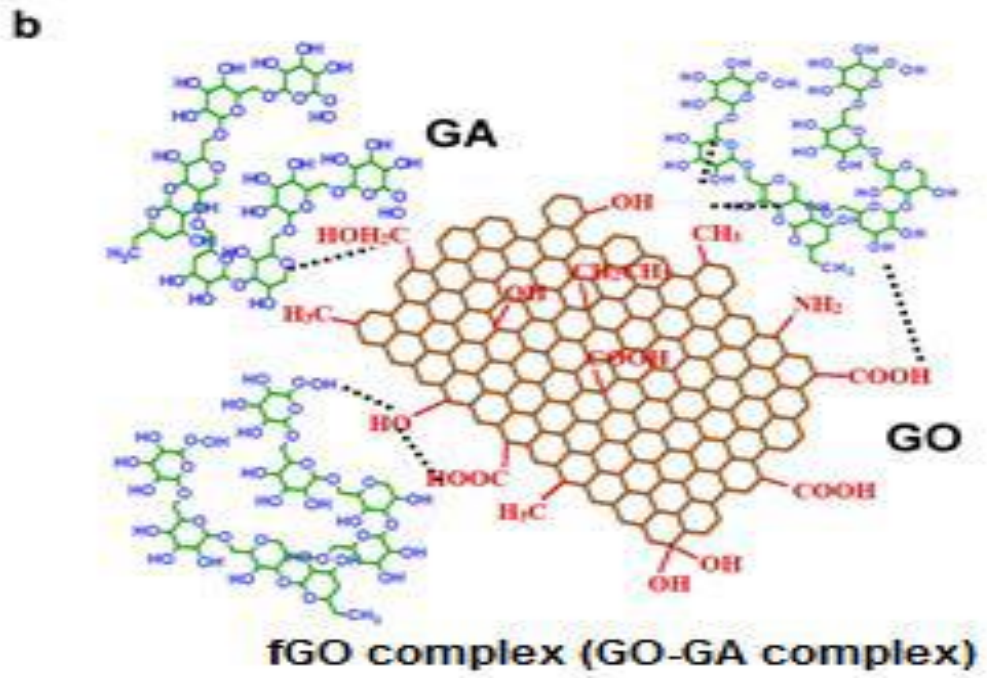
**a**



**b**

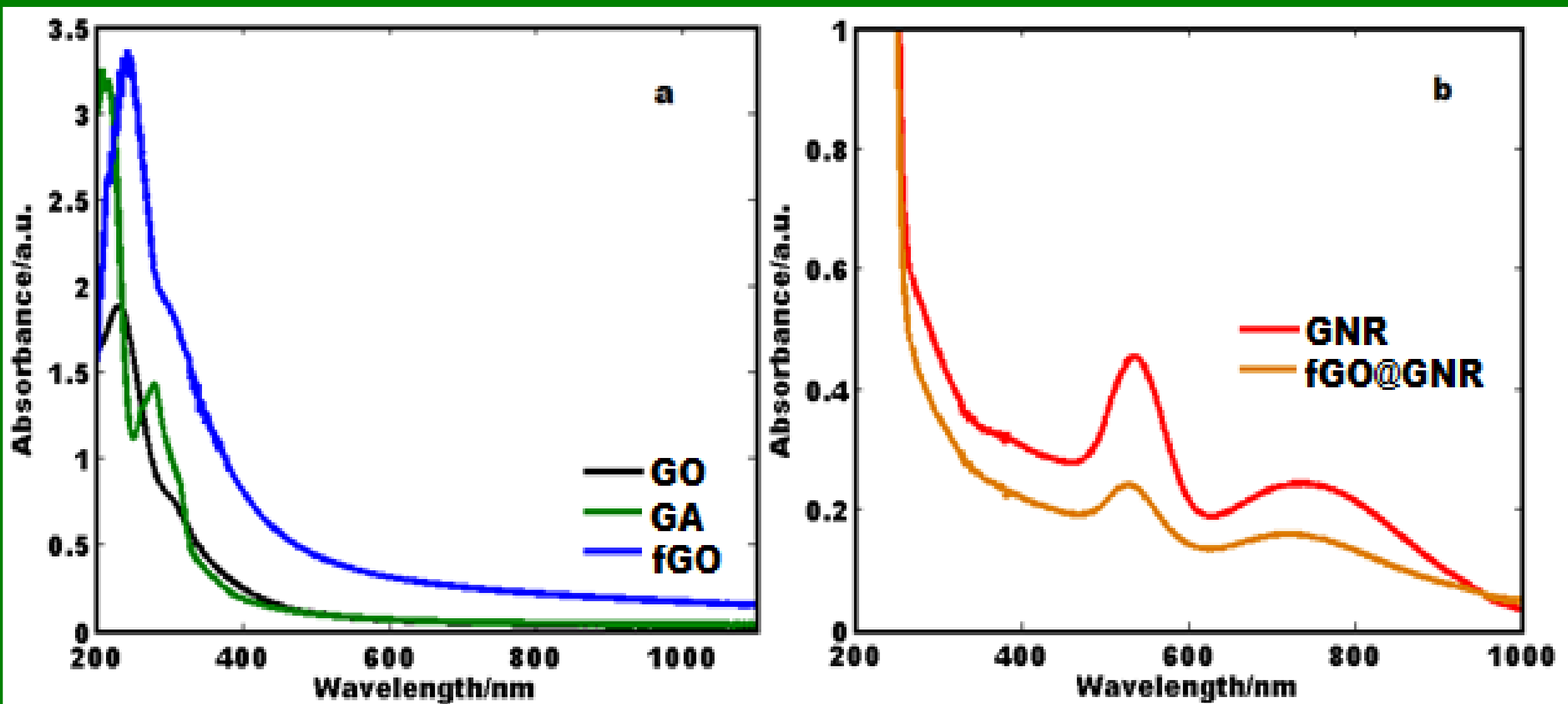


Schematic representation of the important steps involved in synthesis of the drug delivery vehicle based on graphene oxide and gold nanorods (a) Colors of the solution at various stages of reactions to form final conjugate viz i-GO, ii-GA, iii-fGO, iv-fGO@GNRs and v-fGO@GNR-DOX (b) fGO conjugate (GO-GA) synthesis after reaction of GO with GA (c) Incorporation of fGO in the GNRs (fGO@GNRs) during zipping mechanism (d) Loading of anti-cancer drug DOX on fGO@GNRs complex.

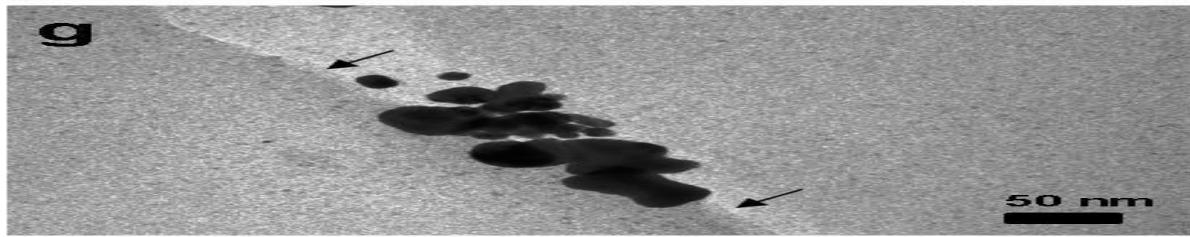
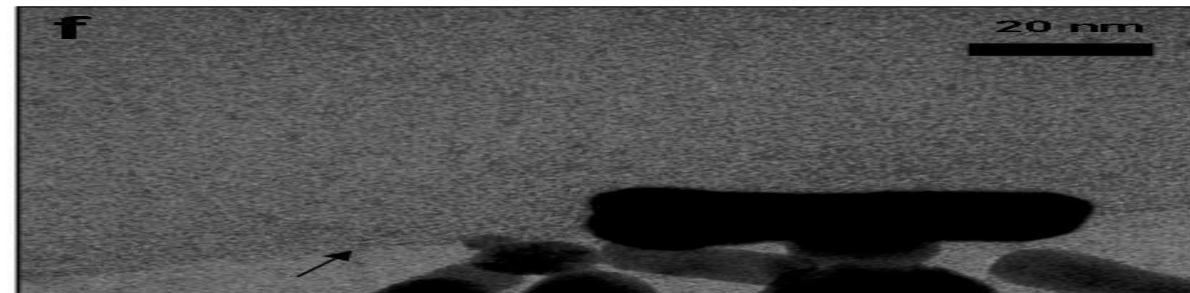
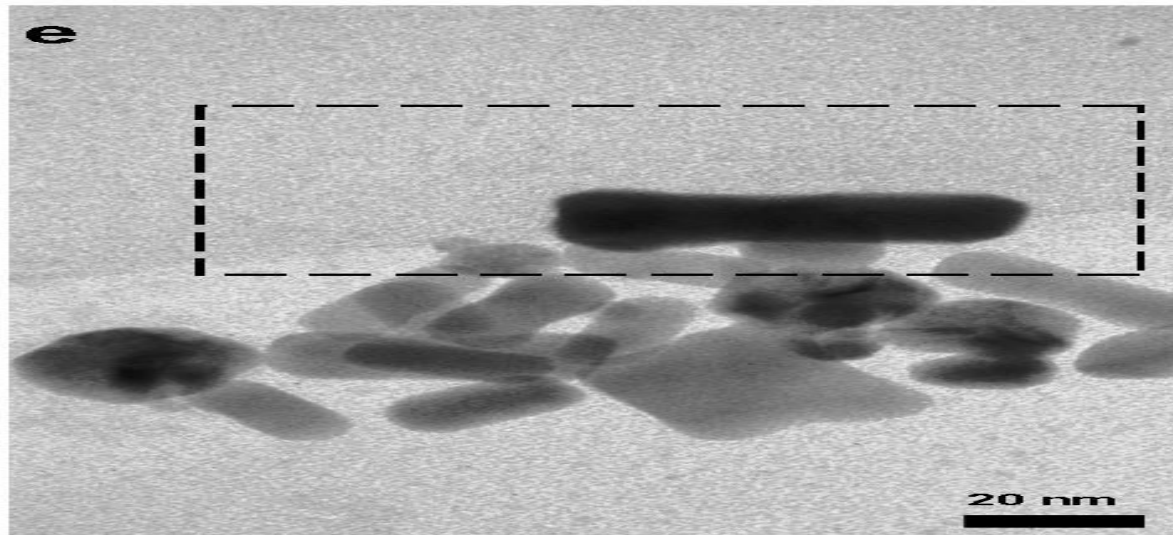
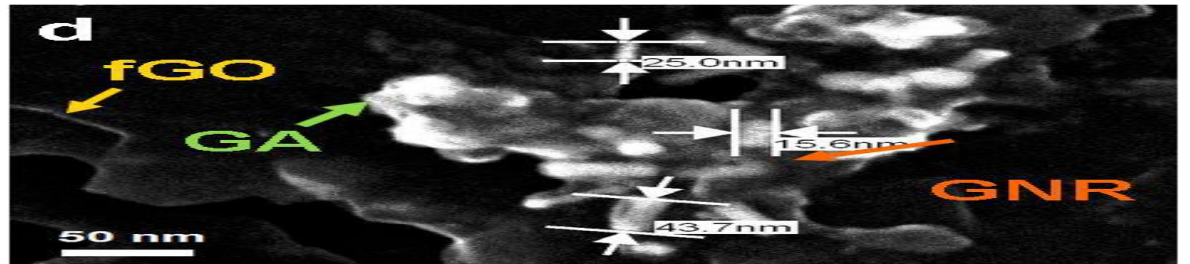
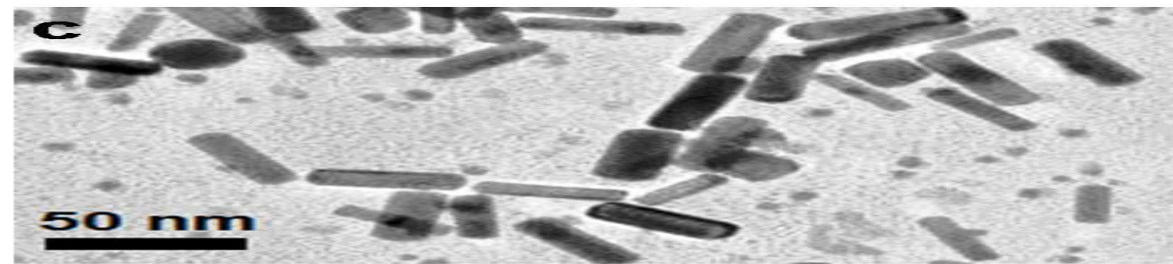
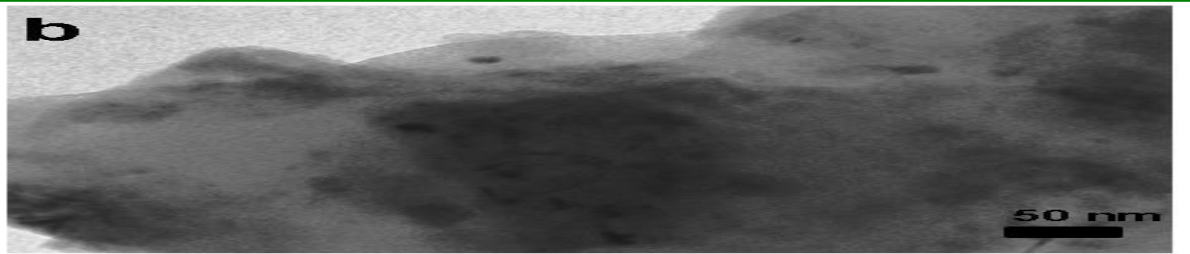
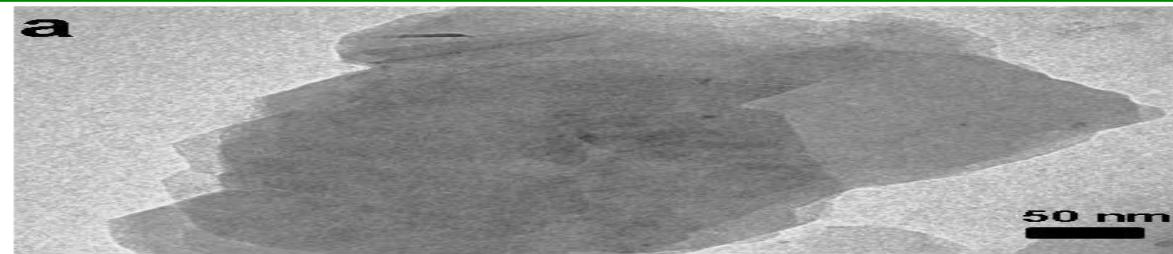




UV-Vis spectra of (a) Graphene Oxide, Gum arabic and their complex and (b) Gold nanorods and its conjugation with fGO.

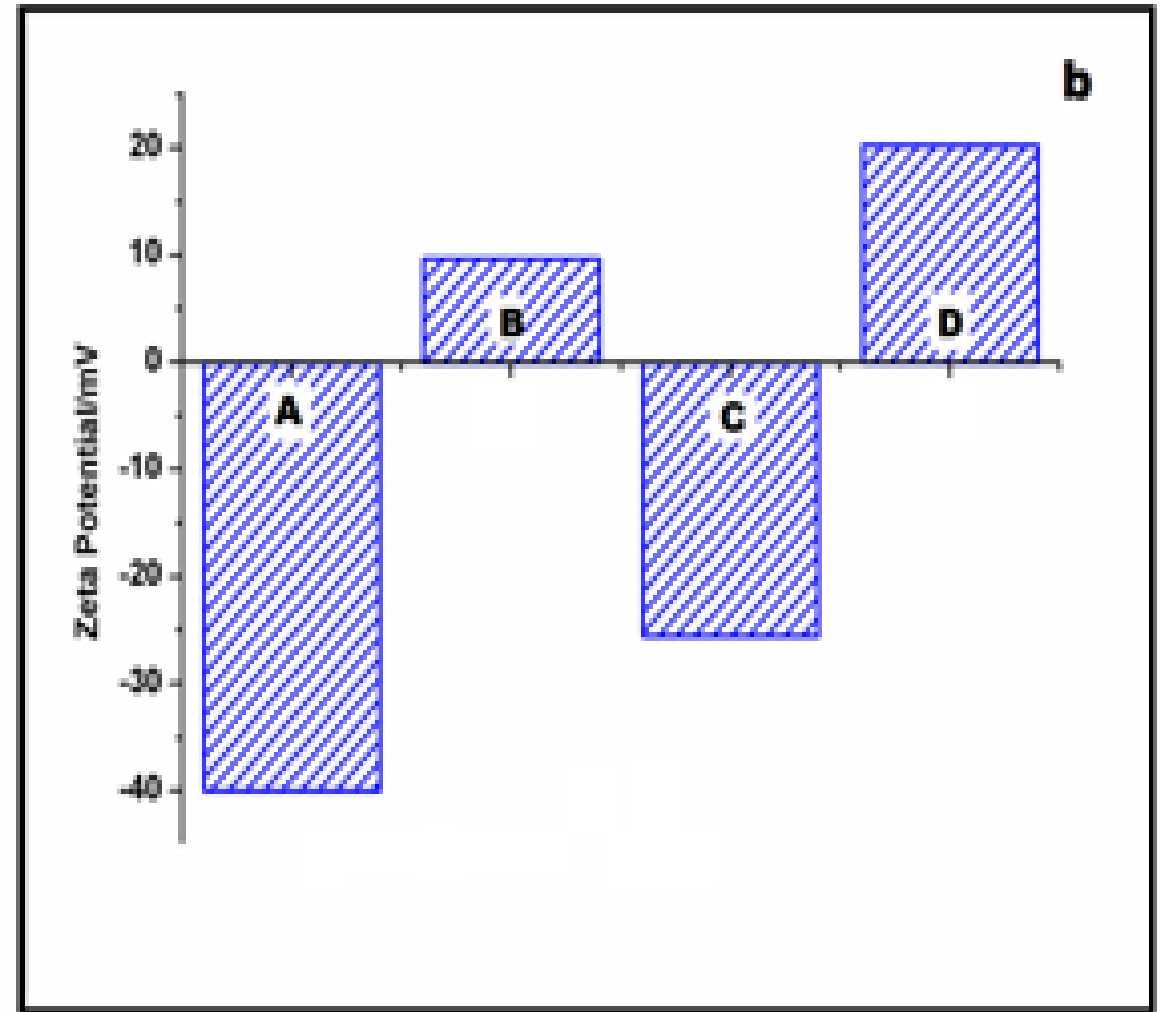
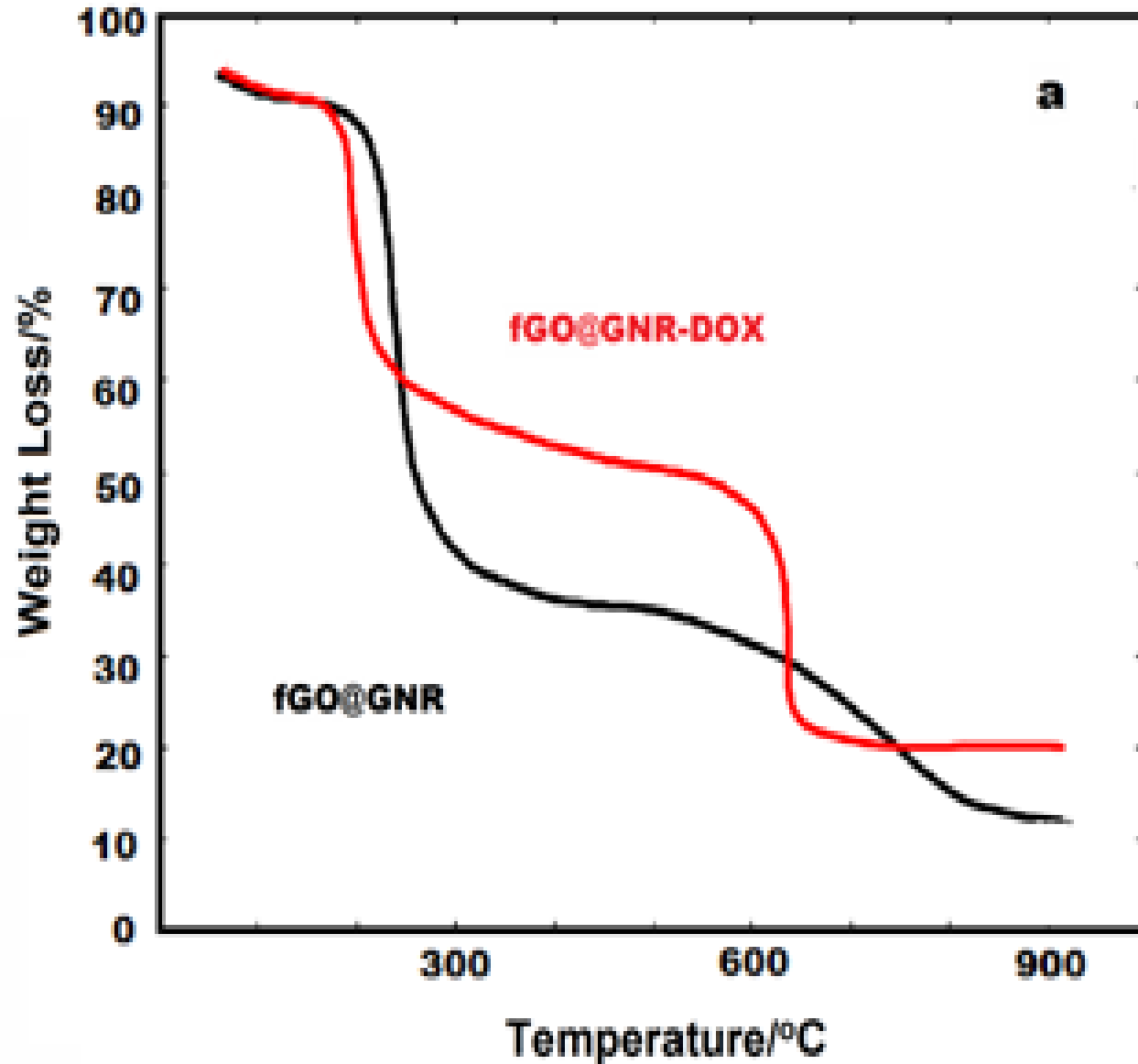


Electron micrograph showing (a) TEM image of graphene oxide (GO), (b) fGO (c) bare GNRs, (d) FE-SEM image of fGO@GNRs, (e) TEM image of fGO@GNRs displaying magnified view of interactions, (f) enlarged contrasted view of highlighted area of (e) showing clear view of dog-bone shaped GNR on a thin layer of fGO and (g) another TEM image showing dog-bone shaped GNR with other anisotropic nanostructures on a thin sheet of fGO.

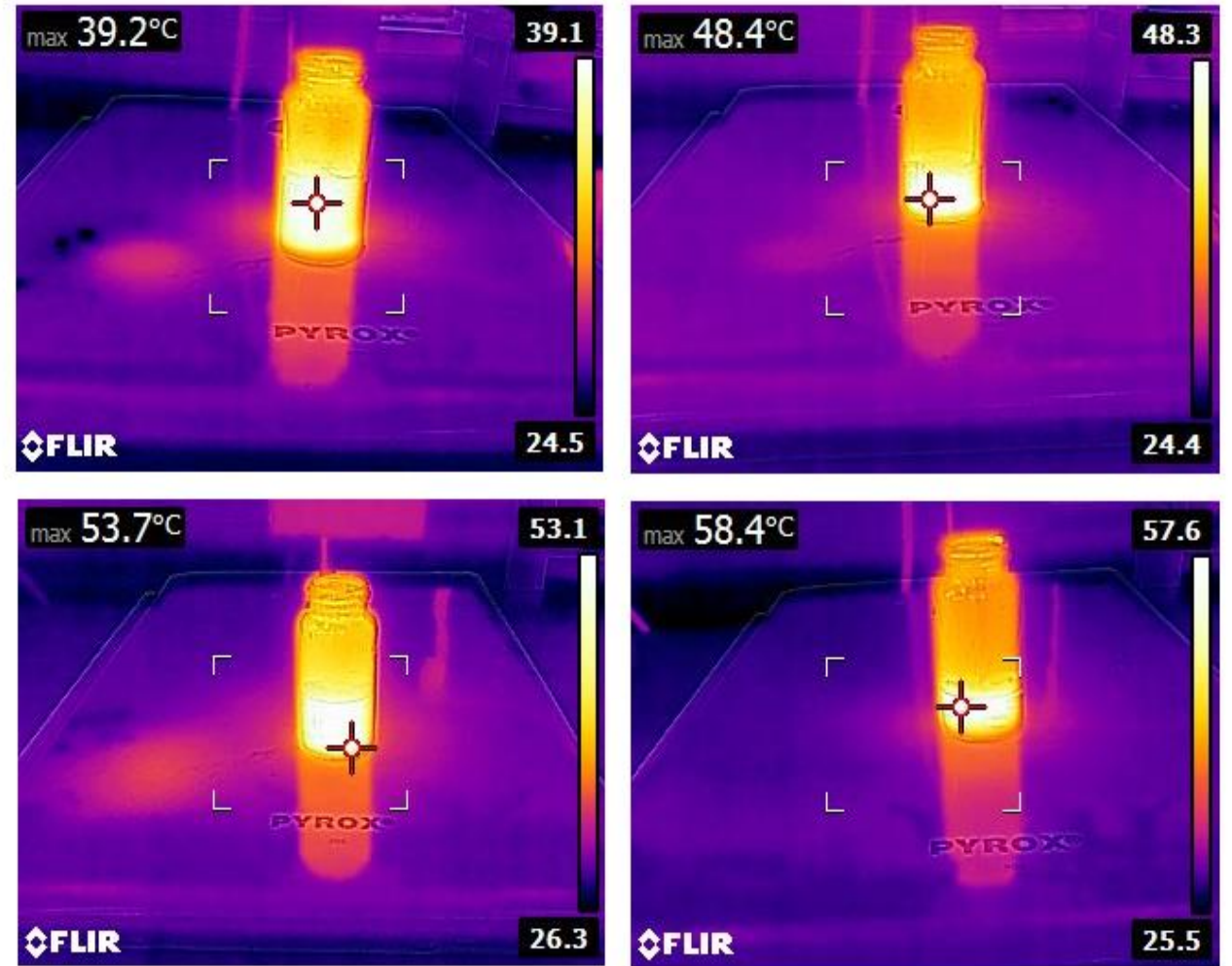
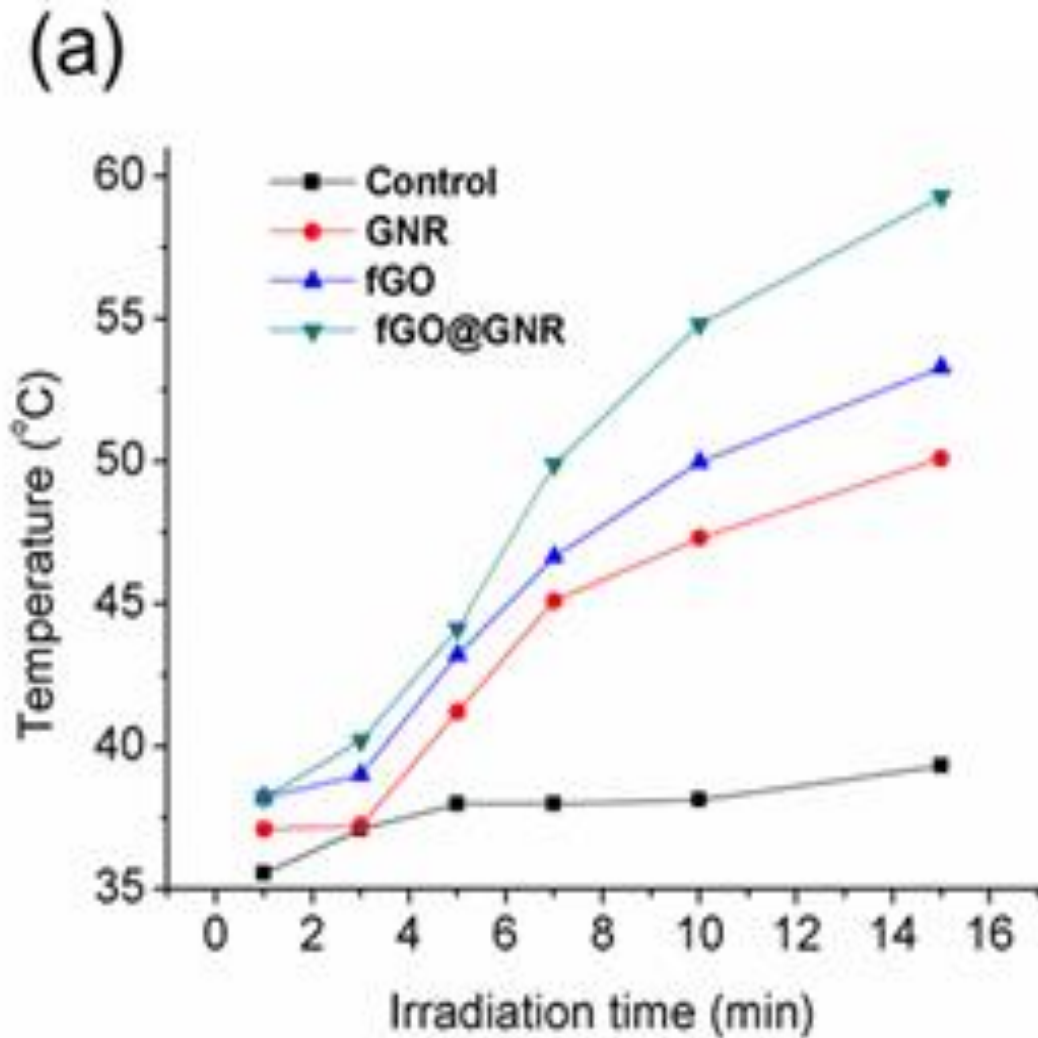




TGA of fGO@GNR and final complex and (b) Zeta potential values various components involved in formation of final complex where A: fGO, B: Pure GNRs, C: fGO@GNR & D: fGO@GNR-DOX.

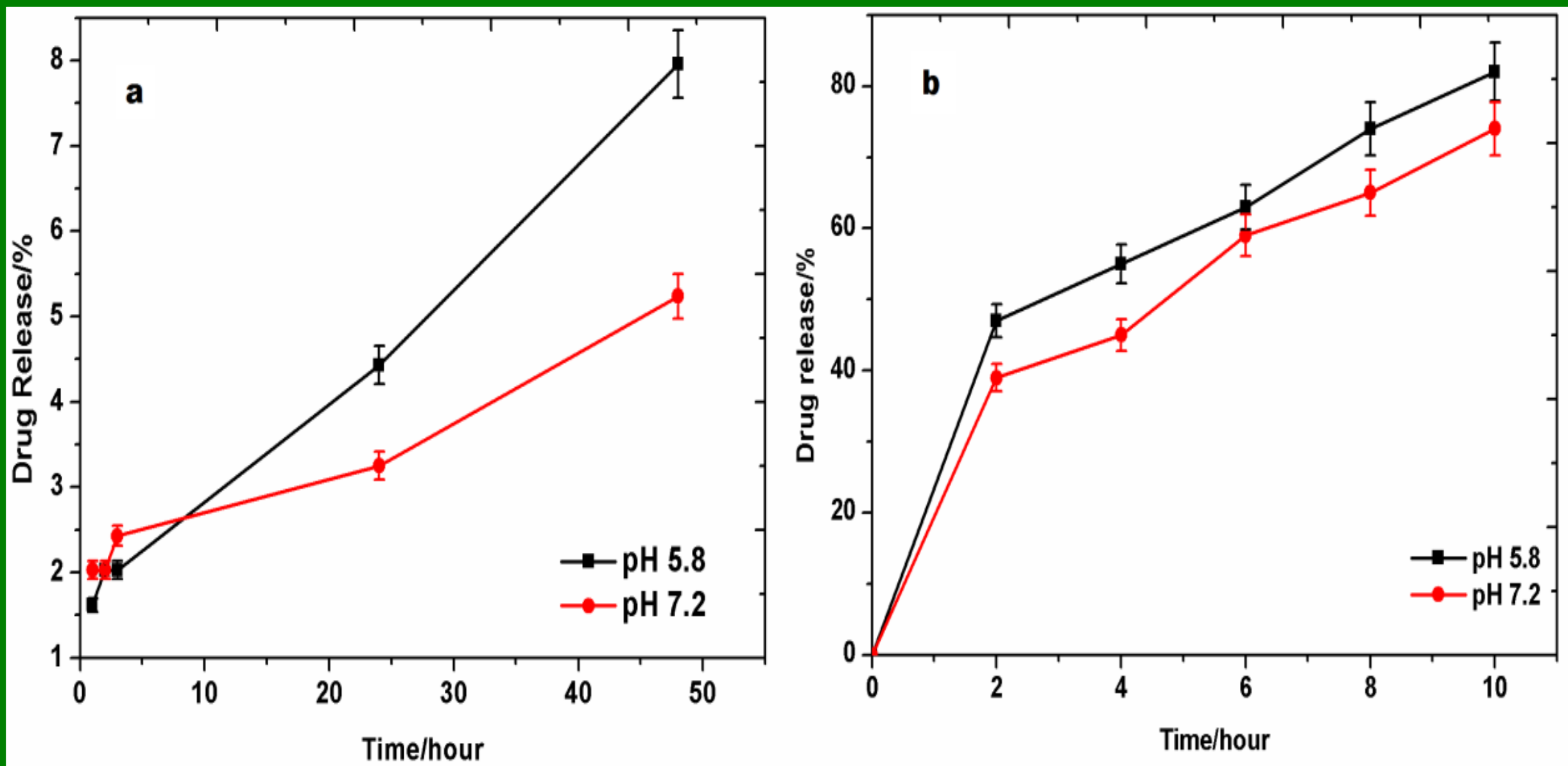


Effect of irradiation time on photothermal temperature of different components in vitro and (b) Infrared image showing increase in temperature of final complex fGO@GNR after 15 min. B. Temp enhancement IR images of PBS, GO, GNR, GO@GNR by using FLIR camera.

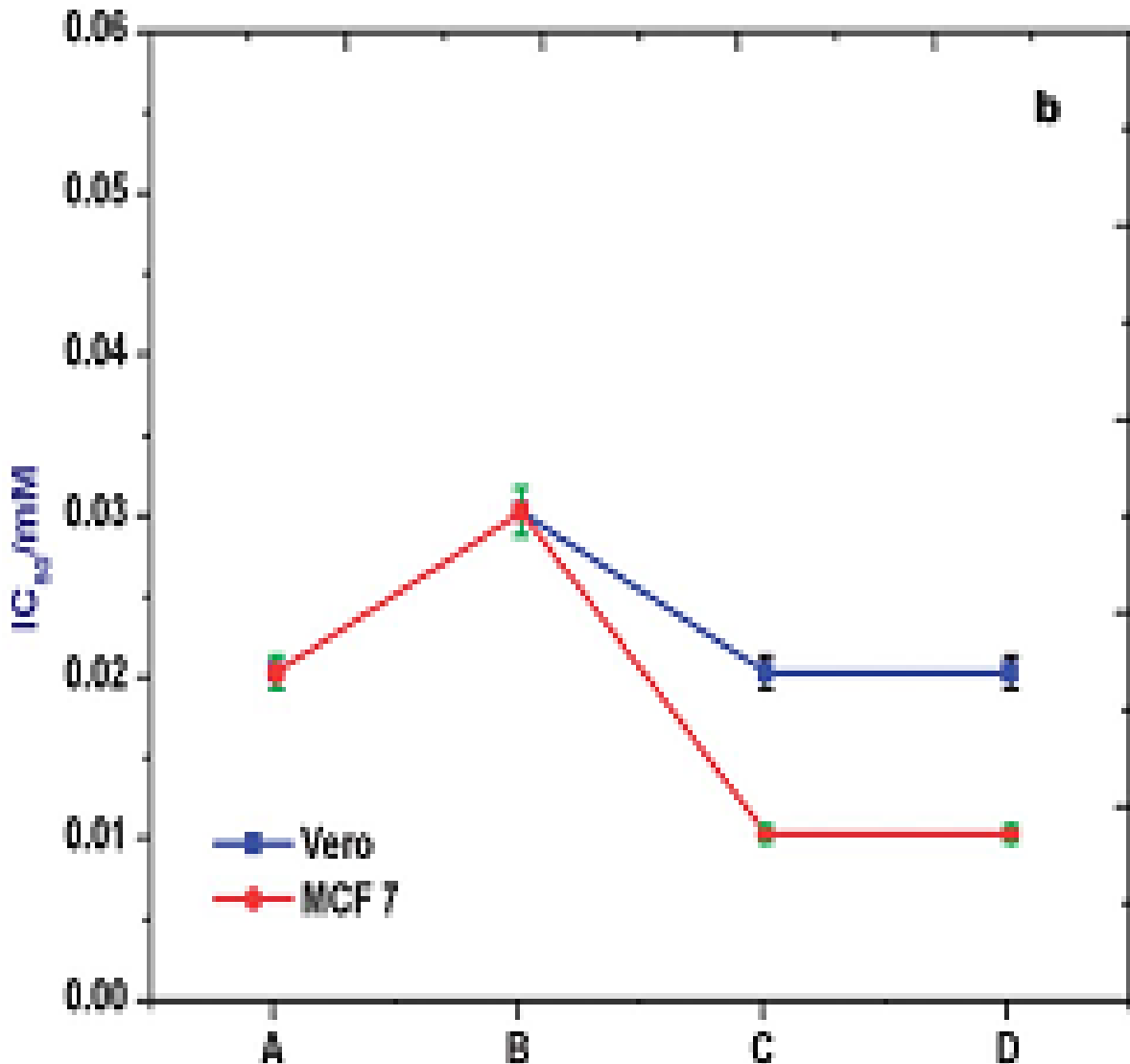
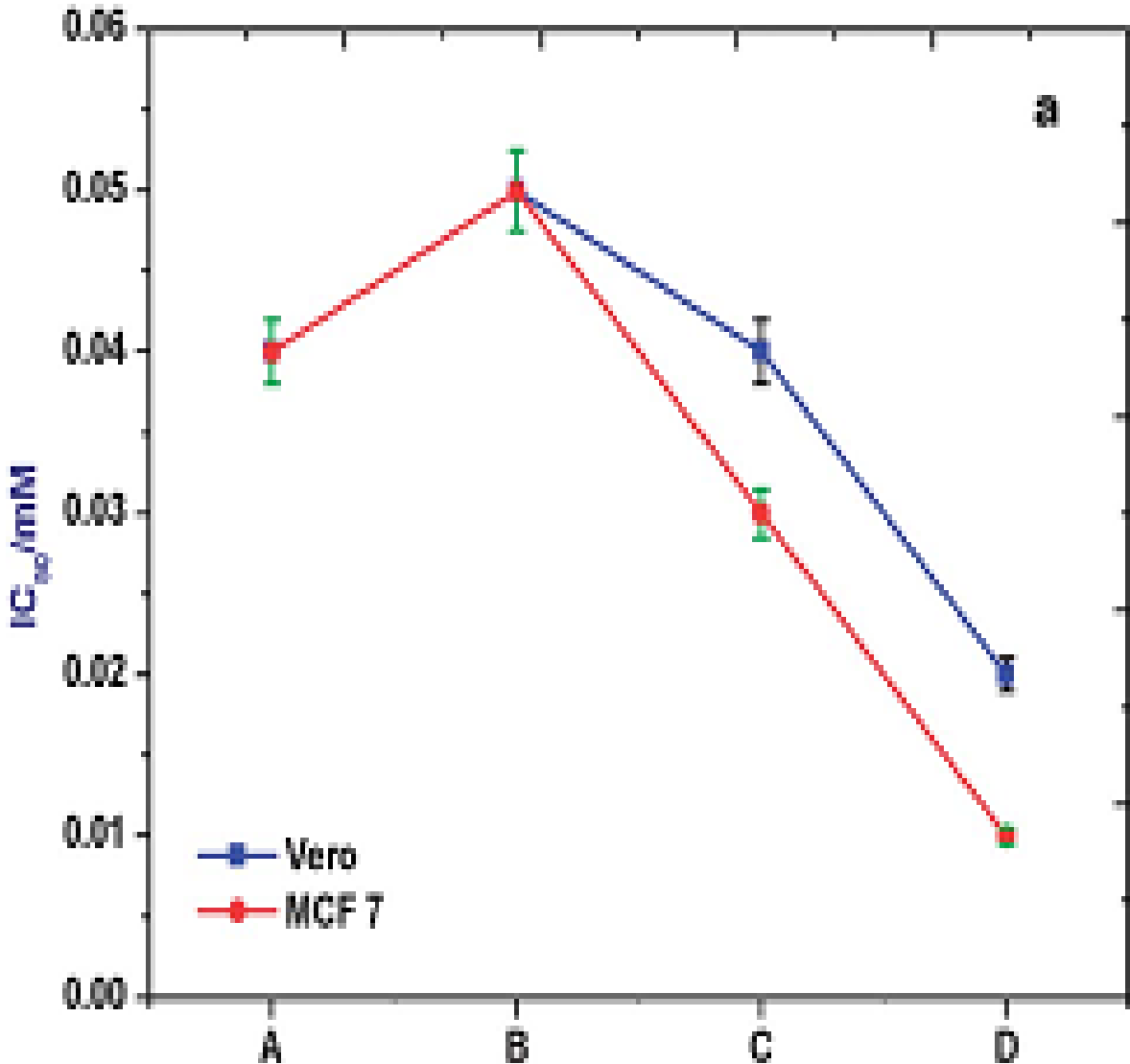




# Percentage Drug Release with respect to time (a) without NIR and (b) with NIR irradiation.

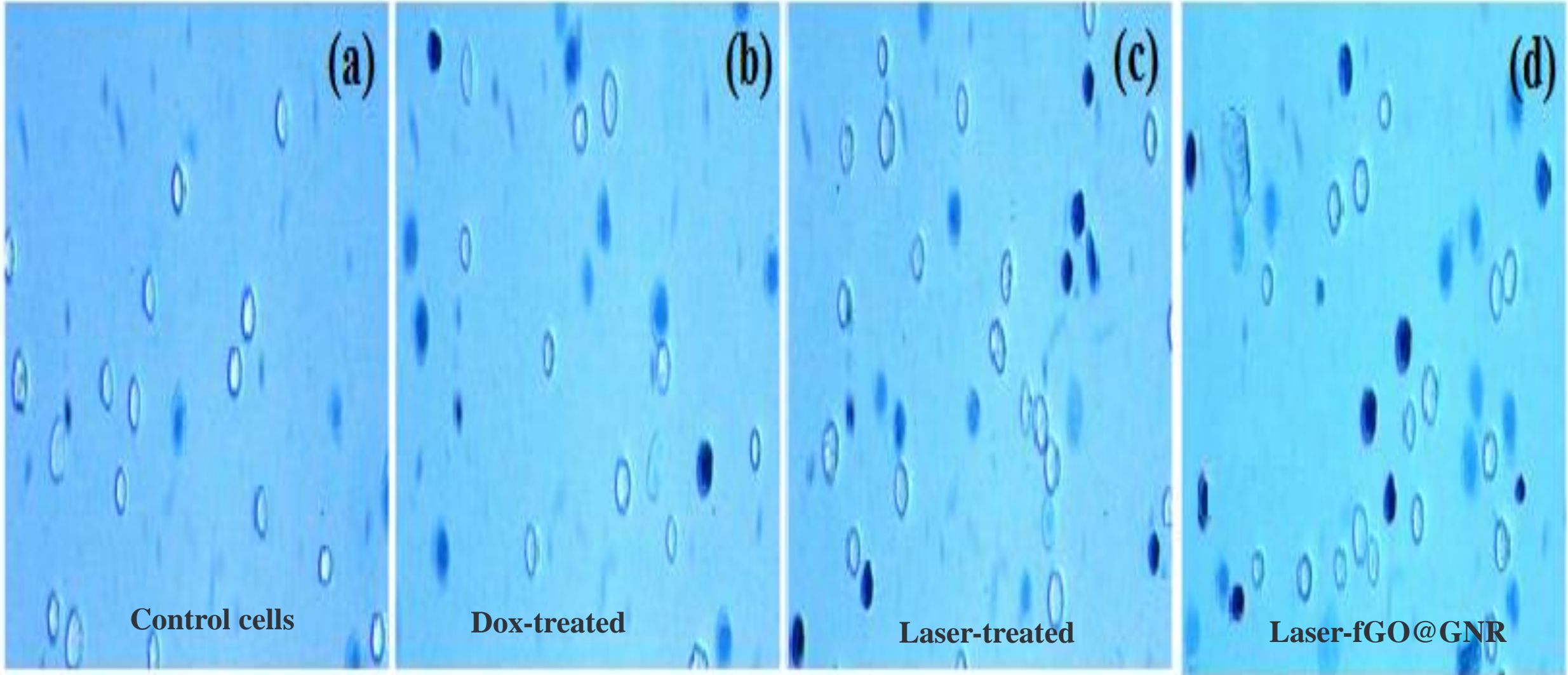


**IC50 values on in vitro cell lines (a) without NIR irradiation and (b) with NIR irradiation where A: GNRs, B: fGO@GNR, C: fGO@GNR-DOX & D: Free DOX.**





# Trypan blue treatment of A549 cancer cells by GO@GNR and laser



# Microtomy

## Tissue Fixation

### Organ dissection



Formalin

50 mint

70% Ethanol

50 mint

80% Ethanol

50 mint

90% Ethanol

50 mint

95% Ethanol

50 mint

100% Ethanol

50 mint

100% Ethanol

→ Xylene

50 mint

→ Paraffin/ 65degree for 1hour

50 mint





# Deparaffinisation of tissue section



1. Incubate the slide for 65° for 30 mint.
2. Incubate the slide for 2 times in Xylene for 30 mint.
3. Incubate the slide for 2 times in 100% ethanol for 10 mint.
4. Incubate the slide for 2 times in 95% ethanol for 10 mint.
5. Incubate the slide for 2 times in 70% ethanol for 10 mint.
6. Incubate the slide for 2 times in 50% ethanol for 10 mint.
7. Incubate the slide for 2 times in 30% ethanol for 10 mint.
8. Incubate the slide in PBS for 5 mint.

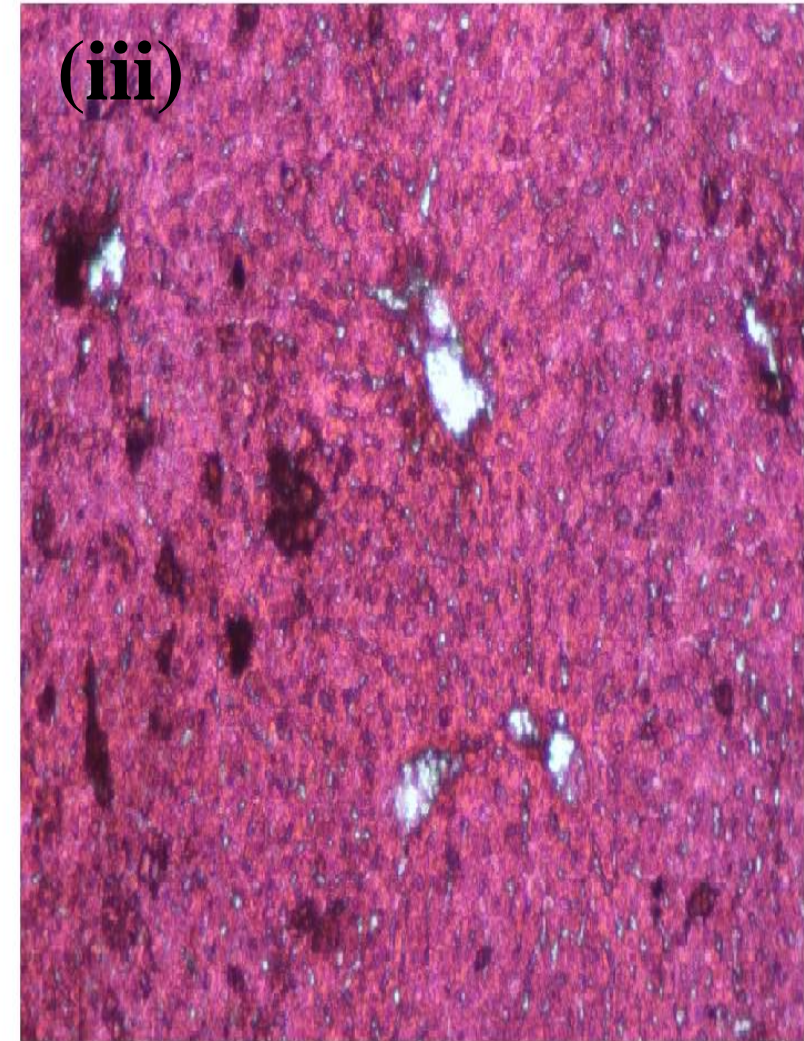
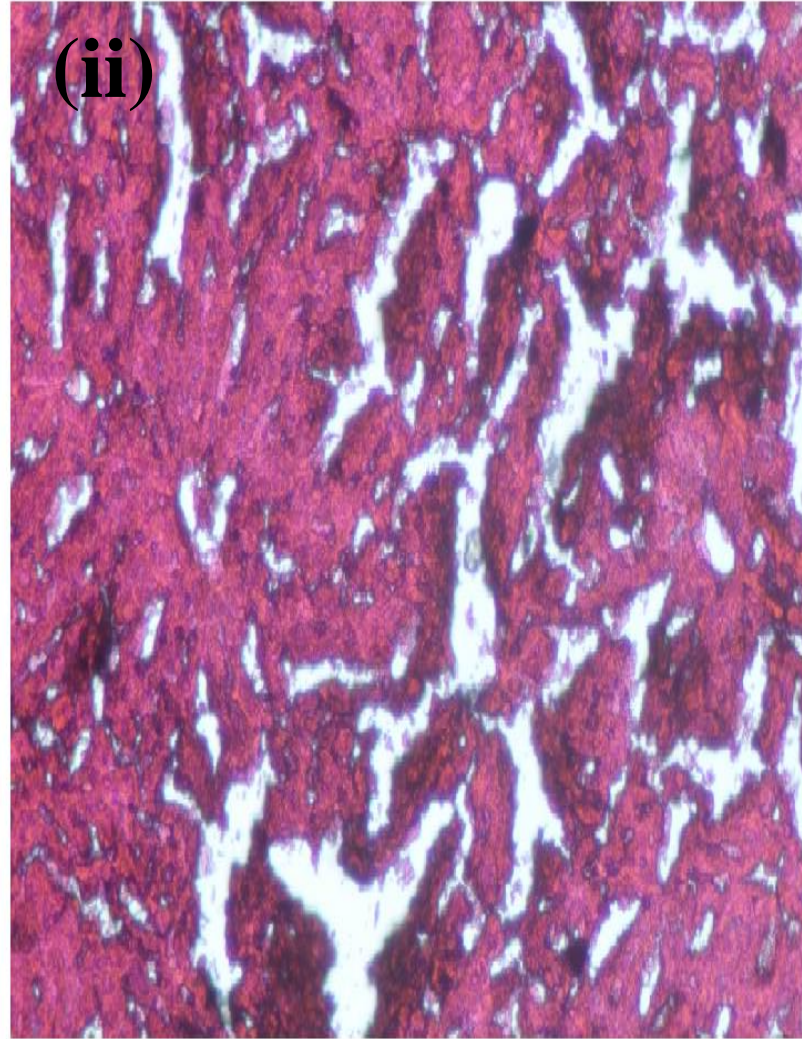
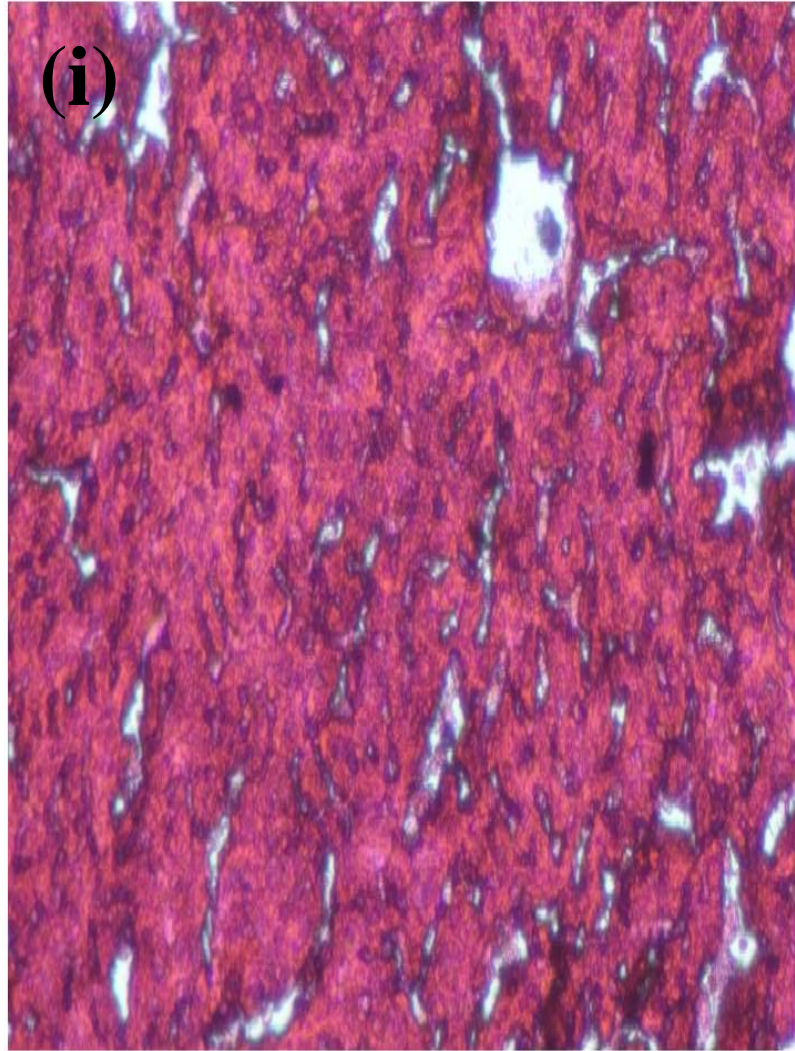
# Deparaffinisation of tissue section

9. Then add 200uL of Haematoxylin for 5 mint.
10. Wash the slide on opposite side by running tap water.
11. Incubate the slide in PBS for 5 mint.
12. 400uL of EOSIN dye on slide
13. Wash the slide on opposite side by running tap water.
14. Incubate the slide in PBS for 5 mint.
15. Incubate the slide for 2 times in 100% ethanol for 2 mint.
16. Incubate the slide for 2 times in Xylene for 10 mint.





# Microtomy of (A) Tumor with different condition, i. Control ii. Dox treatment iii. fGO@GNR-DOX





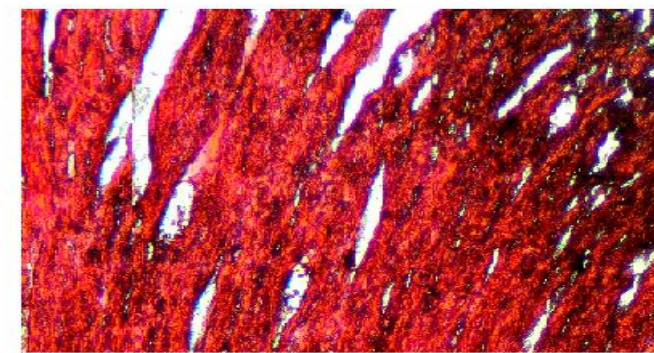
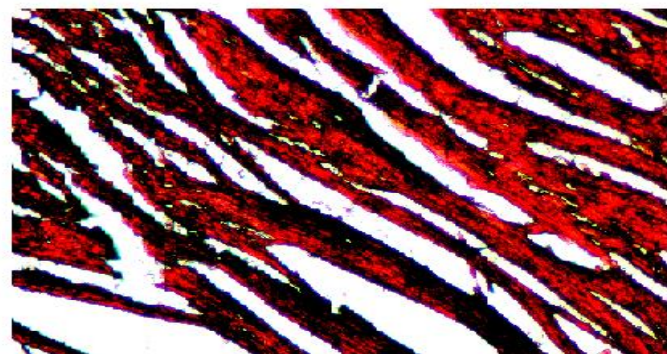
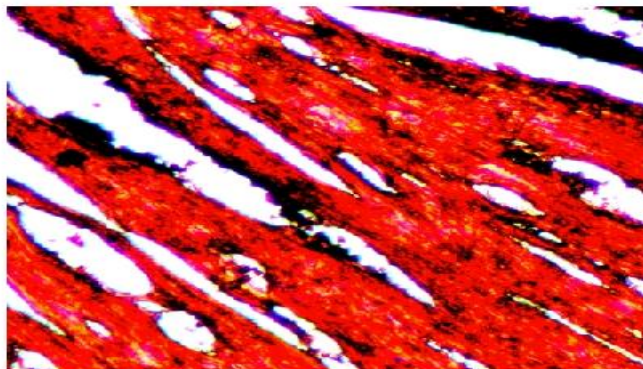
**Microtomy of tumor with different section of organs treated by Dox and fGO-GNR-Dox.**

**Control**

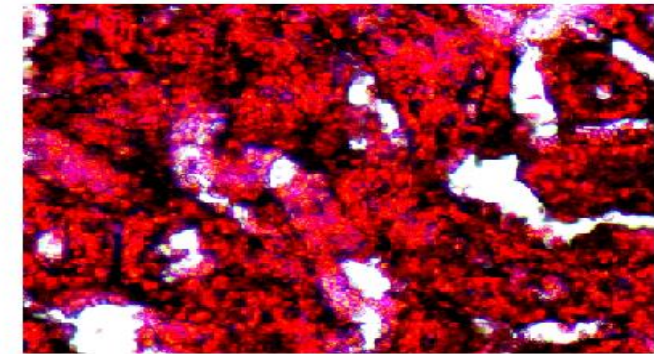
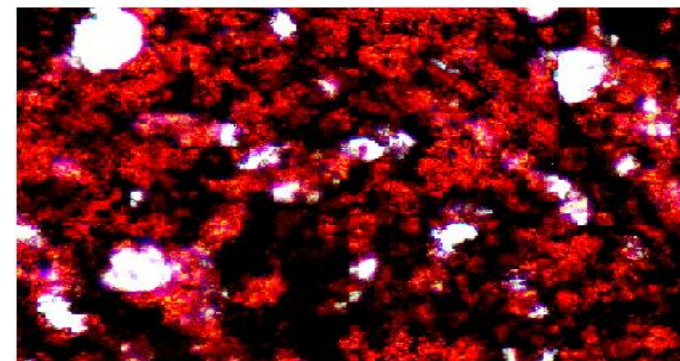
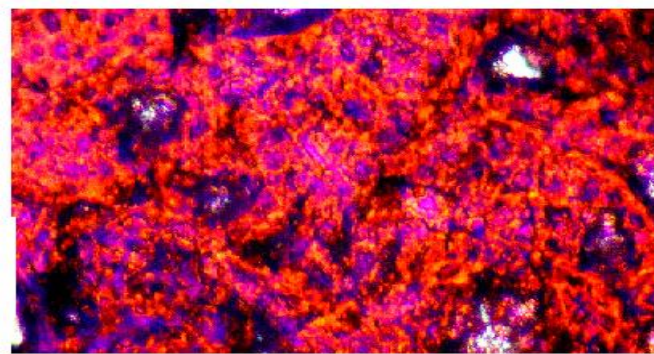
**Dox**

**fGO-GNR-Dox**

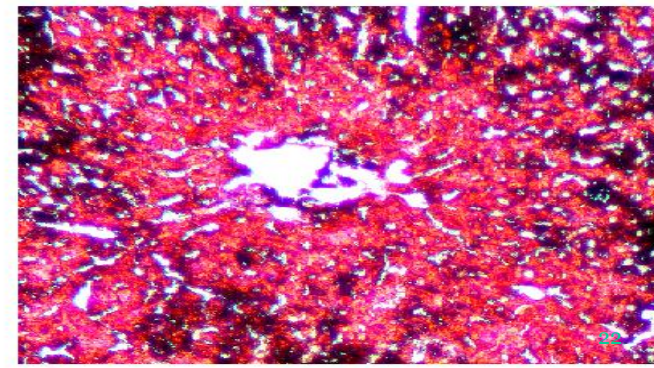
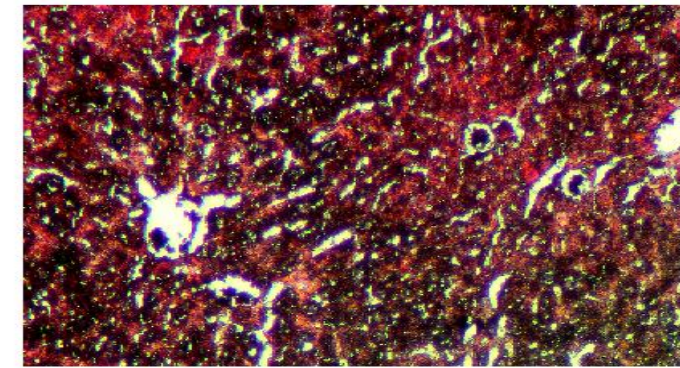
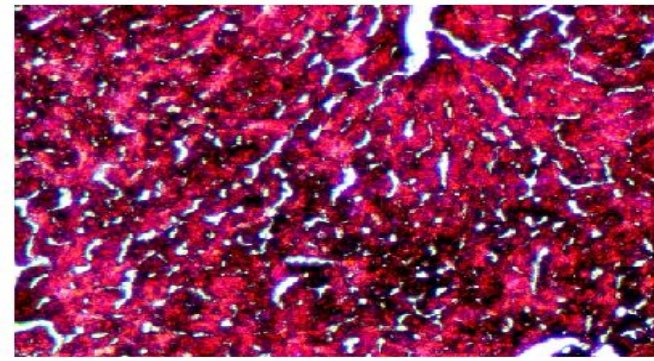
**Heart**



**Kidney**



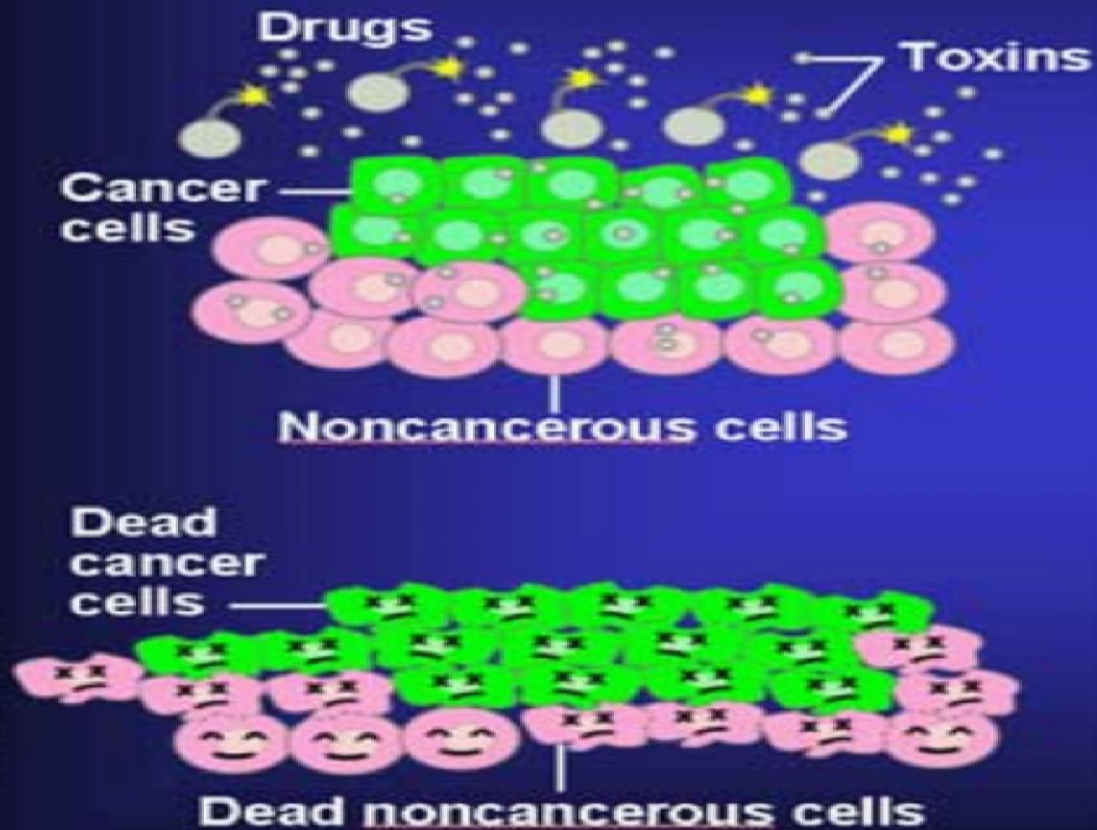
**Liver**



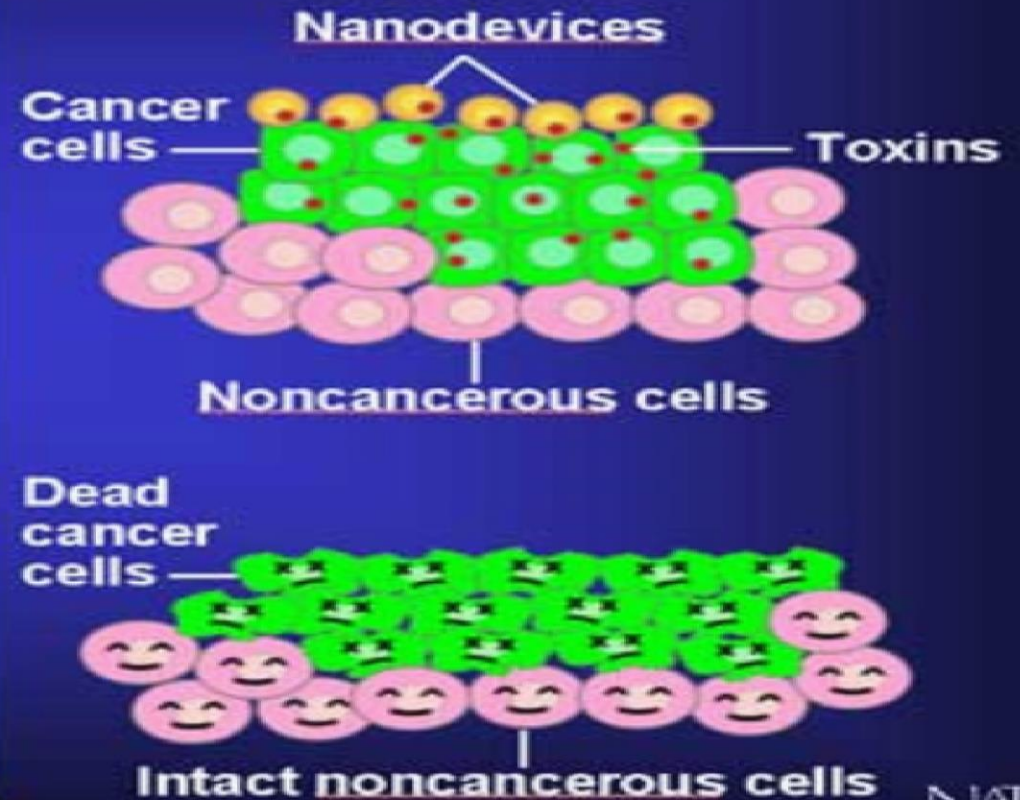


# Improving Cancer Treatment

## Traditional Treatment



## Nanotechnology Treatment



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## Conclusion

**GNRs reduced inherent toxicity of associated with CTAB as well as enhanced photo thermal properties of the conjugate with respect to individual ones (GNRs and GO).**

**Due to shape and size related properties GNRs; they are one of the best nano-materials for efficient delivery of the drugs. In short, we have combined the excellent hemodynamics of GNRs as well as high drug carrying capacity of GO for delivery of doxorubicin.**

**Drug release was found to be more at pH 5.8 which is mandatory for drug delivery to most of the solid tumors.**

**Need more study.....**

## Future Plan

**Synthesize nanomaterial which can control pH, magnetic and photothermal property**

# ACKWLODGEEMENT







# FTIR

