रजिस्ट्री सं. डीएल (एन)-04/0007/2003--05 REGISTERED No. DL(N)—04/0007/2003—05

सत्यमेव जयते

भारत का राजपत्र
The Gazette of India

साप्ताहिक/WEEKLY

प्राधिकार से प्रकाशित

PUBLISHED BY AUTHORITY

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No. 19] NEW DELHI, SATURDAY, MAY 10—MAY 16, 2008 (VAISAKHA 20, 1930)

इस भाग में भिन्न पृष्ठ संख्या दी जाती है जिससे कि यह अलग संकलन के रूप में रखा जा सके।

(Separate paging is given to this Part in order that it may be filed as a separate compilation)

भाग III—खण्ड 4

[PART III—SECTION 4]

[सांविधिक निकायों द्वारा जारी की गई विविध अधिसूचनाएं जिसमें कि आदेश, विज्ञापन और सूचनाएं सम्मिलित हैं]

[Miscellaneous Notifications including Notifications, Orders, Advertisements and Notices issued by Statutory Bodies]

भारतीय रिज़र्व बैंक

मुंबई-400001, दिनांक 9 अप्रैल 2008

सदर्भ : बैंपविवि. सं. आईबीडी.-14241/23.13.048/2007-08--भारतीय रिज़र्व बैंक अधिनियम, 1934 (1934 का 2) की धारा 42 की उप-धारा (6) के खण्ड (ग) के अनुसरण में भारतीय रिज़र्व बैंक इसके द्वारा निदेश देता है कि उक्त अधिनियम की दूसरी अनुसूची में निम्नलिखित परिवर्तन किये जाएं :--

''अरब बांगलादेश बैंक लिमिटेड'' शब्दों के स्थान पर ''एबी बैंक लिमिटेड'' शब्द होंगे।

आनन्द सिन्हा

कार्यपालक निदेशक

[PUBLISHED IN THE GAZETTE OF INDIA, No.19, PART III, SECTION 4]

Ministry of Health and Family Welfare
(Pharmacy Council of India)

New Delhi, 10th May, 2008.

Pharm.D. Regulations 2008

Regulations framed under section 10 of the Pharmacy Act, 1948 (8 of 1948).

(As approved by the Government of India, Ministry of Health vide, letter No.V.13013/1/2007-PMS, dated the 13th March, 2008 and notified by the Pharmacy Council of India).

No.14-126/2007-PCI.— In exercise of the powers conferred by section 10 of the Pharmacy Act, 1948 (8 of 1948), the Pharmacy Council of India, with the approval of the Central Government, hereby makes the following regulations, namely:-

CHAPTER-I

1. Short title and commencement. – (1) These regulations may be called the Pharm.D. Regulations 2008.

   (2) They shall come into force from the date of their publication in the official Gazette.

2. Pharm.D. shall consist of a certificate, having passed the course of study and examination as prescribed in these regulations, for the purpose of registration as a pharmacist to practice the profession under the Pharmacy Act, 1948.

CHAPTER-II

3. Duration of the course. –

a) Pharm.D: The duration of the course shall be six academic years (five years of study and one year of internship or residency) full time with each academic year spread over a period of not less than two hundred working days. The period of six years duration is divided into two phases –

Phase I – consisting of First, Second, Third, Fourth and Fifth academic year.

Phase II – consisting of internship or residency training during sixth year involving posting in speciality units. It is a phase of training wherein a student is exposed to actual pharmacy practice or clinical pharmacy services and acquires skill under supervision so that he or she may become capable of functioning independently.

b) Pharm.D. (Post Baccalaureate): The duration of the course shall be for three academic years (two years of study and one year internship or residency) full time with each academic year spread over a period of not less than two hundred working days. The period of three years duration is divided into two phases –

Phase I – consisting of First and Second academic year.
Phase II – consisting of Internship or residency training during third year involving posting in speciality units. It is a phase of training wherein a student is exposed to actual pharmacy practice or clinical pharmacy services, and acquires skill under supervision so that he or she may become capable of functioning independently.

4. Minimum qualification for admission to. –

a) Pharm.D. Part-I Course – A pass in any of the following examinations -

(1) 10+2 examination with Physics and Chemistry as compulsory subjects along with one of the following subjects:

Mathematics or Biology.

(2) A pass in D.Pharm course from an institution approved by the Pharmacy Council of India under section 12 of the Pharmacy Act.

(3) Any other qualification approved by the Pharmacy Council of India as equivalent to any of the above examinations.

Provided that a student should complete the age of 17 years on or before 31st December of the year of admission to the course.

Provided that there shall be reservation of seats for the students belonging to the Scheduled Castes, Scheduled Tribes and other Backward Classes in accordance with the instructions issued by the Central Government/State Government/Union Territory Administration as the case may be from time to time.

b) Pharm.D. (Post Baccalaureate) Course -

A pass in B.Pharm from an institution approved by the Pharmacy Council of India under section 12 of the Pharmacy Act:

Provided that there shall be reservation of seats for the students belonging to the Scheduled Castes, Scheduled Tribes and other Backward Classes in accordance with the instructions issued by the Central Government/State Government/Union Territory Administration as the case may be from time to time.

5. Number of admissions in the above said programmes shall be as prescribed by the Pharmacy Council of India from time to time and presently be restricted as below –
   i) Pharm.D. Programme – 30 students.
   ii) Pharm.D. (Post Baccalaureate) Programme – 10 students.

6. Institutions running B.Pharm programme approved under section 12 of the Pharmacy Act, will only be permitted to run Pharm.D. programme. Pharm.D. (Post Baccalaureate) programme will be permitted only in those institutions which are permitted to run Pharm.D. programme.

7. Course of study. – The course of study for Pharm.D. shall include the subjects as given in the Tables below. The number of hours in a week, devoted to each subject for its teaching in theory, practical and tutorial shall not be less than that noted against it in columns (3), (4) and (5) below.

T A B L E S

First Year :

S.No.	Name of Subject	No. of hours of Theory	No. of hours of Practical	No. of hours of Tutorial
(1)	(2)	(3)	(4)	(5)
1.1	Human Anatomy and Physiology	3	3	1
1.2	Pharmaceutics	2	3	1
1.3	Medicinal Biochemistry	3	3	1
1.4	Pharmaceutical Organic Chemistry	3	3	1
1.5	Pharmaceutical Inorganic Chemistry	2	3	1
1.6	Remedial Mathematics/ Biology	3	3*	1
	Total hours	**16**	**18**	**6 = (40)**

* For Biology

Second Year:

S.No	Name of Subject	No. of hours of Theory	No. of hours of Practical	No. of hours of Tutorial
(1)	**(2)**	**(3)**	**(4)**	**(5)**
2.1	Pathophysiology	3	-	1
2.2	Pharmaceutical Microbiology	3	3	1
2.3	Pharmacognosy & Phytopharmaceuticals	3	3	1
2.4	Pharmacology-I	3	-	1
2.5	Community Pharmacy	2	-	1
2.6	Pharmacotherapeutics-I	3	3	1
	Total Hours	**17**	**9**	**6 = 32**

Third Year:

S.No.	Name of Subject	No. of hours of Theory	No. of hours of Practical	No. of hours of Tutorial
(1)	**(2)**	**(3)**	**(4)**	**(5)**
3.1	Pharmacology-II	3	3	1
3.2	Pharmaceutical Analysis	3	3	1
3.3	Pharmacotherapeutics-II	3	3	1
3.4	Pharmaceutical Jurisprudence	2	-	-
3.5	Medicinal Chemistry	3	3	1
3.6	Pharmaceutical Formulations	2	3	1
	Total hours	**16**	**15**	**5 = 36**

Fourth Year:

S.No.	Name of Subject	No. of hours of Theory	No. of hours of Practical/ Hospital Posting	No. of hours of Tutorial
(1)	**(2)**	**(3)**	**(4)**	**(5)**
4.1	Pharmacotherapeutics-III	3	3	1
4.2	Hospital Pharmacy	2	3	1
4.3	Clinical Pharmacy	3	3	1
4.4	Biostatistics & Research Methodology	2	-	1
4.5	Biopharmaceutics & Pharmacokinetics	3	3	1
4.6	Clinical Toxicology	2	-	1
	Total hours	**15**	**12**	**6 = 33**

Fifth Year:

S.No.	Name of Subject	No. of hours of Theory	No. of hours of Hospital posting*	No. of hours of Seminar
(1)	**(2)**	**(3)**	**(4)**	**(5)**
5.1	Clinical Research	3	-	1
5.2	Pharmacoepidemiology and Pharmacoeconomics	3	-	1
5.3	Clinical Pharmacokinetics & Pharmacotherapeutic Drug Monitoring	2	-	1
5.4	Clerkship *	-	-	1
5.5	Project work (Six Months)	-	20	-
	Total hours	**8**	**20**	**4 = 32**

***** Attending ward rounds on daily basis.

Sixth Year:

Internship or residency training including postings in speciality units. Student should independently provide the clinical pharmacy services to the allotted wards.

(i) Six months in General Medicine department, and

(ii) Two months each in three other speciality departments

8. Syllabus. – The syllabus for each subject of study in the said Tables shall be as specified in Appendix -A to these regulations.

9. Approval of the authority conducting the course of study. – (1) No person, institution, society or university shall start and conduct Pharm.D or Pharm.D. (Post Baccalaureate) programme without the prior approval of the Pharmacy Council of India.

(2) Any person or pharmacy college for the purpose of obtaining permission under sub-section (1) of section 12 of the Pharmacy Act, shall submit a scheme as prescribed by the Pharmacy Council of India.

(3) The scheme referred to in sub-regulation (2) above, shall be in such form and contain such particulars and be preferred in such manner and be accompanied with such fee as may be prescribed:

Provided that the Pharmacy Council of India shall not approve any institution under these regulations unless it provides adequate arrangements for teaching in regard to building, accommodation, labs., equipments, teaching staff, non-teaching staff, etc., as specified in Appendix-B to these regulations.

10. Examination. – (1) Every year there shall be an examination to examine the students.

(2) Each examination may be held twice every year. The first examination in a year shall be the annual examination and the second examination shall be supplementary examination.

(3) The examinations shall be of written and practical (including oral nature) carrying maximum marks for each part of a subject as indicated in Tables below :

T A B L E S

First Year examination :

S.No.	Name of Subject	Maximum marks for Theory			Maximum marks for Practicals		
		Examination	Sessional	Total	Examination	Sessional	Total
1.1	Human Anatomy and Physiology	70	30	100	70	30	100
1.2	Pharmaceutics	70	30	100	70	30	100
1.3	Medicinal Biochemistry	70	30	100	70	30	100
1.4	Pharmaceutical Organic Chemistry	70	30	100	70	30	100
1.5	Pharmaceutical Inorganic Chemistry	70	30	100	70	30	100
1.6	Remedial Mathematics/ Biology	70	30	100	70*	30*	100*
				600			600 = 1200

* for Biology.

Second Year examination :

S.No.	Name of Subject	Maximum marks for Theory			Maximum marks for Practicals		
		Examination	Sessional	Total	Examination	Sessional	Total
2.1	Pathophysiology	70	30	100	-	-	-
2.2	Pharmaceutical Microbiology	70	30	100	70	30	100
2.3	Pharmacognosy & Phytopharmaceuticals	70	30	100	70	30	100
2.4	Pharmacology-I	70	30	100	-	-	-
2.5	Community Pharmacy	70	30	100	-	-	-
2.6	Pharmacotherapeutics-I	70	30	100	70	30	100
				600			300 = 900

Third Year examination :

S.No.	Name of Subject	Maximum marks for Theory			Maximum marks for Practicals		
		Examination	Sessional	Total	Examination	Sessional	Total
3.1	Pharmacology-II	70	30	100	70	30	100
3.2	Pharmaceutical Analysis	70	30	100	70	30	100
3.3	Pharmacotherapeutics-II	70	30	100	70	30	100
3.4	Pharmaceutical Jurisprudence	70	30	100	-	-	-
3.5	Medicinal Chemistry	70	30	100	70	30	100
3.6	Pharmaceutical Formulations	70	30	100	70	30	100
				600			500 = 1100

Fourth Year examination :

S.No.	Name of Subject	Maximum marks for Theory			Maximum marks for Practicals		
		Examination	Sessional	Total	Examination	Sessional	Total
4.1	Pharmacotherapeutics-III	70	30	100	70	30	100
4.2	Hospital Pharmacy	70	30	100	70	30	100
4.3	Clinical Pharmacy	70	30	100	70	30	100
4.4	Biostatistics & Research Methodology	70	30	100	-	-	-
4.5	Biopharmaceutics & Pharmacokinetics	70	30	100	70	30	100
4.6	Clinical Toxicology	70	30	100	-	-	-
				600			400 = 1000

Fifth Year examination :

S.No.	Name of Subject	Maximum marks for Theory			Maximum marks for Practicals		
		Examination	Sessional	Total	Examination	Sessional	Total
5.1	Clinical Research	70	30	100	-	-	-
5.2	Pharmacoepidemiology and Pharmacoeconomics	70	30	100	-	-	-
5.3	Clinical Pharmacokinetics & Pharmacotherapeutic Drug Monitoring	70	30	100	-	-	-
5.4	Clerkship *	-	-	-	70	30	100
5.5	Project work (Six Months)	-	-	-	100**	-	100
				300			200 = 500

***** Attending ward rounds on daily basis.

****** 30 marks – viva-voce (oral)
70 marks – Thesis work

11. Eligibility for appearing Examination.— Only such students who produce certificate from the Head of the Institution in which he or she has undergone the Pharm.D. or as the case may be, the Pharm.D. (Post Baccalaureate) course, in proof of his or her having regularly and satisfactorily undergone the course of study by attending not less than 80% of the classes held both in theory and in practical separately in each subject shall be eligible for appearing at examination.

12. Mode of examinations.— (1) Theory examination shall be of three hours and practical examination shall be of four hours duration.

    (2) A Student who fails in theory or practical examination of a subject shall re-appear both in theory and practical of the same subject.

    (3) Practical examination shall also consist of a viva –voce (Oral) examination.

    (4) Clerkship examination – Oral examination shall be conducted after the completion of clerkship of students. An external and an internal examiner will evaluate the student. Students may be asked to present the allotted medical cases followed by discussion. Students' capabilities in delivering clinical pharmacy services, pharmaceutical care planning and knowledge of therapeutics shall be assessed.

13. Award of sessional marks and maintenance of records.— (1) A regular record of both theory and practical class work and examinations conducted in an institution imparting training for Pharm.D. or as the case may be, Pharm.D. (Post Baccalaureate) course, shall be maintained for each student in the institution and 30 marks for each theory and 30 marks for each practical subject shall be allotted as sessional.

    (2) There shall be at least two periodic sessional examinations during each academic year and the highest aggregate of any two performances shall form the basis of calculating sessional marks.

    (3) The sessional marks in practicals shall be allotted on the following basis:-

        (i) Actual performance in the sessional examination (20 marks);
        (ii) Day to day assessment in the practical class work, promptness, viva-voce record maintenance, etc. (10 marks).

14. Minimum marks for passing examination.— A student shall not be declared to have passed examination unless he or she secures at least 50% marks in each of the subjects separately in the theory examinations, including sessional marks and at least 50% marks in each of the practical examinations including sessional marks. The students securing 60% marks or above in aggregate in all subjects in a single attempt at the Pharm.D. or as the case may be, Pharm. D. (Post Baccalaureate) course examination shall be declared to have passed in first class. Students securing 75% marks or above in any subject or subjects shall be declared to have passed with distinction in the subject or those subjects provided he or she passes in all the subjects in a single attempt.

15. Eligibility for promotion to next year.— All students who have appeared for all the subjects and passed the first year annual examination are eligible for promotion to the second year and, so on. However, failure in more than two subjects shall debar him or her from promotion to the next year classes.

16. Internship.— (1) Internship is a phase of training wherein a student is expected to conduct actual practice of pharmacy and health care and acquires skills under the supervision so that he or she may become capable of functioning independently.

    (2) Every student has to undergo one year internship as per Appendix-C to these regulations.

17. Approval of examinations.— Examinations mentioned in regulations 10 to12 and 14 shall be held by the examining authority hereinafter referred to as the university, which shall be approved by the Pharmacy Council of India under sub-section (2) of section 12 of the Pharmacy Act, 1948. Such approval shall be granted only if the examining authority concerned fulfills the conditions as specified in Appendix–D to these regulations.

18. Certificate of passing examination.— Every student who has passed the examinations for the Pharm.D. (Doctor of Pharmacy) or Pharm.D. (Post Baccalaureate) (Doctor of Pharmacy) as the case may be, shall be granted a certificate by the examining authority.

CHAPTER-III
Practical training

19. Hospital posting.— Every student shall be posted in constituent hospital for a period of not less than fifty hours to be covered in not less than 200 working days in each of second, third & fourth year course. Each student shall submit report duly certified by the preceptor and duly attested by the Head of the Department or Institution as prescribed. In the fifth year, every student shall spend half a day in the morning hours attending ward rounds on daily basis as a part of clerkship. Theory teaching may be scheduled in the afternoon.

20. Project work.— (1) To allow the student to develop data collection and reporting skills in the area of community, hospital and clinical pharmacy, a project work shall be carried out under the supervision of a teacher. The project topic must be approved by the Head of the Department or Head of the Institution. The same shall be announced to students within one month of commencement of the fifth year classes. Project work shall be presented in a written report and as a seminar at the end of the year. External and the internal examiners shall do the assessment of the project work.

    (2) Project work shall comprise of objectives of the work, methodology, results, discussions and conclusions.

21. Objectives of project work.— The main objectives of the project work is to—

    (i) show the evidence of having made accurate description of published work of others and of having recorded the findings in an impartial manner; and

    (ii) develop the students in data collection, analysis and reporting and interpretation skills.

22. Methodology.— To complete the project work following methodology shall be adopted, namely:—

    (i) students shall work in groups of not less than *two* and not more than *four* under an authorised teacher;

    (ii) project topic shall be approved by the Head of the Department or Head of the Institution;

    (iii) project work chosen shall be related to the pharmacy practice in community, hospital and clinical setup. It shall be patient and treatment (Medicine) oriented, like drug utilisation reviews, pharmacoepidemiology, pharmacovigilance or pharmacoeconomics;

    (iv) project work shall be approved by the institutional ethics committee;

    (v) student shall present at least three seminars, one in the beginning, one at middle and one at the end of the project work; and

    (vi) two-page write-up of the project indicating title, objectives, methodology anticipated benefits and references shall be submitted to the Head of the Department or Head of the Institution.

23. Reporting .— (1) Student working on the project shall submit jointly to the Head of the Department or Head of the Institution a project report of about 40-50 pages. Project report should include a certificate issued by the authorised teacher, Head of the Department as well as by the Head of the Institution

(2) Project report shall be computer typed in double space using Times Roman font on A4 paper. The title shall be in bold with font size 18, sub-tiles in bold with font size 14 and the text with font size 12. The cover page of the project report shall contain details about the name of the student and the name of the authorised teacher with font size 14.

(3) Submission of the project report shall be done at least one month prior to the commencement of annual or supplementary examination.

24. Evaluation.— The following methodology shall be adopted for evaluating the project work—

(i) Project work shall be evaluated by internal and external examiners.

(ii) Students shall be evaluated in groups for four hours (i.e., about half an hour for a group of four students).

(iii) Three seminars presented by students shall be evaluated for twenty marks each and the average of best two shall be forwarded to the university with marks of other subjects.

(iv) Evaluation shall be done on the following items:

	Marks
a) Write up of the seminar	(7.5)
b) Presentation of work	(7.5)
c) Communication skills	(7.5)
d) Question and answer skills	(7.5)
Total	(30 marks)

(v) Final evaluation of project work shall be done on the following items:

	Marks
a) Write up of the seminar	(17.5)
b) Presentation of work	(17.5)
c) Communication skills	(17.5)
d) Question and answer skills	(17.5)
Total	(70 marks)

Explanation.— For the purposes of differentiation in the evaluation in case of topic being the same for the group of students, the same shall be done based on item numbers b, c and d mentioned above.

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Directorate of Academic Planning

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY KAKINADA
KAKINADA-533003, Andhra Pradesh, INDIA
(Established by AP Government Act No. 30 of 2008)

Lr. No. 10-8/JNTUK/DAP/AC/II Year/Pharm D/2020-21 *Date: 29-12-2020*

Dr. R. Srinivasa Rao,
Director, Academic Planning
JNTUK, Kakinada

To
All the Principals of Affiliated Colleges,
JNTUK, Kakinada.

Academic Calendar of II, III, IV and V Year Pharm D
Academic year 2020-21

Description	From	To	Weeks
Commencement of Class Work	**02.11.2020**		
I Unit of Instruction	02.11.2020	16.01.2021	11W
II Unit of Instructions	18.01.2021	23.01.2021	1W
I Mid Examinations	25.01.2021	30.01.2021	1W
II Unit of Instructions (Continued)	01.02.2021	10.04.2021	10W
II Mid Examinations	05.04.2021	10.04.2021	
III Unit of Instructions	12.04.2021	26.06.2021	11W
III Mid Examinations	21.06.2021	26.06.2021	
Preparation & Practical Exams	28.07.2021	03.07.2021	1W
End Examinations	05.07.2021	17.07.2021	2W
Commencement of next Year Class Work	**26.07.2021**		
Note: Calendar is prepared with 8 hrs/day hence 7 weeks per instruction period			

R. Srinivasa Rao
Director Academic Planning

Director
Academic Planning
JNTUK Kakinada

Copy to the Secretary to the Hon'ble Vice Chancellor, JNTUK
Copy to Rector, JNTUK
Copy to Registrar, JNTUK
Copy to Director Academic Audit, JNTUK
Copy to Director of Evaluation, JNTUK

INSTITUTIONAL EXAMINATION COMMITTEE

VIJAYA INSTITUTE OF PHARMACEUTICAL SCIENCES FOR WOMEN
ENIKEPADU, VIJAYAWADA

INSTITUTIONAL EXAMINATION COMMITTEE 2020-21

Date:02-11-20

ROLES & RESPONSIBILITIES:

- Ensure proper dissemination of information with regard to examination among all the stakeholders' viz. students / faculty / non – teaching staff / university authorities etc.
- To receive exam notification / schedule from JNTUK web portal.
- To ensure proper organization of internal assessments / sessional / end semester examinations in the college.
- Ensure proper communication with JNTUK with regards to examination and fulfillment of university circulars.
- To communicate with the faculty regarding the setting of question paper and the other requisites that go along with it.
- To ensure proper seating plan and invigilation duties.
- Appoint alternative internal examiners / external examiners for conduct of end semester theory/ practical examination with permission of university authorities.
- Record and issue the answer books and other exam related stationery to the invigilators / internal examiners 30 minutes before the commencement of the exam
- Download and print the appropriate number of question papers at least 20 minutes before the commencement of the exam and maintain absolute confidentiality
- To have an internal squad committee to ensure the smooth conduct of examinations and also to avoid issues of malpractices.
- Resolve students / faculty / university grievances with regards to examinations.
- Uploading internal theory / practical examination marks on JNTUK web portal.
- Maintain records with regards to conduct of examination and results.

MEETING SCHEDULE:

The committee members meet twice in the academic year.

CONSTITUTION: The details of the members are as follow:

S. No	Name of the Faculty	Designation	Post
1	Dr. K. Padmalatha	Professor & Principal	Chairperson
2	Mr. S. Venkateswara Rao	Associate Professor	College Examination Officer
3	Mrs. B. Hemalatha	Assistant Professor	Member
4	Mr. M. Bala krishna	Assistant Professor	Member
5	Dr. N. Prathibha	Assistant Professor	Member

Vijaya Institute of Pharmaceutical Sciences for Women
ENIKEPADU VIJAYAWADA.

PRINCIPAL
VIJAYA INSTITUTE OF
PHARMACEUTICAL SCIENCES FOR WOMEN
ENIKEPADU, VIJAYAWADA - 521 108.

Vijaya Institute of Pharmaceutical Sciences for Women
Enikepadu, Vijayawada – 521108

Date: 01.04.2021

IV Pharm. D / II Mid Exam Time Table

Date	Subject Name	Staff Name	Staff Signature
08-04-2021 (Thursday)	Pharmacotherapeutics-III (T4101)	Dr. Y .Naveen	
09-04-2021 (Friday)	Hospital Pharmacy (T4102)	Dr.M.Tabitha sharon	
10-04-2021 (Saturday)	Clinical Pharmacy (T4103)	Mrs. D. Shanthi Krupa	
12-04-2021 (Monday)	Biostatistics & Research Methodology (T4104)	Mr. V.Srinivas	
15-04-2021 (Thursday)	Biopharmaceutics & Pharmacokinetics (T4105)	Dr. S. Praveen	
16-04-2021 (Friday)	Clinical Toxicology (T4106)	Dr. N. Prathibha	

NOTE:

1. Timings: **01.30 PM – 03.30 PM**
2. Send the Question Papers to Exam Section Mail. Id: vipwexams@gmail.com

Vijaya Institute of Pharmaceutical Sciences for Women ENIKEPADU VIJAYAWADA

Principal
(Dr. K. Padmalatha)
VIJAYA INSTITUTE OF
PHARMACEUTICAL SCIENCES FOR WOMEN
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VIJAYA INSTITUTE OF PHARMACEUTICAL SCIENCES FOR WOMEN

ENIKEPADU, VIJAYAWADA - 521108

II, III, IV & V PHARM.D II MID EXAMS
STAFF INVIGILATION DUTIES

DATE: 02.04.2021

Time: 01.30 PM to 03.30 PM

DATE	Room - 1		Room - 2		Room - 3		Room - 4	
	Staff	Sign	Staff	Sign	Staff	Sign	Staff	Sign
08.04.2021 (Thursday)	Ms. V. Akhila		Mrs. B. Navya		Mrs. D. Padma		Ms. S. Hari Priya	
09.04.2021 (Friday)	Dr. P. Aparna		Mrs. A. V. S. Hima Bindu		Ms. S. Hari Priya		Ms. V. Uma	
10.04.2021 (Saturday)	Mrs. D. Padma		Mrs. B. Navya		Dr. N. Prathibha		Ms. S. Hari Priya	
12.04.2021 (Monday)	Ms. V. Uma		Ms. S. Hari Priya		Mrs. B. Hemalatha		Mrs. B. Navya	
15.04.2021 (Thrusday)	Mrs. B. Navya		Dr. N. Prathibha		Dr. Y. Naveen		Dr. M. Tabitha Sharoon	
16.04.2021 (Friday)	Ms. V. Uma		Ms. S. Hari Priya		Mrs. B. Navya		Dr. N. Prathibha	

Vijaya Institute of Pharmaceutical Sciences for Women
ENIKEPADU
VIJAYAWADA

Principal
(Dr. K. Padmalatha)
VIJAYA INSTITUTE OF
PHARMACEUTICAL SCIENCES FOR WOMEN
ENIKEPADU, VIJAYAWADA
PIN - 521 108

INTERNAL SQUAD COMMITTEE

VIJAYA INSTITUTE OF PHARMACEUTICAL SCIENCES FOR WOMEN
ENIKEPADU, VIJAYAWADA

INTERNAL SQUAD COMMITTEE 2020-21

Date:02-11-20

ROLES & RESPONSIBILITIES:

- Strict checking of unfair means is sole responsibility of members of committee.
- Before the start of examination, the committee members should check every student.
- Care should be taken by committee members, that the students should not carry mobile phones, calculator or any sort of electronic material inside the examination hall.
- Check whether students are carrying hall tickets by committee members to maintain environment of examination. Any issue related to the unfair means should immediately report to the principal or college examination officer.

CONSTITUTION: The details of the members are as follow:

S. No	Name of the Faculty	Designation	Post
1	Dr. K. Padmalatha	Professor & Principal	Chairperson
2	Dr. S. Venkateswara Rao	Associate Professor	College Examination Officer
3	Mrs. B. Hemalatha	Assistant Professor	Member
4	Mr. M. Bala krishna	Assistant Professor	Member
5	Dr. N. Prathibha	Assistant Professor	Member

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VIJAYA INSTITUTE OF PHARMACEUTICAL SCIENCES FOR WOMEN

ENIKAPDU,VIJAYAWADA-521108.

IV PHARM. D / MID EXAMS

ATTENDANCE DIARY

Subject Name: Biopharmaceutics & Pharmacokinetics (T4105)

S. No	ROLL. No	STUDENT SIGNATURE		
		I MID	II MID	III MID
1	177N1T0001	Sumaiya.	Sumaiya.	Sumaiya.
2	177N1T0002	K.Parameswari	K.Parameswari	K.Parameswari
3	177N1T0003	Swathi.B	Swathi.B	Swathi.B
4	177N1T0004	G.Haritha.	Haritha.G	Haritha.G.
5	177N1T0005	-Ay-	T.Bharathi	T.Bharathi
6	177N1T0006	P.Nadiya.	P.Nadiya.	P.Nadiya.
7	177N1T0007	J.Harisha	J.Harisha	J.Herisha.
8	177N1T0008	M.Pallavi	M.Pallavi	M.Pallavi
9	177N1T0009	M.SriLakshmi.	-Ab-	M.SriLakshmi
10	177N1T0010	G. Shiny	G. Shiny	G. Shiny
11	177N1T0011	V.Meghana	V.Meghana	V.Meghana.
12	177N1T0012	T.Sravani.	T.Sravani.	T.Sravani.
13	177N1T0013	Jyothsna.K	Jyothsna.K	Jyothsna.K
14	177N1T0014	B.V.Sainika	B.V.Sainika	B.V.Sainika
15	177N1T0015	S.Nancy.	S.Nancy.	S.Nancy.
16	177N1T0016	Sk.Chandini	Sk.Chandini	Sk.Chandini
17	177N1T0017	T.Mahalakshmi	T.Mahalakshmi	T.Mahalakshmi
18	177N1T0018	-Ay-	Kumamaheswari	Kumamaheswari
19	177N1T0019	G.Sharada Sri	G.Sharada Sri	G.Sharada Sri
20	177N1T0020	V.umamaheswari	V.umamaheswari -Ab-	V.umamaheswari
21	177N1T0021	-Ay-	P.Tejasri	P.Tejasri
22	177N1T0022	Vineela.J	Vineela.J	Vineela.J
23	177N1T0023	SriThanmayi.N	SriThanmayi.N.	SriThanmayi.N
24	177N1T0024	P.kiran Swetha	P.kiran Swetha	P.kiran Swetha
25	177N1T0025	V.Prathyusha	V.Prathyusha	V.Prathyusha
26	177N1T0026	G.Lakshmipriya	G.Lakshmipriya	G.Lakshmipriya.
27	177N1T0027	M.Naga Jyothi	M.Naga Jyothi	M.Naga Jyothi
28	177N1T0028	D.Kunthitha.	D.Kunthitha	D.Kunthitha
29	177N1T0029	Blessyfydi.D	-Ab-	Blessyfydi.D
30	177N1T0030	T.AswiniTeja	T.AswiniTeja	T.AswiniTeja.
Total Number of Students		27/30	27 Present	29 present
Signature of Invigilator		Rajani.B	Prathyusha	B.Haneelatha
Exams Incharge		S. Venkateswarlu	S.Venkateswarlu	S.Venkateswarlu
Signature of Head of the Institution				

VIJAYA INSTITUTE OF PHARMACEUTICAL SCIENCES FOR WOMEN

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IV PHARM. D (PB)/ MID EXAMS
ATTENDANCE DIARY

Subject Name: Biopharmaceutics and Pharmacokinetics (T4105)

S.No	ROLL. No	STUDENT SIGNATURE		
		I MID	II MID	III MID
1	207N1T0101	-AL-	Sk. Shamila	Sk. Shamila
2	207N1T0102	K. Kalyayani	K. Kalyayani	K. Kalyayani
3	207N1T0103	M. Jay prise	M. Jay prise	M. Jay prise
4	207N1T0104	R. Bhanu		R. Bhanu
5	207N1T0105	-AL-	A. Sirisha	A. Sirisha
Total Number of Students		3	05	05
Signature of Invigilator		B. Hemalatha		B. Hemalatha
Exams Incharge		S. Venkatesh	S. Venkatesh	S. Venkatesh
Signature of Head of the Institution				

Model of Evaluated Mid Exam

Answer Script

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KNOWLEDGE IS POWER

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VIJAYAWADA

2020 - 2021

SESSIONAL BOOK

Name : SUMAIYA SALEEM

Class : IV PHARM D

Roll No. : 177N1T0001

Subject : BIOPHARMACEUTICS AND PHARMACOKINETICS

Internal	Objective	Subjective	Assignment	Total	Staff Sign	Student Sign
I		28		28	S. Praveen	Sumaiya
II		29		29	S. Praveen	Sumaiya
III		28		28.	S. Praveen	Sumaiya

Final Average :

S. Praveen

Staff Sign

HOD Sign

I-MID EXAMINATION

2. ABSORPTION:

Absorption is the process of transfer or movement of drug molecules from the site of administration to the systemic circulation.

- Absorption of a drug molecule depends on the route of administration.
- The measure of the concentration of the drug is more accurate at site of administration, but this is not possible thus, the measurement is taken at the plasma level. ie: absorption is the movement of drug molecules from the site of administration to the site of measurement ie: plasma.

Mechanisms of drug absorption.

- Absorption of a drug requires the movement of drugs through the semipermeable membrane of the cell, which is a bilipid layer having intrinsic and extrinsic proteins.
- The movement of drug accross the membrane is called the drug transport.
- Types of drug transport are:

I. Transcellular / Intercellular transport.

1. Passive transport.
   a. Passive diffusion
   b. Pore transport
   c. Ion-pair transport
   d. Carrier mediated transport.

2. Active transport
   a. Primary active transport
   b. Secondary active transport

II. Paracellular / Intercellular transport
   a. Transport through the junctions of the cells.
   b. Persorption.

III. Vesicular transport (Endocytosis).
   1. Phagocytosis
   2. Pinocytosis.

I. Transcellular transport.

The transport of drug molecules occurs through the cell membrane / through the cell.

- It is of two types.

1. Passive transport.

The movement of drug occurs in the absence of energy. No ATP is used for the transport. The driving force is the kinetic energy of the molecules due to presence of a concentration gradient across the cell membrane (Brownian movement).

- There are different types of passive transports

a. Passive diffusion.

This process involves the diffusion of molecules from area of high concentration to the area of low concentration.

- The movement of the molecules occurs from the area where high concentration of drug present ie. site of administration to the low concentration ie the system circulation.

- Passive diffusion depends on the "Fick's law of diffusion"

The fick's law of diffusion states the movement of molecules occurs from area of high concentration to area of low concentration until an equilibrium is established accross the membrane.

- It is written as:

$$\frac{dQ}{dt} = \frac{DAK_{m/w}(C_{GIT} - C)}{h}$$

- Where $\frac{dQ}{dt}$ = Diffusion rate constant for time t.

D = Diffusion coefficient

A = Surface area.

$K_{m/w}$ = Partition coefficient between the two sites or accross membrane

$(C_{GIT} - C)$ = Concentration gradient between the GIT and plasma / circulation.

- With the formula, we can determine that.

- The rate of diffusion increases with the increase in surface area. Increased surface area, more area for diffusion.

- Diffusion increases with high partition coefficient

as, the membrane is highly lipophilic, thus the drugs that are lipophilic can diffuse easily.

- Diffusion rate increase, with an increase in the concentration gradient across the cell membrane.
- The diffusion rate is more when the thickness of membrane is less.

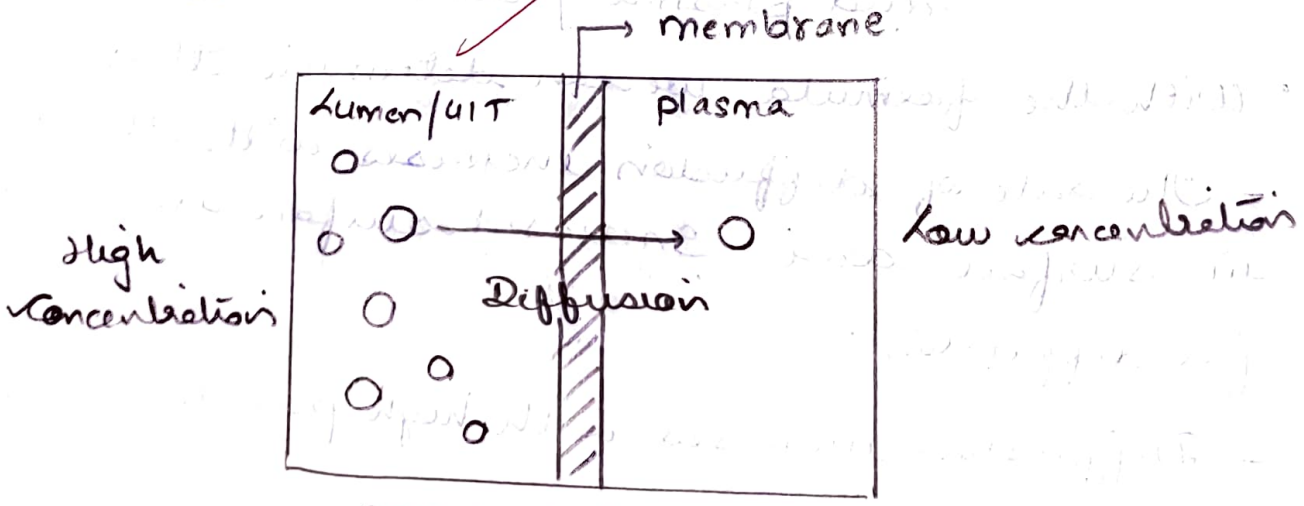
- Usually the movement is said to occur only until equilibrium is established, but the transported or diffused amount of drug is rapidly cleared in systemic circulation, thus there is no equilibrium and diffusion occurs. GIT conc. ↑ than Conc. in plasma.
- The ficks law can also written as:

$$\frac{dQ}{dt} = K(C_{GIT} - C)$$

where K is the constant.

- Here C_{GIT} more than C, ∴ C can be neglected,

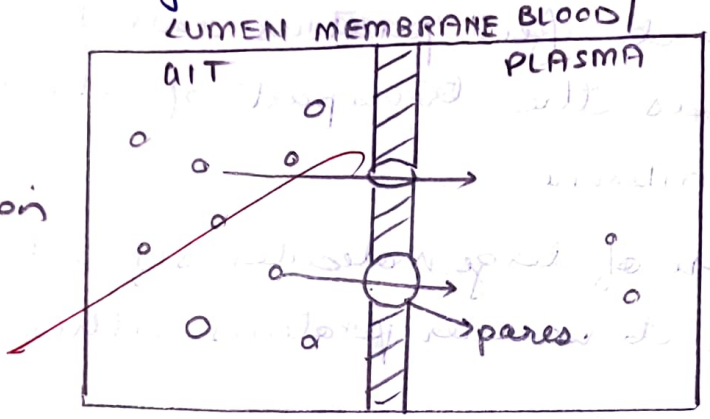
$$\frac{dQ}{dt} = K C_{GIT}$$



PASSIVE DIFFUSION.

b. Pore transport.

- The transport of drug molecules is through the pores present in the cell membrane.
- The movement is across the membrane due to presence of a conc. gradient.
- The pores of protein pores create path for the movement of molecules.
- This is more important in transport of hydrophilic molecules through the cell.

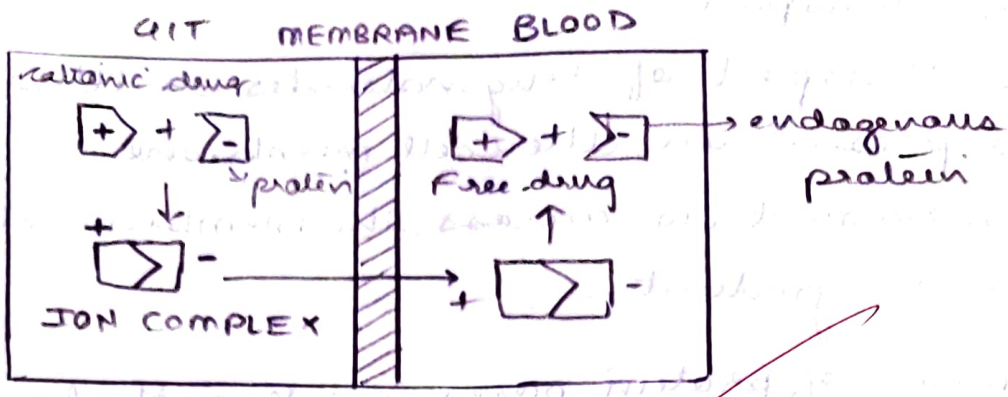


PORE TRANSPORT.

c. Ion pair transport.

- The unionized drugs easily transport through the membrane.
- Drugs like ammonium compounds etc ionize on entering the body, these bind with endogenous ion cmpnds like mucin and transfer across membrane.
- The binding is reversible

Eg: Paracetamol binds to oleic acid molecule reversibly and transports across the membrane



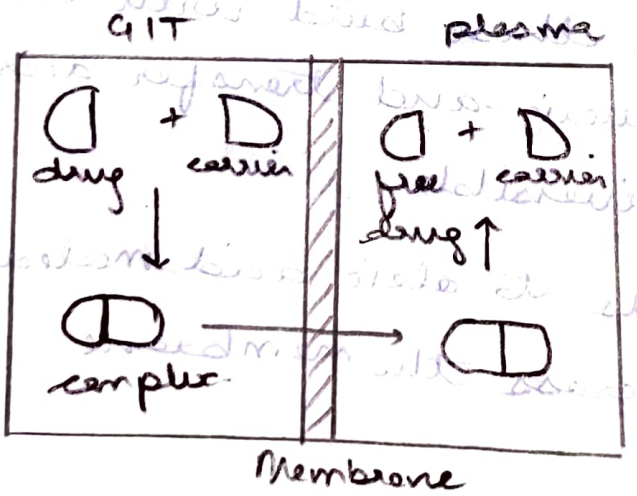
ION PAIR TRANSPORT.

d. Carrier mediated transport.

- Few drugs that do not easily diffuse through the cell bund to few proteins called carriers which assist in the transport of the molecule accross the membrane.
- Drugs that are of large molecular size, hydrophillic in nature bund to carrier proteins, this facilitates diffusion

→ ~~Facilitated~~ diffusion.

In this drug molecule binds to carrier protein and transport accross cell membrane, based on the concentration gradient.



FACITATED DIFFUSION.

2. Active transport.

- This transport of drugs accross the membrane is energy dependent.
- There is utilization of ATP molecules.
- The movement opposes the concentration gradient (upward).

- It is of two types

a. Primary active transport.

The transport occurs in or out of the cell.

- Ion transporters.
- Ion transporters assist in transportation of ionized molecules accross the membrane.
- Eg: proton pump inhibitors which transport protons (H^+) from parietal cells to the GI lumen.
- ABC (ATP Binding Cassette) transports.
- ABC binding protein transporters facilitate in the transport of drug accross the membrane utilizing ATP for energy to move accross the membrane.

b. Secondary active transport

- This is of two types

- Antiport.

2 molecules are transported simultaneously but in opposite directions utilizing ATP

Eg: $Na^+ - K^+$ transporters

- Symport.

Two molecules are transported across membrane simultaneously in same direction using ATP.

Eg: $Na^+ - H_2O$ transporters.

II. Paracellular transport:

The transport of molecules occurs by junctional space between cells.

a. Transport through junctions.

The transport of molecules is through connections or junctions b/w cells.

b. Through pores.

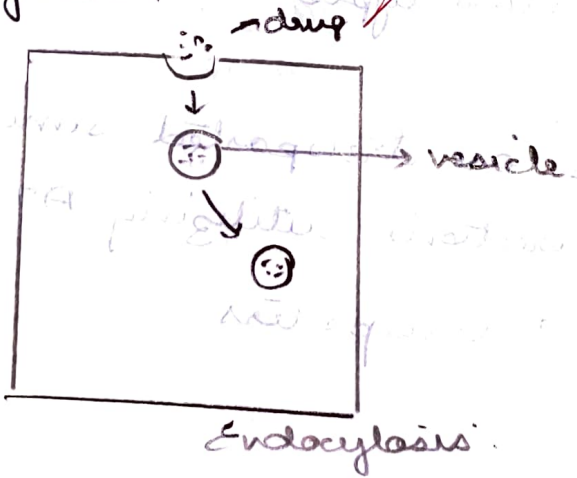
Pores are formed in membrane due to epithelial cell death. Through these pores transport occurs

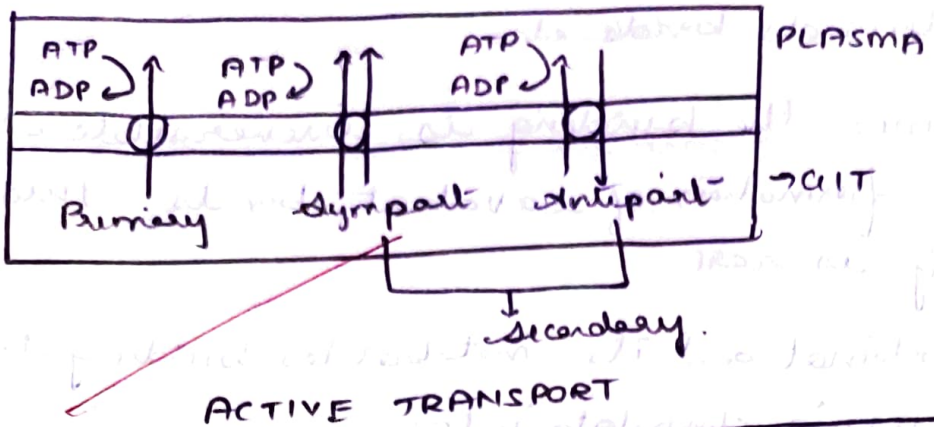
III. Vesicular transport.

The transport of drug is by formation of vesicles, vesicles are formed by engulfing the molecules to be transported.

a. Phagocytosis: engulfment of solid substances.

b. ~~Phago~~ Pinocytosis.





9

ACTIVE TRANSPORT

3.

a. **PROTEIN BINDING.**

It is the process of ~~for~~ formation of complexes between the protein and the drug.

- The drug binds with proteins to form complexes.
- This can be of two types.

1. Intracellular binding = The binding of drug to protein occurs inside the cell. (intracellular). The protein may be a drug receptor. This causes a physiological response in the cell, also called primary response.

2. Extracellular binding = The binding of drug occurs to the extracellular proteins. It may ~~not~~ cause a response and is called secondary binding or silent receptors.

Mechanism of protein binding.

- The binding of drugs to proteins is a reversible process.
- The bonds formed are
  - Ionic bonds

- Hydrogen bonds
- Vanderwaal's bonds etc.

- Sometimes the binding is irreversible that is there is formation of covalent bonds. This type of binding is rare.

Eg: Paracetomol and its metabolites binding to liver cells causing hepatotoxicity.

- The binding can occur to plasma proteins or to blood components.
- Binding also occurs to the tissue proteins etc.

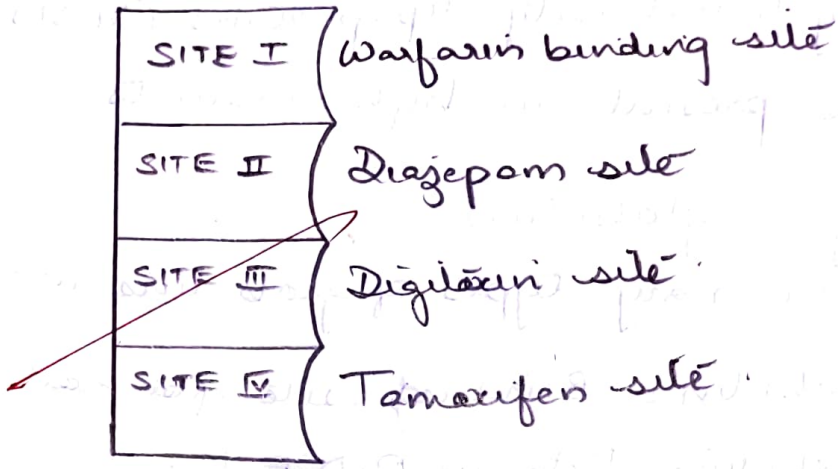
Plasma protein binding:

- The drugs bind to the proteins present in the plasma. The protein that is highly bounded is albumin.
- Albumin > α acid glycoprotein > lipoprotein > globulin.

Binding to Human serum albumen (HSA).

- HSA is most abundant in the plasma and is synthesized by liver, molecular wt (65,000), concentration (3.5 - 5g/dl).
- Most drugs bind to HSA, mostly lipophilic and acidic drugs are highly bound.
- Neutral drugs also bind to albumin.
- There are four sites on the albumin protein.

- Site I: Warfarin site. At this site NSAID's like ibuprofen etc and dicoumarol etc bind to protein.
- Site II: Diazepam site. Benzodiazepines etc bind at this site.
- Site I and II are most commonly used sites.
- Site III: Digitoxin site.
- Site IV: Tamoxifen site.



ALBUMIN BINDING SITES

Binding to α_1- acid glycoprotein (AAG).

- Most lipophilic, basic drugs bind to AAG.
  Eg: imipramine, propranolol, lidocaine etc.
- This is not abundantly present in the body plasma.

Binding to lipoproteins.

- Lipoproteins these are complex of lipids and proteins, these are binding sites for many lipophilic drugs.

- Most lipophilic drugs bind to lipid part of the lipoprotein. diffuse
- Many lipoproteins are present in our body.
  - Triglycerides
  - Cholesterols
  - Chylomicrons
  - Low density lipoproteins (LDL)
  - High density lipoproteins (HDL)
  - Very low density lipoproteins (VLDL).
- LDL is present in high amounts.

Binding to globulins.

- There are many types of globulins in our body
- α_1-globulin = Binding site for corticosteroids
- α_2-globulin = Vitamin A, D, E, K.
- β-globulin = Iron compounds
- γ-globulin = Fc antigens.

Binding to blood related compounds.

→ Most drugs bind to RBC, the different sites are:

- Hb = Drugs like mipiremine etc bind to hemoglobin.
- Carbonic anhydrase = Chlorthiazides bind to these enzymes.

Binding to tissue components:

- Drugs binding to tissues may be a, basic or neutral in nature. These bind to many organs in our body.
- Liver > kidney > Lung > Muscles.

Examples:

- Liver = paracetomol, acetaminophen etc.
- Lung = Corticosteroids
- Kidney = Metallothionins binding to heavy metals like lead, arsenic.
- Eyes = Melanin binding chloroquine
- Hair = Arsenicals
- skin = Chloroquine.

3.
b. VOLUME OF DISTRIBUTION.

- The drugs bind to protein, the unbound drugs give the concentration of drug in plasma.
- The amount distributed is an apparent volume since it is not specific and distribution varies in different parts.
- The unbound drug is utilized causing releasing of bounded drug, thus volume of distribution calculated is not real value but apparent volume.

- The concentration of drug present is proportional to the amount of drug.

$$C \propto X$$

$$C = Vd\ X$$

Vd = apparent volume of distribution

C = Concentration of drug.

X = Amount of drug present.

- The concentration of drug in plasma is Cp and Volume is Vp, in tissues it is C_T and V_T.

$$Vd = Vt + Vp.$$

- The volume of distribution is dependent on concentration of drug in body and unbound drug present.

Significance:

1. The volume of distribution is related to the protein binding.
2. Vd can be calculated wrt to protein binding of drug.
3. The amount of drug distributed depends on the unbound plasma protein present and is not same in every part of body.
4. Vd differs in different parts of body, thus is not a std or real value.

4.

a. FACTORS AFFECTING PROTEIN BINDING.

The factors include -

1. Drug related factors

a. Concentration of drug.

b. Physicochemical characteristics of drug.

c. Affinity towards the binding protein.

2. Protein related factors -

a. Concentration of protein -

b. Physicochemical properties or characteristics of protein

c. Number of binding sites on protein.

3. Drug interactions

a. Competition between two drug.

b. Competition between drug and the body constituents

c. Allosteric changes in protein.

4. Patient related factors

a. Age

b. Disease

1. Drug related factors

a. Concentration of drug.

- The conc. of drug in plasma also is a factor in protein binding.
- Drugs binding to albumin cannot be overturned

due to excess amount of albumin present than the drug itself, except in diseased conditions
• In case of AAG binding drugs, there is more drug than protein. This can cause competition.

b. Characteristics of drug.
• The drugs nature eg: acidic drugs bind to HSA eg: Warfarin etc.
• Basic drugs like imipramine, propranolol, lidocaine bind to AAG,
• Highly lipophilic drugs bind to lipoproteins.

c. Affinity towards binding protein.
The nature of drug determines its affinity
• Lipophilic and acidic → HSA.
• Lipophilic, basic, neutral → AAG.
• Highly lipophilic → lipoproteins
• Few drugs → Hb etc.

2. Protein related factors:
a. Concentration of protein.
• The no. of albumin or other binding proteins determines the binding of drugs.
• The albumin should be available for the drug to bind.
• In conditions of ascites, hepatitis etc. There

is decreased albumin, this decreases the protein binding of drug.

b. Characteristics of protein:

- The nature of protein for binding is the factor.
- Drug and protein nature depends on the their acidic or basic or neutral nature, thus causing bonds. It also depends on type of bond a protein or drug can form. c. The no. of binding sites is also a factor

c. Allosteric changes in protein: Drug interactions

- The protein configuration changes wrt to the drug binding to the protein.
- Eg: NSAIDs binding to proteins.

3. Drug interactions:

a. Competition b/w drug molecules.

- 1 drug can displace another from binding to protein.
- Eg: phenylbutazone displaces warfarin from protein. Both these are highly bound to albumin.
- The displacement depends on conc. of drug, its affinity etc.

b. Competition b/w drug & body constituent:

There is competition for binding site between a drug and constituents in body.

• Bilirubin binded to albumin for transportation to liver. can be displaced by drug like warfarin.
• This causes Hyperbilirubenemia causing jaundice in children and adults.

+ Patient related factors:

a. Age.

• Neonates have less albumin, thus drugs enter blood causing elimination earlier.
• Elderly also have less HSA & AAG due to decreased func- of liver etc.

b. Diseases:

• Renal damage → ↓ albumin conc.
• Hepatic damage → ↓ albumin synthesis
• Inflammation → ↓ albumin present in plasma

4.
b.

SIGNIFICANCE OF PROTEIN BINDING.

1. Absorption:

The absorption of drug is based on the number of unbound drug present in plasma, protein binding influences absorption.

2. Distribution:

- The drug distributed across the body is the amount of unbound drug conc. present.
- The bound drug is released, when the plasma conc. of drug decreases.
- The distribution is not even in all areas of the body

3. Apparent volume of distribution:

- The Vd depends on unbound drug present.
- It is based on the apparent volume and not the real volume as it cannot be exactly determined, due to the absence of complete 100% free drug and different distribution rates in factors at different parts of body.

4. Drug displacement:

- Displacement of a drug off a protein due to another drug competing for the same site.
- The displacement of a drug can cause toxic levels of the prevails drug bound to protein causing adverse effects.
- This is similar in regard to competition between bound constituents of body like jaundice
- The drugs given should be changed or doses to be decreased to avoid interactions

5. Diagnosis:

- Diagnosing of a disease can be done due to concept of protein binding.
- Eg: I_2 is highly bound to thyroid gland and has high affinity towards it.
- A labelled I_2 molecules can be used to detect disease of the thyroid gland.

6. Target specific therapy.

- The therapy can be made specific to a particular site, by using drugs that bind only to specific protein of the site for therapy.
- This can exclude symptoms or reactions related to other sites unlike the intended site of therapy.

28/30

15/4/21

2. a. PHARMACOKINETICS:

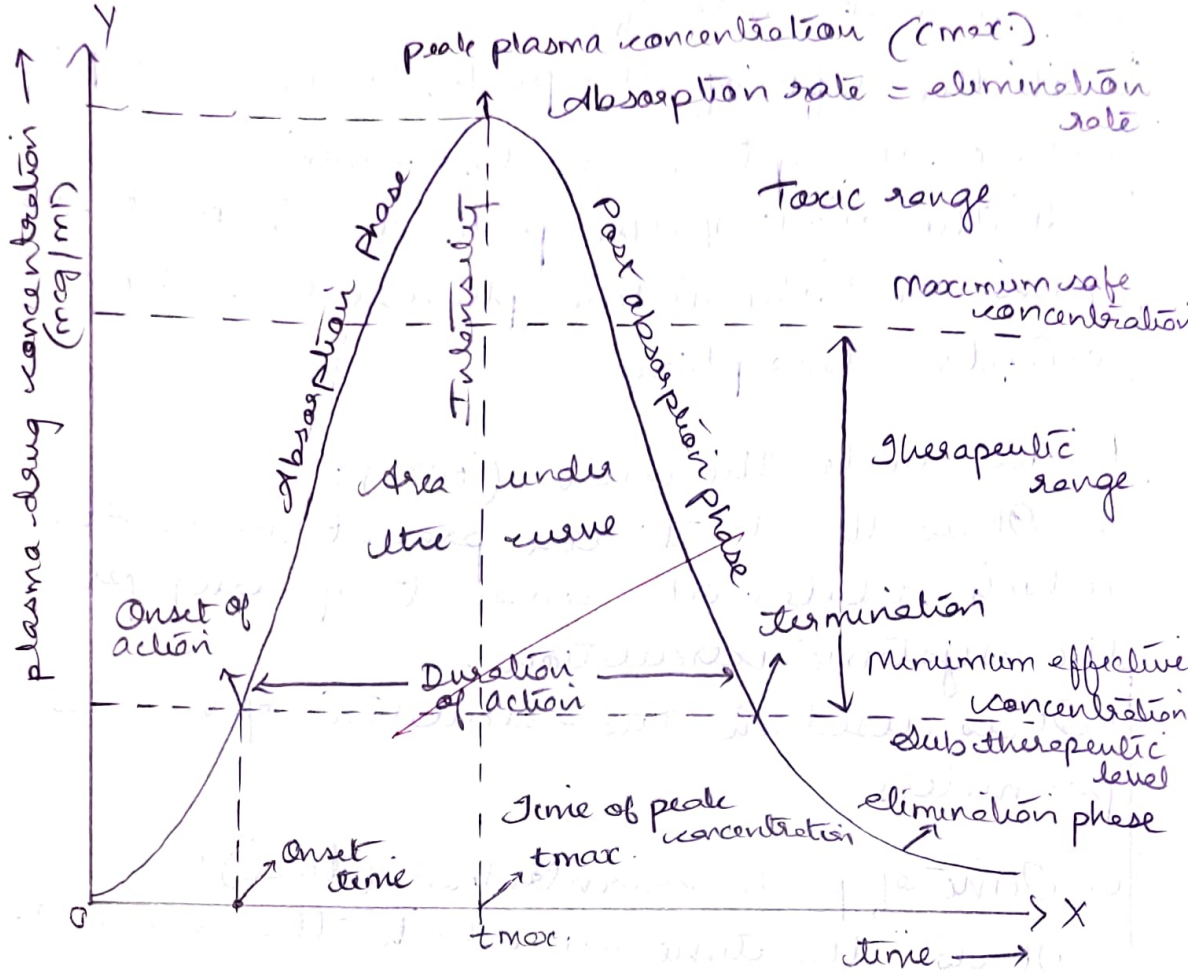
- It is the process/study of kinetics involved in drug absorption, distribution, metabolism and excretion in relation with pharmacological, therapeutic and toxic effects of the drug.
- Pharmacokinetics is derived from 2 Greek words mainly 'Pharmakon' meaning drug and 'kinetics' meaning movement.
- The drug dose regimen is established by understanding the pharmacokinetic parameters of the drug.
- The frequency of the drug dosing is also based on the pharmacokinetic properties of the drug.
- It is based on two types:

1. Theoretical pharmacokinetics = establishment of models regarding the drug disposition.
2. Experimental pharmacokinetics = collecting of blood/plasma/urine samples to check for the concentration of the drug.

Blood/Plasma drug level curve/profile.

- There is a relation between the blood concentration of the drug and time.
- A graph is plotted with concentration on the y-axis and time on the x-axis.
- The concentration is mentioned mcg/ml and time in hours or minutes.
- The curve obtained after plotting the graph is a means for calculation of various pharmacokinetic

and pharmacodynamic parameters.



Using the blood level curve two types of pharmacokinetic parameters can be identified.

1. Pharmacokinetic
2. Pharmacodynamic

1. Pharmacokinetic parameters:

These include 3 parameters which are important in understanding the drug disposition.

a. Peak plasma concentration (Cmax):

- The highest concentration in the curve is at the peak. The concentration at the peak is called peak plasma concentration. It depends on the

i) Dose of drug.

ii) Rate of absorption of the drug.

iii). Rate of drug elimination
• At the peak, it denotes that the absorption rate is equal to rate of elimination.
• At the left of the peak, it is absorption phase where absorption exceeds elimination.
• At the right of the peak, it is post absorption phase and elimination phase, where elimination exceeds absorption.

b. Area under the curve (AUC):
• It is the total area present under the curve which relates the amount of drug present in the systemic circulation.
• It is used in the calculation of various other parameters.

c. Time of peak concentration (tmax):
• It is the time at which the concentration is maximum or the highest.
• It is used to determine the efficacy of drug
• It is better for Cmax to remain in between max. safe concentration and minimum effective concentration.
• Tmax can help determine onset time, elimination time etc.

2. Pharmacodynamic parameters:
a. Minimum effective concentration (MEC):
• It is the minimum concentration of a drug required to produce a therapeutic effect in the body.
• Concentrations below MEC are called sub the

-tic levels.

• In case of antibiotics MEC is called MIC which is minimum inhibitory concentration of the drug required from killing or stopping the growth of bacteria.

b. Maximum safety concentration (MSC):
. It is the maximum concentration of the drug whose use is safe and concentrations exceeding MSC cause toxic effects in the body.

c. Therapeutic range:
. It is the concentration of drug between minimum effective concentration and maximum safety concentration.
. It is the range of drug concentrations showing therapeutic response in the body.

d. Onset of action:
• It is the concentration at which therapeutic response starts to exhibit in the body. MEC starts from onset of action.

e. Duration of action:
. The duration of action is the maximum time the drugs effect is observed in the body.
. It gives the time period of drug action in the body.

f. Onset time:
. It is the time at which the onset of action occurs. It provides with the time after administration where the activity of drug occurs.

g. Therapeutic index:

· It is the ratio between maximum safety concentration and minimum effective concentration.

Therapeutic index = $\frac{MSC}{MEC}$.

2b. COMPARTMENTAL APPROACH.

· It is the approach where the body is assumed to be divided into various compartments.

· A model is a hypothetical visual chart which is used to study pharmacokinetic properties of the drug.

· There are model and non-model based approaches.

· Model based is of 3 types.

1. Compartment model.
   - Mammillary.
   - Catenary
2. Physiological model.
   - Perfusion based.
   - Diffusion based
3. Dispersion of the drug.

Compartmental model is where the body is divided into compartments.

· The compartments are divided as.

1. Highly perfused compartments = which include organs with high blood perfusion like kidney, liver, lungs etc.
2. Moderately / Poorly perfused = Eg: include skeletal muscle, adipose tissue etc.
3. Not perfusable = Eg: bone, tendon, ligament etc

Assumptions of compartment model:

1. The body is divided based on compartments (various compartments) arranged in series or parallel.
2. The compartments formed are not physiologically or anatomically true. It is just a virtual or fictious model.
3. The rate processes follow first order kinetics
4. The drug is assumed to be well distributed
5. Number of rate processes are used to determine drug disposition.

Types of compartmental model:

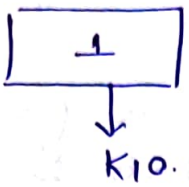
1. Mammillary:
   - It is the most common type of model. In this compartments are arranged in series or parallel.
   - The main compartment is the central compartment (compartment 1) which include highly perfused organs like lungs, liver, kidney etc.
   - The elimination is also said to be occuring from the central compartment since excretion also occurs from liver and kidney.
   - The compartment 2 is called periphery compartments which are poorly perfused organs like skeletal muscles etc.
   - The rate of drug transfer is denoted by K which is denoted as K12 (transfer from compartment 1 to 2) and K21 vice versa.
   - The no. of rate constants is determined using the formulas:

- Intravenous administration = $2n-1$.
- Extravascular administration = $2n$.

where n = no. of compartment.

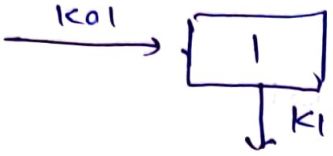
Model 1: One compartment IV model.

$2n-1$
$= 2-1 = 1.$



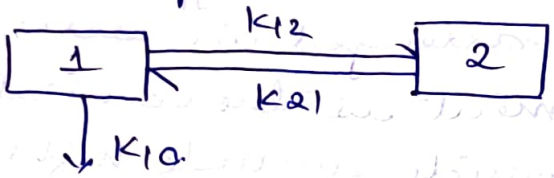
Model 2: One compartment extravascular model

$2n$
$= 2 \times 1 = 2.$



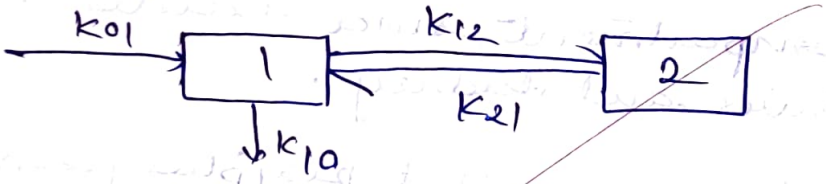
Model 3: Two compartment IV model.

$2n-1$
$2(2)-1$
$= 3.$



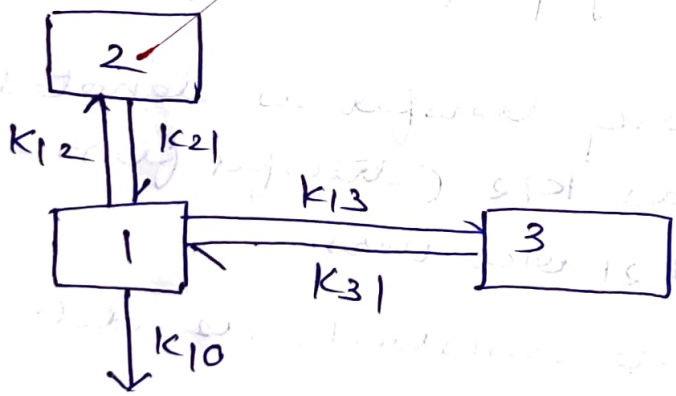
Model 4: Two compartment extravascular model

$2n$
$2(2) = 4.$

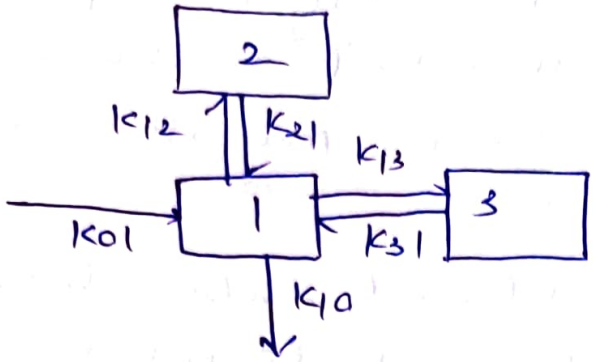


Model 5: Three compartment IV model

$2n-1$
$2(3)-1$
$= 5$

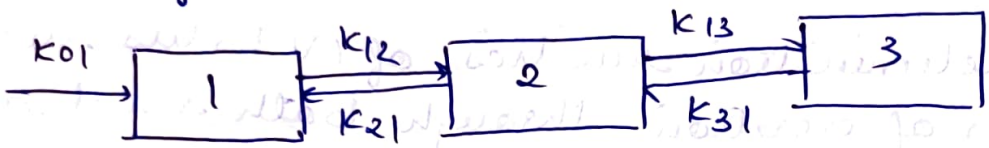


Model 6: Three compartment extravascular model



2. Catenary model:

It is rarely used. The various compartments are arranged in series similar to that of a train.



Advantages of compartmental model.

1. It is a simple and flexible process.
2. It gives a virtual idea of no. of rate process involved
3. It explains the process of drug disposition
4. It used to compare studies of various drug.
5. It gives the drug disposition in pathological and normal conditions.
6. Various parameters like Vd, $t_{1/2}$ etc can be calculated.
7. The pharmacokinetist is able to obtain equations to obtain various parameters.
8. Patient specific parameters can be calculated.

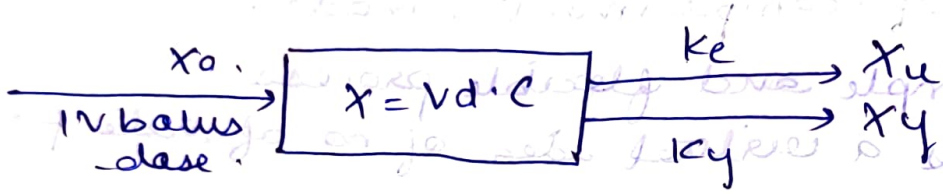
Disadvantages:

1. It is virtual or fictious model ~~and~~ unrelated

to anatomical aspects.
2. It cannot be used to study multiple drugs
3. It has complex mathematical equations.
4. Population based studies may alter from different populations.
5. It is a flexible model and can be abused.
6. There are a no. of rate constants involved.

3a. ONE COMPARTMENT OPEN IV BOLUS MODEL BY URINARY EXCRETION:

- In the elimination kinetics of IV bolus, it comprises of excretion through both renal and non renal routes.



where X_o = IV bolus dose
X = Amount of drug in the compartment
V_d = Apparent volume of distribution
C = Concentration drug in the compartment.
X_u = Amount excreted in urine / kidneys
X_y = Amount excreted through non-renal routes.
K_e = renal elimination rate constant
K_y = Non-renal elimination rate constant

- The rate of excretion of drug in urine with respect to time t is directly proportional to the amount of drug in the compartment

$$\frac{dx_u}{dt} \propto X.$$

$$\frac{dx_u}{dt} = k_e X \longrightarrow 1.$$

where k_e = elimination rate constant (renal).

According to IV bolus plasma deviation.

$$X = x_0 \cdot e^{-k_E t}.$$

Substitute value of X in equation 1.

$$\frac{dx_u}{dt} = k_e x_0 \cdot e^{-k_E t}.$$

The elimination kinetics is based on two methods

1. ~~Etm~~ Excretion rate method
2. Sigma minus method

1. Excretion rate method:

$$\frac{dx_u}{dt} \propto X$$

$$\frac{dx_u}{dt} = k_e X$$

$$\frac{dx_u}{dt} = k_e x_0 \cdot e^{-k_E t} \quad (\text{from } X = x_0 \cdot e^{-k_E t}).$$

Apply logarithm on both sides.

$$\log\left(\frac{dx_u}{dt}\right) = \log k_e x_0 - \frac{k_E t}{2.303}.$$

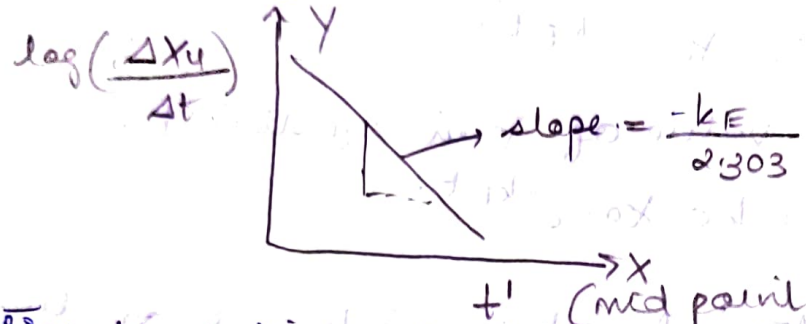
· In this method it is assumed that $\frac{dx_u}{dt}$ which is instantaneous rate is equal to the average rate $\frac{\Delta x_u}{\Delta t}$ at midpoint of time intervals of sample collection t'.

$$\therefore \log\left(\frac{dx_u}{dt}\right) = \log k_e x_0 - \frac{k_E t}{2.303}$$

$$\log\left(\frac{\Delta x_u}{\Delta t}\right) = \log k_e x_0 - \frac{k_E t'}{2.303}$$

t' = midpoint of time interval.

On plotting a graph between $\log\left(\frac{\Delta x_u}{\Delta t}\right)$ against t', a slope $\frac{-k_E}{2.303}$ is obtained.



The intercept of line extended $= \log k_e x_0$

slope $(m) = \frac{-k_E}{2.303}$.

$$k_E = -(m) \times 2.303.$$

2. Sigma minus method:

$$\frac{dx_u}{dt} = k_e x_0 \cdot e^{-k_E t} \quad \text{---} (2).$$

~~Derivate~~ the equation from $t=0$ to $t=t$.

Integrate

$$\int_0^t \frac{dx_u}{dt} = k_e x_0 \int_0^t e^{-k_E t}.$$

$$\int_0^t dx_u = k_e x_0 \int_0^t e^{-k_E t}.dt.$$

$$|x_u|_0^t = k_e x_0 \int_0^t e^{-k_E t}.dt.$$

$$x_u^t - x_u^0 = k_e x_0 \left[\frac{e^{-k_E t}}{-k} - \frac{e^{-k_E 0}}{-k}\right]$$

$$x_u t - x_u 0 = k_e x_0 \left[\frac{e^{-k_E t}}{-k_E} + \frac{1}{k_E} \right].$$

$x_u 0 = 0$ as it is the amount at time 0.

$e^0 = 1$.

$$x_u t = \frac{k_e x_0}{k_E} \left[1 - e^{-k_E t} \right] \quad \text{---(3)}.$$

→ Integrate equation number 2 from $t=0$ to $t=\infty$.

$$\int_0^\infty \frac{dx_u}{dt} = k_e x_0 \int_0^\infty e^{-k_E t}.$$

$$\int_0^\infty dx_u = k_e x_0 \int_0^\infty e^{-k_E t}.\, dt$$

$$x_u \infty - x_u 0 = k_e x_0 \left[\frac{e^{-k_E \infty}}{-k_E} - \frac{e^{-k_E 0}}{-k_E} \right]$$

$e^0 = 1$

$e^\infty = 0$.

$$x_u \infty - x_u 0 = k_e x_0 \left[\frac{+1}{k} \right]$$

$x_u 0 = 0$ $\quad \therefore x_u \infty = \frac{k_e x_0}{k_E}$

Substitute the value of $x_u \infty$ in equation (3).

$$x_u t = \frac{k_e x_0}{k_E} \left[1 - e^{-k_E t} \right]$$

$$x_u t = x_u \infty \left[1 - k_E e^{-k_E t} \right]$$

$$x_u t = x_u \infty - x_u \infty e^{-k_E t}.$$

Subtract $x_u \infty$ from both sides.

$$x_u \infty - x_u t = x_u \infty - x_u \infty + x_u \infty e^{-k_E t}.$$

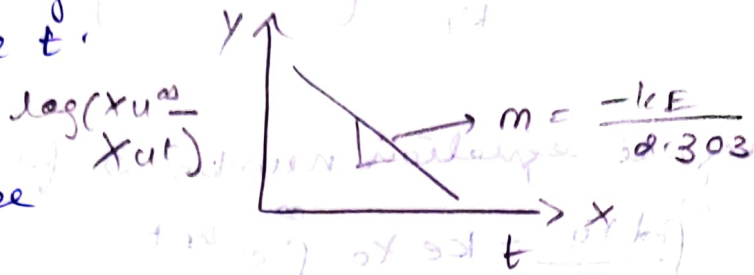
$$x_u \infty - x_u t = x_u \infty e^{-k_E t}.$$

Apply log on both sides.

$$\log(x_u^\infty) - \log(x_u t) = \log x_u^\infty - \frac{kEt}{2.303}$$

$$\log(x_u^\infty - x_u t) = \log x_u^\infty - \frac{kEt}{2.303}$$

Plot a semilogarithmic graph between $\log(x_u^\infty - x_u t)$ against time t.



From the slope

$$m = \frac{-kE}{2.303}$$

$$k_E = -(m) \times 2.303$$

Elemination rate constant is obtained.

Clearance:

$$\frac{dx_u}{dt} = Cl_R \cdot C.$$

$$Cl_R = \frac{-dx_u/dt}{C.} \quad -5$$

$$\frac{\Delta x_u}{\Delta t} = k_e x_0.$$

substitute $\frac{\Delta x_u}{\Delta t}$ value in equation (5),

$$Cl_R = \frac{k_e x_0}{C}$$

$$X_0 = Vd \cdot C_0$$

$$Vd = \frac{X_0}{C}$$

$Cl_R = k_e Vd$ on substitution

Cl_R = renal clearance.

k_e = rate constant for renal elemination.

$Cl_T = K_E \cdot Vd$,

where Cl_T → total clearance.

3, b. DOSE ADJUSTMENT IN RENAL FAILURE.

- In patients with renal failure and renal dysfunction there is a decrease in elimination, the half life is increased and the volume of distribution is altered.
- To avoid the further complications of drug intake in renal failure, dose adjustments are required
- It is needed when therapeutic doses cause a wide variation in the renal function.
- Dose adjustment is not required when.
  - The fraction of unchanged drug eliminated drug fe is ≤ 0.3.
  - The rate of excretion is ≥ 0.7.
- The above is based on assumption that there is no effect to the renal function, metabolites are inert in nature, no difference in renal clearance.
- If the elimination rate becomes 0 and fe as unity, there is high required of dose adjustment.
- The doses of renal failure can be calculated using renal function.

Dose in renal impairment = Normal dose × renal function

- For frequency of drug use:

$$\text{Frequency} = \frac{\text{Frequency of drug (days)}}{\text{Renal function}}$$

- When the drug is excreted through both renal and non-renal routes:

Dose = [RF × fraction of drug eliminated renally + fraction of drug eliminated non-renally].

- The dose adjustment is required as decre clearance of drug causes toxicity in the body and causes further harm to the bod

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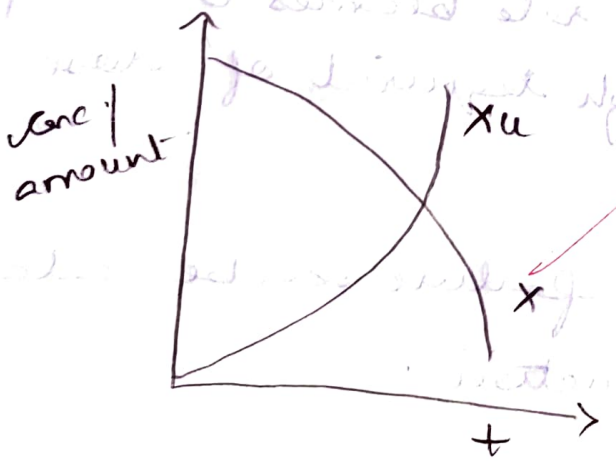
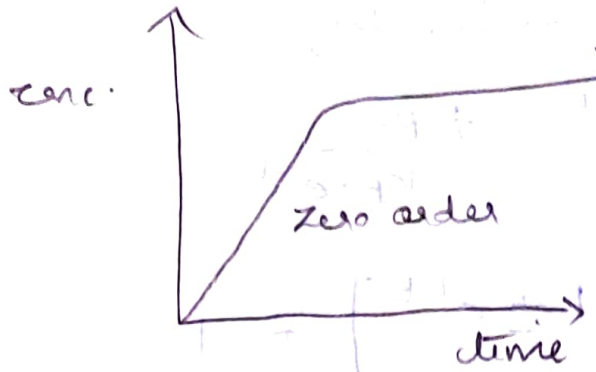
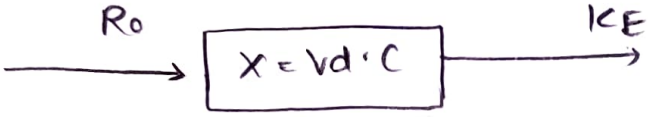
ONE COMPARTMENT OPEN IV MODEL FOR INFUSION.

- Infusion of a drug intravenously is given to maintain the amount of drug released with respect to time until a steady state concentration is reached.





- In IV infusion, it follows zero order when entering the body and first order when eliminated.
- The amount of drug with respect to time is based on input + output.



Where Ro = infusion rate.
Vd = Volume of distribution.
K_E = elimination rate constant.
X = Amount of drug in body.
C = Concentration of drug in body.

$$\frac{dx}{dt} = Ro + K_E X_o$$

Multiply on both sides with e^{+kt}.

$$\frac{dx}{dt} \cdot e^{+kt} = Ro \cdot e^{+kt} + ke\, x_o \cdot e^{+kt}.$$

On integration using $t=0$ to $t=t$

$$\int_0^t \frac{dx}{dt} \cdot e^{+kt} = \int_0^t Ro \cdot e^{+kt} + ke\, x_o \cdot e^{+kt}.$$

$$X \cdot e^{-kt} = \frac{Ro \cdot e^{+kt}}{+k.} + \frac{Ro}{K_E}.$$

Divide both sides by e^{kt}

$$\frac{X \cdot e^{kt}}{e^{kt}} = \frac{R_0 e^{kt}}{K_E \cdot e^{kt}} + \frac{R_0}{K_E \cdot e^{kt}}$$

$$X = \frac{R_0}{K_E}\left[1 \pm e^{-kt}\right] \longrightarrow 1$$

$X = V_d \cdot C$.

substitute X value in equation 1.

$$V_d \cdot C = \frac{R_0}{K_E}\left(1 \pm e^{-kt}\right].$$

$$C = \frac{R_0}{K_E \cdot V_d}\left(1 \pm e^{-kt}\right].$$

$K_E \cdot V_d = Cl_T$.

$$\therefore C = \frac{R_0}{Cl_T}\left(1 \pm e^{-kt}\right], \longrightarrow 2.$$

4 During steady state.

$C = C_{ss}$ $\quad \frac{dx}{dt} = 0$ $\quad X = X_{ss}$.

$$\frac{dx}{dt} = R_0 \pm K_E X_{ss}$$

$$0 = R_0 - K_E X_{ss}$$

$$R_0 = K_E X_{ss}$$

$$R_0 = K_E V_d \cdot C_{ss}$$

$$C_{ss} = \frac{R_0}{K_E \cdot V_d} = \frac{R_0}{Cl_T}$$

Substitute value of C_{ss} in equation 2.

$$C = C_{ss}\left(1 \pm e^{-kt}\right]$$

$C = C_{SS} \cdot (1 + e^{-kt})$

$C = C_{SS} + C_{SS} e^{-kt}$

$C - C_{SS} = -C_{SS} e^{-kt}$

multiple with (-) on both sides

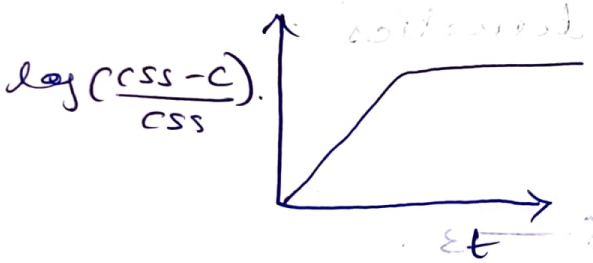
$C_{SS} - C = C_{SS} e^{-kt}$

Logarithm on both sides

$\text{Log } C_{SS} - \text{Log } C = \log C_{SS} - \frac{kt}{2.303}$

$\text{Log}\left(\frac{C_{SS}-C}{C_{SS}}\right) = \frac{-kt}{2.303}$

Plot graph against $\text{Log}\left(\frac{C_{SS}-C}{C_{SS}}\right)$ and t.



The slope of the graph (m) $= \frac{-k}{2.303}$

$-k = m \times 2.303$

$k = -(m) \times 2.303$

Post infusion rate:

$\frac{dx}{dt} \propto C$

$\frac{dx}{dt} = K_E \cdot C$

$C = C_{SS} \cdot e^{-kt}$

When steady state is not reached then

$C = \frac{R_0}{K_E V_d}(1 - e^{-kt})(e^{-kt})$

Loading dose + IV infusion

IV injection (bolus) is given to get a steady concentration of drug in the body, after which IV infusion is given.

Concentration = $\angle D + MD$.

Loading dose = $\frac{X_0}{Vd}$

Maintenance dose = $\frac{R_0}{K_E Vd}\left(1 - e^{-kt}\right)$.

$$C = \frac{X_0}{Vd} + \frac{R_0}{K_E Vd}\left(1 - e^{-kt}\right).$$

Elimination rate kinetics :

$$\frac{dX_u}{dt} \propto X.$$

$$\frac{dX_u}{dt} = K_E X. \quad \text{---} 3.$$

$X = \frac{R_0}{K_E}\left[1 - e^{-kt}\right]$. substitute in eq 3

$$\frac{dX_u}{dt} = K_E \cdot \frac{R_0}{K_E}\left[1 - e^{-kt}\right].$$

Integrate on both sides from $t=0$ to $t=t$

$$\int_0^t \frac{dX_u}{dt} = \int_0^t K \frac{X R_0}{K_E}\left(1 - e^{-k_E t}\right)$$

$$X_u{}^t = \frac{K R_0}{K_E}\left[t - \left(\frac{e^{-k_E t}}{-K_E} + \frac{1}{K_E}\right)\right]$$

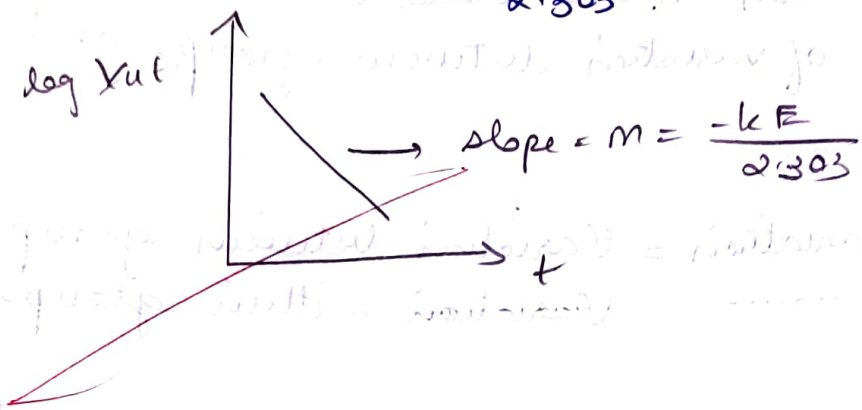
$$X_u{}^t = \frac{R_0}{K_E}\left[t - \left[\frac{1 - e^{-k_E t}}{K_E}\right]\right].$$

$$X_{ut} = \frac{R_0 t}{kE} - \frac{R_0}{kE^2} - \frac{R_0 e^{-kEt}}{kE^2}$$

$$X_{ut} = \frac{R_0 t}{kE} - \frac{R_0}{kE^2}\left[1 - e^{-kEt}\right].$$

$$\text{Log } X_{ut} = \frac{\text{Log } R_0 t}{kE} - \text{Log}\frac{R_0}{kE^2} - \frac{kEt}{2.303}.$$

Plot a graph between Log X_{ut} and t & obtain the slope $= m = \frac{-kE}{2.303}$.



10.

29/30

2.
a. ANOVA.

Analysis of variance is a parametric analytical t
that divides data into multiple components fo
homogeneity of the data analysis.

- In ANOVA, the data is split into various comp
to understand variations present in the data.
- The variation in the data can be due to the
presence of variation between groups and within
groups.
- Total variation = Variation between groups +
Variation within groups

- Consider there are 4 plots in which seeds are
added. The yield obtained may vary, due to
variations present within the plots and th
seeds used.
- ANOVA is based on the average variations
present and the chances occured.
- ANOVA is of two types.

a. ANOVA of one way classification
b. ANOVA of 2 way classification.

Assumptions of ANOVA

1. The experimental errors are same for all
groups.
2. The occurences of variation is uniform

3. Sampling is independent and random.

Procedure for ANOVA:-

Step I: Set up null hypothesis (H_0).

$$H_0: \mu_1 = \mu_2 = \mu_3 \cdots\cdots = \mu_k.$$

Step II: Set up alternate hypothesis (H_1)

$$H_1: \mu_1 \neq \mu_2 \neq \mu_3 \cdots\cdots \neq \mu_k.$$

Step III:

Sum of squares calculation

1. Total sum of squares (TSS)

$$= \Sigma\Sigma x_{ij}^2 - (G^2/N).$$

N = total no. of observations

G^2 = sum of observations

2. Treatment sum of squares (TrSS)

$$= \Sigma(T_i^2/n_i) - G^2/N.$$

n_i = no. of observations in each row

3. Error sum of squares (ESS).

$$= TSS - TrSS.$$

Step-IV: Calculation of degrees of freedom

1. TSS (df) = $\frac{TSS}{N-1}$ $N-1$

2. TrSS (df) = $\frac{TrSS}{k-1}$ $k-1$

3. ESS (df) = $(N-1)-(k-1)$

$= N-k.$

Step V: Mean sum of squares

MSS due to treatments $(St^2) = \frac{TSS}{K-1}$

MSS due to error $(Se^2) = \frac{ESS}{N-K}$

Step VI: Variance ratio test

$$f = \frac{St^2}{Se^2}$$

- If $Se^2 > St^2$ then the numerator can be s since f shouldn't be > 1.

Conclusion:

The calculated f value should be less t table f value. ∴ we accept Ho, if not we r Ho.

Sources	Sum of squares	D(f).	Mean sum of squares	Ratio test
Between groups	TSS	K-1	St^2	$f = \frac{St^2}{Se^2}$
Error	ESS	N-K	Se^2	
Total	TSS	N-1		

Applications of ANOVA in pharmacy:

1. It is used to determine the effectiveness of various drugs.
2. Used to analyse effectiveness of drug in patient.
3. If psychiatric patient undergoes s treat

chemical, behavioural, biofeedback, ANOVA can be used to determine which was more effective.

4. Used to identify therapeutic response in a patient
5. Used in various clinical trials for production of drugs etc.
6. Used in comparing effectiveness of various dosage forms
7. Used in comparing drugs which are same but from different manufacturers etc.
8. Used in bioavailability studies.

2.

b. IVIVC.

Invitro - In vivo correlation is a predictive mathematical model that correlates invitro dissolution (dissolution time etc) to invivo bioavailability (absorption; AUC) etc of drugs.

IVIVC is used as an alternative to the invivo bioavailability studies in human subjects / models

Advantages:

- It gives batch to batch studies of bioavailability.
- To determine dissolution parameter protocol.
- To avoid invivo studies / alternative to that

Assumptions:

- The assumption is that the process follows

first order elimination kinetics.

2. The previous bioavailability test reports can be utilized for better invitro results.

Quantitative correlations of IVIVC.

1. Correlation with plasma concentration data:
The invitro dissolution is correlated to the invivo bioavailability parameters.

Eg: Absorption of drug in body (invitro) ⟶ ka, Cmax etc (invivo).

2. Correlation with urinary excretion data:
Based on the fraction of drug excreted unchanged, cumulative values etc.

3. Correlation based on physiology:
Based on the least effective or LD50 dosing etc.

4

→ In few situations positive correlation may not be possible due to difference in physio-chemical properties, physiology etc.
Eg: corticosteroids.

Levels of correlation:

1. Level A:

- It is a point to point correlation betw invitro dissolution and invivo absorption studies.
- It is said that both curves of invitro dissolution and invivo absorption superim

on each other.

Advantages:

- It gives point to point correlation.
- If there is change in the manufacturing, methodology etc changes/modifications can be made without performing invivo studies.
- It can be used for quality studies.

Level B:

- It is not a point to point correlation. The correlation is between mean dissolution time and invivo mean residence time (MRT).
- It is not point to point, since there are many curves having same MRT, ∴ modifications cannot be made as in Level A. Quality studies can also be not performed.

Level C:

- It is a single point correlation. It is correlation with Cmax, AUC, ka etc. It is the least used level.

Multiple Level C:

- Multiple single point correlations are made similar to that of Level C.

→ Order of use:

Level A — Level B — Level C — Multiple Level C.

9.
a. MICHAELES MENTON EQUATION:

• It is a single compact saturable process which is given by equation.

$$\frac{-dc}{dt} = \frac{V_{max} \cdot c}{K_m + c} \quad \text{— ①.}$$

• where; $\frac{-dc}{dt}$ = rate of decline in concentration with time.

V_{max} = Max. rate of process

K_m = Michaeles-menton constant

c = Concentration

→ Three situations can be concluded based on value of K_m and c.

1. $K_m = c$.

When substituting in equation ①.

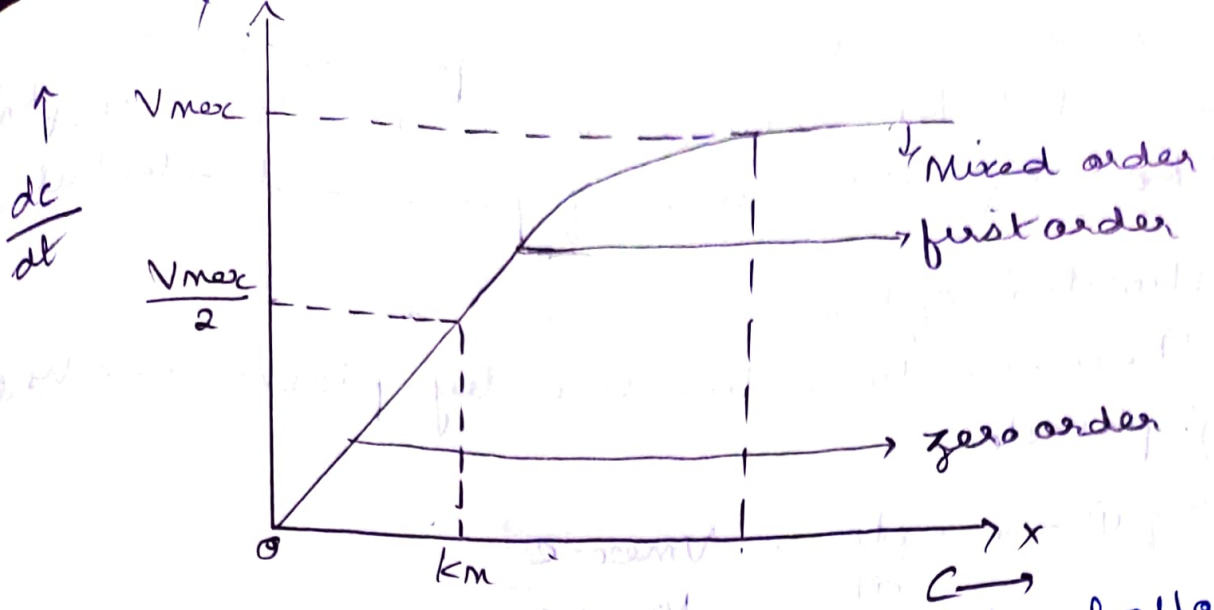
$$\frac{-dc}{dt} = \frac{V_{max} \cdot K_m}{K_m + K_m}$$

$$= \frac{V_{max} \cdot \cancel{K_m}}{2\cancel{K_m}}$$

$$\frac{-dc}{dt} = \frac{V_{max}}{2}$$

• The decline in rate of concentration is one half of the maximum rate process.

• A plot between $\frac{dc}{dt}$ vs c gives both V_m and K_m on Y and X axis respectively.



The graph contains first part as 0 order followed by first order and then state state is mixed order.

2. $Km << C$.

$Km + C = C$, since Km is very less than C, Km is negligible.

- On substitution in eq ①.

$$\frac{-dc}{dt} = \frac{Vmax \cdot C}{C}$$

$$-\frac{dc}{dt} = Vmax$$

- It denotes 0 order process. The rate of concentration is constant with max rate process

3. $Km >>> C$.

$Km + C = Km$, since Km is greater than C.

On substitution in eq ①.

$$\frac{-dc}{dt} = \frac{Vmax \cdot C}{Km}$$

It is similar to first order process where V_{max} is equal to K_E, there it is less than that K_m of K_e. Eg: Metabolism of phenol and alcohol

Estimation of K_m and V_{max}.

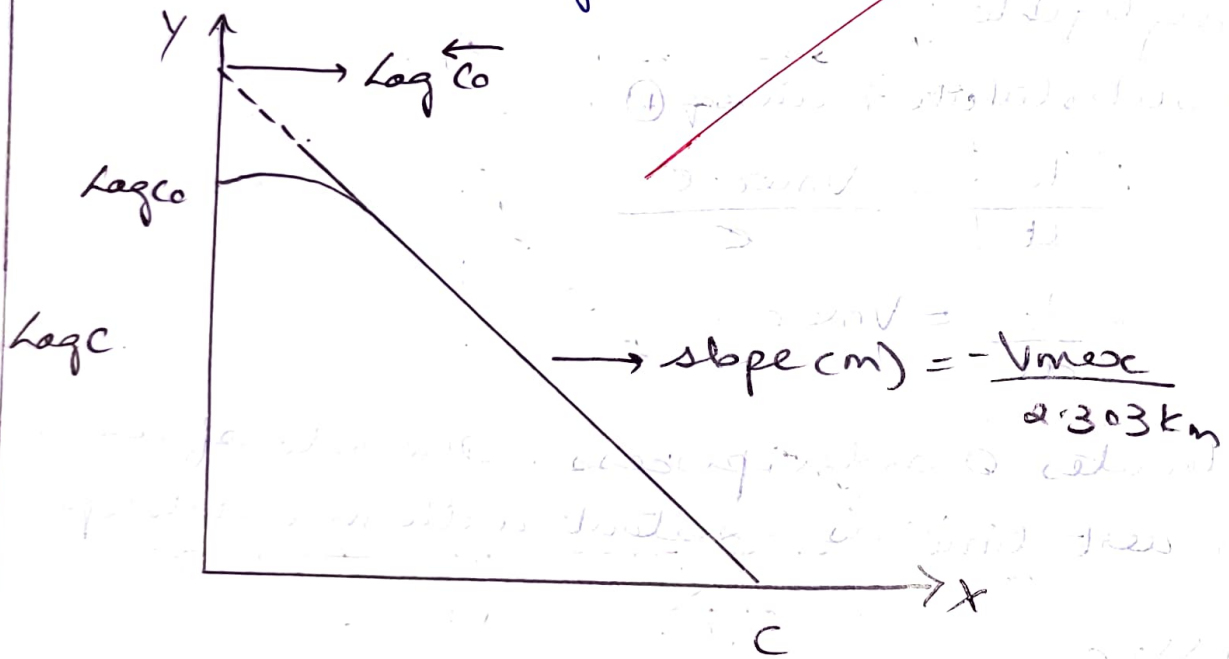
These can be estimated by plasma conc vs graphs etc

Eq ① $\rightarrow$ $\frac{-dc}{dt} = \frac{V_{max} \cdot C}{K_m + C}$

On forming derivative and log we get the equation.

$$\log C = \log C_0 + \frac{(C_0 - C)}{2.303\, K_m} - \frac{V_{max}}{2.303\, K_m} \quad -②$$

Graph between log C vs C.



On extrapolation $\log \overleftarrow{C_0}$ is obtained. The new equation becomes

$$\log C_0 = \log \overleftarrow{C_0} - \frac{V_{max}}{2.303 K_m} \quad -③.$$

On combining eq ② and eq ③ we get

$$\frac{C_0 - C}{2.303 K_m} = \log \frac{C_0}{C}$$

K_m value can be calculated and this can be substituted in slope to estimate V_{max}.

Alternative method.

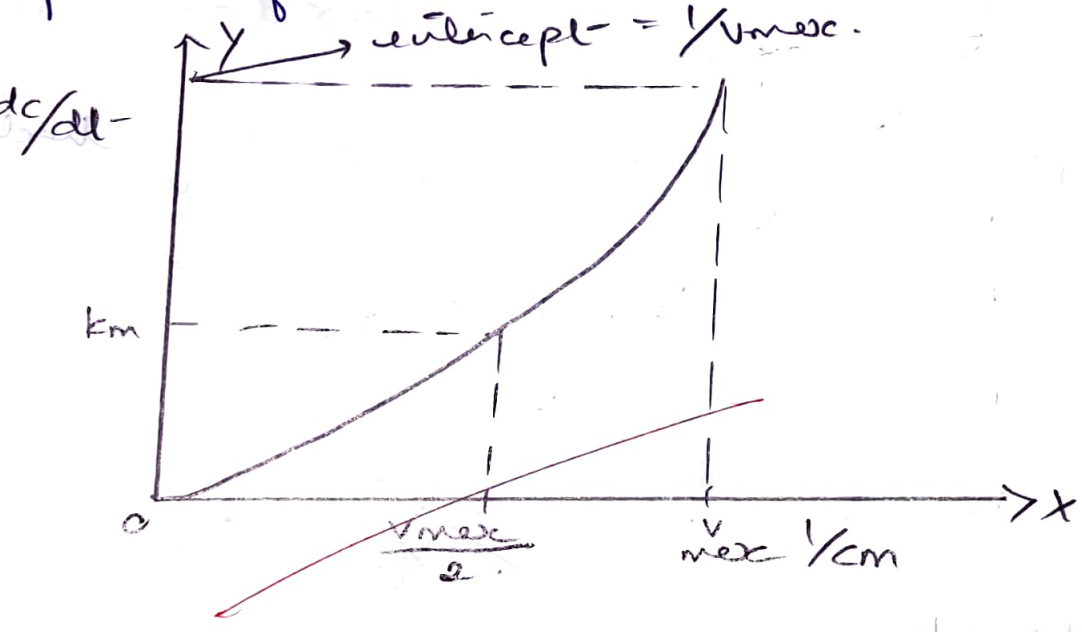
- Reversing eq ①.

$$\frac{1}{dc/dt} = \frac{K_m + C}{V_{max} \cdot C}$$

$$\frac{1}{dc/dt} = \frac{K_m}{V_{max} \cdot C} + \frac{C}{V_{max} \cdot C}$$

$$\frac{1}{dc/dt} = \frac{K_m}{V_{max} \cdot C_m} + \frac{1}{V_{max}}$$

- Graph between $1/dc/dt$ and $\frac{1}{C_m}$, here C_m is conc. at midpoint of time.



$$\text{slope} = m = \frac{K_m}{V_{max}}.$$

$$\text{Intercept} = \frac{1}{V_{max}}.$$

$$\rightarrow \frac{C_m}{dc/dt} = \frac{K_m}{V_{max}} + \frac{C_m}{V_{max}}$$ ⟶ can also be used to estimate K_m & V_{max}

Km and Vmax at steady state concentration:

At steady state concentration, is the dosing rate.

$$DR = \frac{V_{max} \cdot C_{ss}}{K_m + C_{ss}} \quad (4)$$

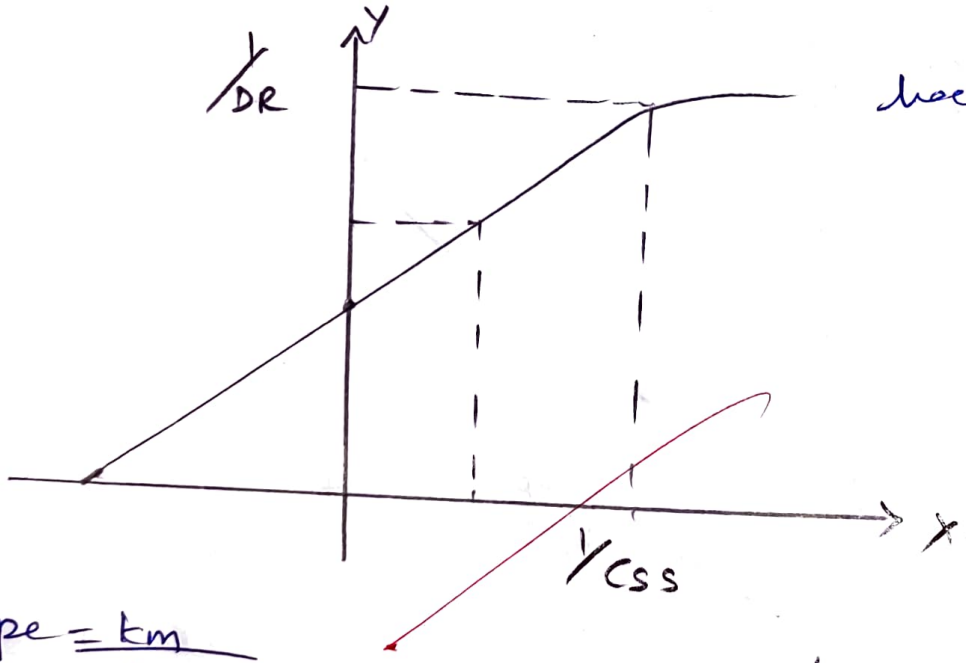
DR = R_0 = dose administered

$$R_0 = \frac{F X_0}{\tau}$$ where F is fraction absorbed and τ is dosing interval.

1. Lineweaver – Burke plot

Reverse of equation (4)

$$\frac{1}{DR} = \frac{K_m}{V_{max} \cdot C_{ss}} + \frac{1}{V_{max}}$$



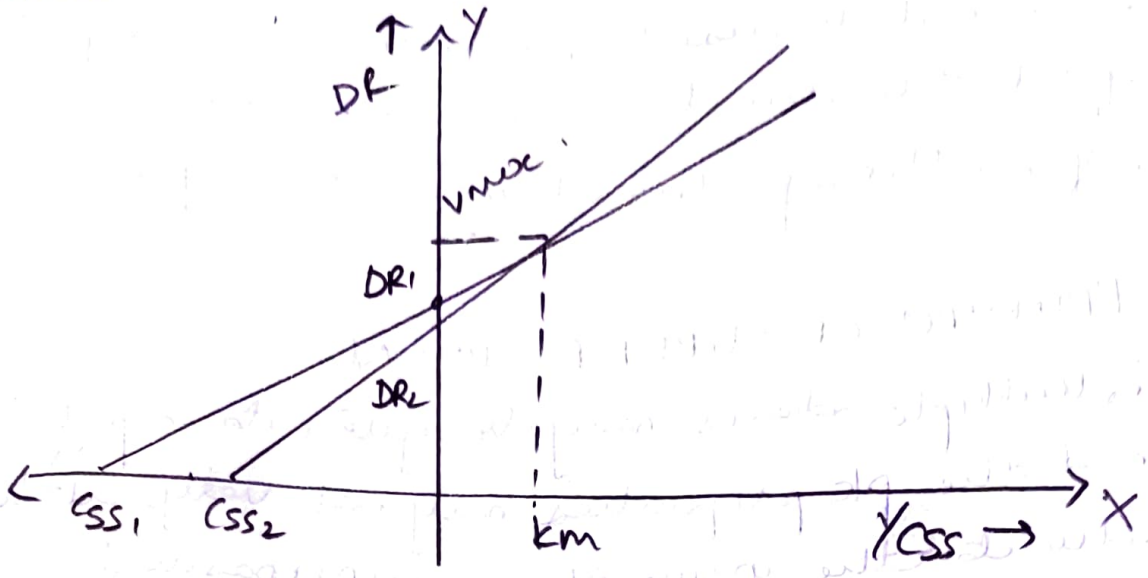
Hockey shaped curve

$$\text{Slope} = \frac{K_m}{V_{max}}$$

$$\text{Intercept} = \frac{1}{V_{max}}$$

2. Direct linear plot.

Here 2 dosing rates DR_1 & DR_2 are used with conc. Css_1 & Css_2 respectively, a linear plot is formed.



The extrapolated points on y-axis are DR_1 and DR_2 when extended meet at a point, from which a line drawn at x axis gives Km and to y axis gives Vmax

3. Third graphical plot.

It is using the formula:

$$\frac{1}{DR} = Vmax + \frac{1/DR \cdot Km}{Css}$$

Formula can be written based on DR_1 & DR_2

$$DR_1 = \frac{Vmax \cdot Css_1}{Km + Css_1}$$

$$DR_2 = \frac{Vmax \cdot Css_2}{Km + Css_2}$$

On combining:

$$Km = \frac{DR_1 - DR_2}{DR_1/Css_1 - DR_2/Css_2}$$

- Km is less variable than Vmax thus Vmax can be calculated using Css of Km as previously calculated.
- It cannot be used if equation doesn't follow first order kinetics and is not single method
- If multicompartment method is present.

3b.

PRINCIPLE OF SUPERPOSITION

- Multiple doses may be given to a patient and the pk properties may not vary. it is due to the principle of superposition.
- The curve can be determined by first dose itself and on multiple doses the pharmacokinetics do not vary as it is thought to be overlapped or superimposed.

4

- The AUC of first curve is said to be similar to steady state AUC.
- In principle of superposition, a single dose curve can predict the concentration of drug available in the blood after absorption, to provide the next dose
- The concentration of residual dose should be added to the next dose to get the plasma concentration.

• The doses given in equal are inequal intervals cannot change the time it reaches the steady state concentration, only the plasma parameters may vary proportionally.

• The half life of the multple doses after superposition can be calculated as accumulation $t_{1/2}$.

$$\text{Accumulation } t_{1/2} = t_{1/2}\left(1 + 3.3\left(\frac{\log(k_a)}{k_a - k}\right)\right)$$

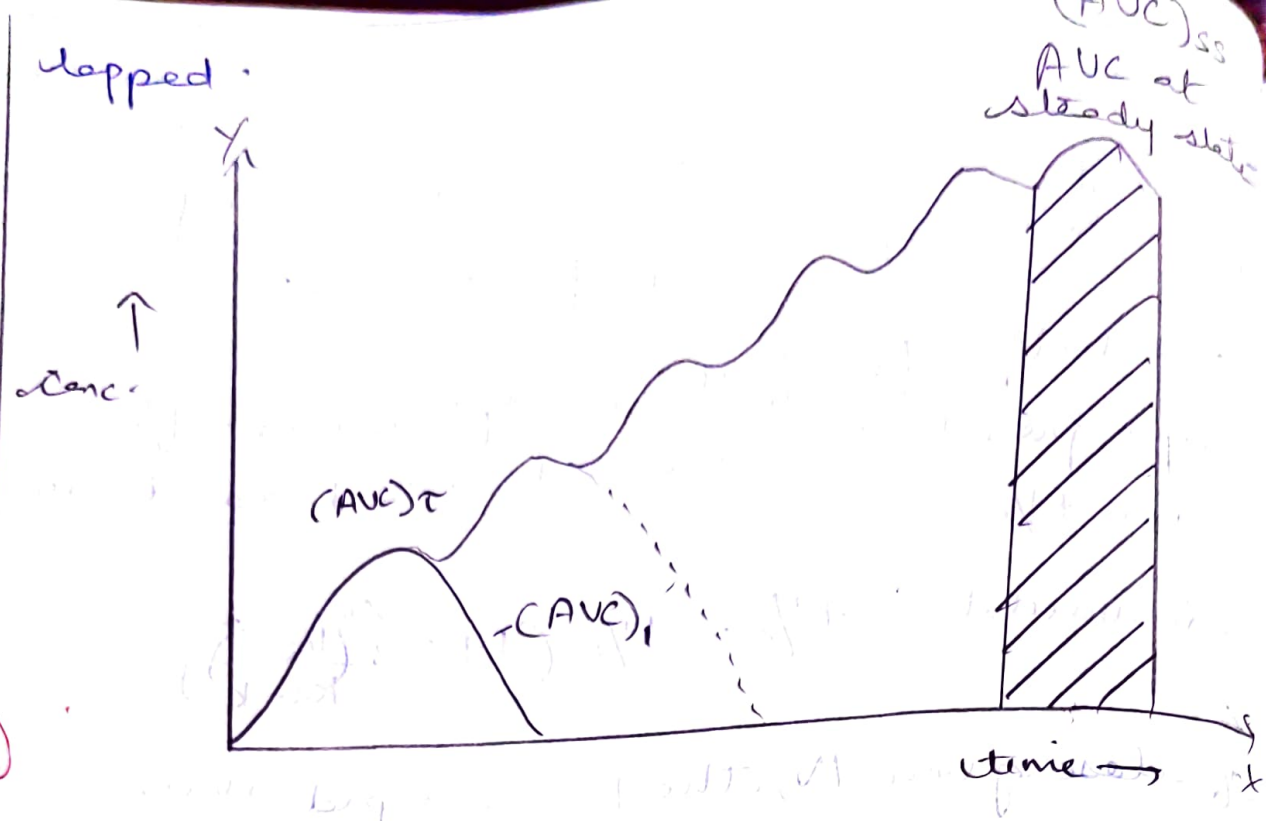
• If dose given IV, the k_a is rapid thus making k negligible we get the equation.

$$\text{Accumulation } t_{1/2} = t_{1/2}\left(1 + 3.3\left(\frac{\log(k_a)}{k_a}\right)\right).$$

• Here $k_a/k_e = 1 \therefore \log 1 = 0$. therefore we can conclude that $t_{1/2}$ is similar to the elimination half life of the drug.

• The half life at 90% ~~minutes~~ is said to be 3.3 times more than elimination half life and for 99% it is 6.6 times more than elimination half life.

• The process is said to follow first order elimination kinetics and the assumption is that pharmacokinetics parameters do not vary since curves are superpositioned or over



4 Limitations:

Principle of superposition doesn't work for few drugs due to various factors like physicochemical changes, enzyme induction, physiology, presence of enzymes, receptors, etc.

4.

a. WAGNER - NELSON METHOD.

- Absorption rate constant K_a can be calculated using this method. The method is used when the process is not first order, it is absorption the 0 order or more complex process.
- The assumption is that it follows elimination by first order kinetics.

The amount of drug given is both amount absorbed (A) and amount unabsorbed (Aun)

$\therefore X_0 = A + A_{un}$.

Absorbed amount (A) is sum of amount present in body and amount eliminated.

$\therefore \rightarrow \quad A = X + X_e$.

On performing derivation wrt time.

$$\frac{dA}{dt} = \frac{dX}{dt} + \frac{dX_e}{dt} \quad \text{— ①}$$

Here. $X = V_d \cdot C$

$$\therefore \frac{dX}{dt} = V_d \cdot \frac{dc}{dt} \quad \text{and — ②}$$

$$\frac{dX_e}{dt} = KX \quad (\text{but } X = V_d \cdot C).$$

$$\therefore \frac{dX_e}{dt} = K \cdot (V_d \cdot C) \quad \text{— ③}$$

substitute ② & ③ in eq ①.

$$\frac{dA}{dt} = V_d \cdot \frac{dc}{dt} + K \cdot V_d \cdot C.$$

Multiply dt on all sides.

$$dA = V_d \cdot dC + K V_d \cdot C dt \quad \text{— ④}.$$

Apply integration from t=0 to t. of eq ④.

$$\int_0^t dA = Vd \int_0^t dC + kVd \int_0^t C\,dt.$$

$$A_t - A_0 = Vd(C_t - C_0) + kVd \int_0^t C \cdot dt.$$

Absorption at $t=0$ is 0 $\therefore A_0 = 0$.

Conc. at $t=0$ is 0 $\therefore C_0 = 0$.

$\therefore$ equation can be written as

$$A_t = VdC_t + kVd \int_0^t C \cdot dt.$$

On rearranging,

$$\frac{A_t}{Vd} = C_t + k \int_0^t C \cdot dt. \quad \text{—— (5)}$$

Integrate eq (4) from $t=0$ to $t=\infty$.

$$\int_0^\infty dA = Vd \int_0^\infty dC + kVd \int_0^\infty C \cdot dt.$$

$$A_\infty - A_0 = Vd(C_\infty - C_0) + kVd \int_0^\infty C \cdot dt.$$

$A_0 = 0$

$C_\infty = 0$

$C_0 = 0$

$\therefore A_\infty = kVd \int_0^\infty C \cdot dt$

On rearranging,

$$\frac{A_\infty}{Vd} = k \int_0^\infty C \cdot dt. \quad \text{—— (6)}$$

Divide eq 5 & (6).

$$A_t/Vd \;/\; A_\infty/Vd = C_t + k\int_0^t C \cdot dt \;/\; k\int_0^\infty C \cdot d$$

$$\frac{At}{A\infty} = \frac{Ct + k\int_0^t C\cdot dt}{k\int_0^\infty C\cdot dt} \quad \longrightarrow \text{amount of drug absorbed.}$$

— eq (7).

To obtain amount of drug unabsorbed, subtract eq (7) from 1.

$$\left(1 - \frac{At}{A\infty}\right) = 1 - \left(\frac{Ct + k\int_0^t C\cdot dt}{k\int_0^\infty C\cdot dt}\right) \quad \text{— eq (8)}$$

To obtain percentage of unabsorbed drug multiple eq (8) with 100.

$$100\left(1 - \frac{At}{A\infty}\right) = 100\left(1 - \left(\frac{Ct + k\int_0^t C\cdot dt}{k\int_0^\infty C\cdot dt}\right)\right)$$

Wagner and Nelson method can be used to determine the rate of absorption of a drug.

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b. MEAN RESIDENCE TIME (MRT).

- Mean residence time is defined as the average amount of time the drug molecules reside in the body.
- Let 1 to m be no. of groups of molecules, and n be no. of molecules at i to m

then MRT = $\frac{\text{Total residence time of all molecules}}{\text{Total number of molecules}}$

$$MRT = \frac{\sum_{i=1}^{n} n_i t_i}{\sum_{i=1}^{n} n_i}$$

$$MRT = \frac{\sum_{i=1}^{n} n_i t_i}{N.}$$

Drugs can be eliminated and denoted as x_e.

then MRT can be written as

$$MRT = \frac{\sum_{i=1}^{n} x_{ei} t_i}{\sum_{i=1}^{n} x_{ei}.}$$

MRT in one compartment model.

We know $$x = x_0 \cdot e^{-kt} \cdot - (1).$$

On derivative of (1)

$$\frac{dx}{dt} = -k x_0 e^{-kt}.$$

$\rightarrow \frac{dx_e}{dt}$ is the elimination amount of the molecules.

$$\frac{dx_e}{dt} = -\frac{dx}{dt} = k x_0 e^{-kt}.$$

$$\frac{dx_e}{dt} = k x_0 e^{-kt}$$

$$dXe = k X_0 e^{-kt} \cdot dt.$$

On performing integration from $t = 0 - \infty$ and dividing equation by X_0 on both sides, we get.

$$\int_0^\infty \frac{dXe}{X_0} = \int_0^\infty k e^{-kt} \cdot dt \cdot \longrightarrow \int_0^\infty \frac{dXe}{X_0} = \int_0^\infty \frac{k X_0 e^{-kt} dt}{X_0}$$

(1).

$$MRT = \int_0^\infty k e^{-kt} \cdot dt.$$

With respect to concentration.

$$X_0 = Vd \cdot C_0.$$

On substitution in eq (2).

$$MRT = \int_0^\infty \frac{k\, Vd\, C_0\, e^{-kt} dt}{Vd\, C_0}$$

$$MRT = \int_0^\infty \frac{k C_0 e^{-kt} dt}{C_0}$$

$C = C_0 e^{-kt}$.

$$MRT = \int_0^\infty \frac{k C dt}{C_0}.$$

Divide equation by k and multiple by t.

$$MRT = \int_0^\infty Kct\,dt \Big/ \int_0^\infty KC\,dt.$$

$\int_0^\infty Ct\,dt$ = AUMC = Area under first moment curve with respect to time t.

$\int_0^\infty C \cdot dt$ = plasma concentration area under curve.

$\therefore MRT = \frac{AUMC}{AUC}$.

For IV bolus:

Mean value = 0,

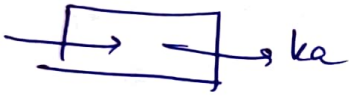
$MRT = 1/k$.

For IV infusion:

Mean value = $2k_o/\tau$

$MRT = 1/k + \frac{2k_o}{\tau}$

For extravascular drugs:



Mean value = $1/k_a$

$MRT = 1/k + 1/k_a$.

Significance:

1. It is used to determine the amount of time the drug molecules reside in the ~~body~~ body.
2. It is also used to determine activity of drugs like hypertensives and coagulation drugs.

Mid exam marks scored by students are entered in the Mother register

SUB: BIOPHARMACEUTICS AND PHARMACOKINETICS (TH105)

1-6

S.No	Reg No	Name of the Student	mid-I Theory	mid-I Practical	mid-II Theory	mid-II practical	mid-III Theory	mid-III practical	Avg of best of 2 mid Theory	Avg of best of 2 mid practice
1.	177N1T0001	Sumaiya Saleem	28	29	29	27	28	29	29	29
2	177N1T0002	Kondaveeti Parameswari	25	28	28	27	27	28	28	28
3	177N1T0003	Bollineni Swathi	25	29	28	27	28	28	28	29
4	177N1T0004	Gudela Haritha	26	28	27	26	28	27	28	28
5	177N1T0005	Indurthi Bharathi	Ab	22	22	26	20	26	21	27
6	177N1T0006	Pangulluri Nadiya	25	28	29	26	28	28	29	28
7	177N1T0007	Harisha Jangala	24	28	28	26	27	26	28	27
8	177N1T0008	Makkena pallavi	24	27	22	26	25	26	25	27
9	177N1T0009	Maadu Sri lakshmi	27	Ab	Ab	26	21	27	22	22
10	177N1T0010	Golla Chiny	23	22	28	25	26	27	27	22
11	177N1T0011	Vuddanti Meghana	27	27	29	27	28	27	29	27
12	177N1T0012	Thati Sravani	22	22	26	26	28	27	27	27
13	177N1T0013	Jyothsna kumari Kasukurthi	23	27	27	26	29	28	28	28
14	177N1T0014	Bezawada vijaya Sirisha	26	27	27	26	28	28	28	28
15	177N1T0015	Sali Manoj	23	29	27	27	27	27	27	28

1-7

S.NO	Reg No	Name of the Student	mid-I Theory	mid-I practical
16	177NIT0016	Shaik chandini	25	27
17	177NIT0017	Thumalasetti maha Lakshmi	22	27
18	177NIT0018	Katragadda umamaheswara	Ab	27
19	177NIT0019	Gonji Sarada sri	23	27
20	177NIT0020	Vydana uma maheswari	26	26
21	177NIT0021	Penchala Tejaswi	Ab	23
22	177NIT0022	Jonnalagadda Pineela	26	25
23	177NIT0023	Nandamuri sri ranmayi	26	25
24	177NIT0024	Pedapudi Kiran Sowthe	23	25
25	177NIT0025	Vallapu Prathyusha	23	22
26	177NIT0026	Lakshmi priya Grantasala	25	23
27	177NIT0027	Mandadapu Nagavyshnavi	27	27
28	177NIT0028	Devagupta pu kunthithe devi	15	23
29	177NIT0029	Pandala Bhavy Lydia	27	27
30.	177NIT0030	Thammandru Akshini Teja	20	25

mid-II Theory	mid-II practical	mid-IV Theory	mid-IV practical	Avg of best of 2 mids Theory	Avg of best of 2 mids practical
28	26	28	27	28	27
24	27	26	26	25	27
26	26	26	28	26	28
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22	26	23	26	23	26
Ab	27	27	25	27	27
22	25	20	26	21	26

S.No	Reg No	Name of Student	mid-I Theory	mid-I practical
31	207N1T0101	Shaik Shamila	Ab	28
32	207N1T0102	Kuvapiti Kalyapani	28	26
33	207N1T0103	Manda Jay prse	27	27
34	207N1T0104	Repalle Bhavana	25	25
35	207N1T0105	Achala Sirisha	Ab	23

Entered by: P. Anitha

mid-II Theory	mid-II practical	mid-III Theory	mid-III practical	Avg of best of 2 mids theory	Avg of best of 2 mids practical
27	26	26	28	27	28
27	25	9	26	28	26
26	25	9	26	27	27
24	25	12	25	25	25
21	24	22	25	22	25

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Exam Section Incharge

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VIJAYA INSTITUTE OF
PHARMACEUTICAL SCIENCES FOR WOMEN
ENIKEPADU, VIJAYAWADA - 521 108.

Mid exam marks uploaded to JNTUK University online portal

HTNO	SUBJECT	MID_1	MID_2	MID_3	FINAL	SUB_TYPE	YEAR
187N1T0030	T3107	0	0	27	27	L	3
187N1T0030	T3108	0	0	24	24	L	3
187N1T0030	T3109	0	0	27	27	L	3
187N1T0030	T3110	0	0	27	27	L	3
187N1T0030	T3111	0	0	25	25	L	3
177N1T0001	T4101	25	29	24	27	T	4
177N1T0001	T4102	29	29	29	29	T	4
177N1T0001	T4103	30	30	28	30	T	4
177N1T0001	T4104	30	30	30	30	T	4
177N1T0001	T4105	28	29	28	29	T	4
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177N1T0002	T4102	27	28	27	28	T	4
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177N1T0004	T4101	26	28	23	27	T	4
177N1T0004	T4102	28	28	28	28	T	4
177N1T0004	T4103	27	28	24	28	T	4
177N1T0004	T4104	29	30	30	30	T	4
177N1T0004	T4105	26	27	28	28	T	4
177N1T0004	T4106	23	27	28	28	T	4
177N1T0004	T4107	0	0	27	27	L	4
177N1T0004	T4108	0	0	28	28	L	4
177N1T0004	T4109	0	0	29	29	L	4
177N1T0004	T4110	0	0	28	28	L	4
177N1T0005	T4101	20	24	23	24	T	4
177N1T0005	T4102	0	28	27	28	T	4
177N1T0005	T4103	27	0	25	26	T	4

HTNO	SUBJECT	MID_1	MID_2	MID_3	FINAL	SUB_TYPE	YEAR
187N1T0030	T3107	0	0	27	27	L	3
187N1T0030	T3108	0	0	24	24	L	3
187N1T0030	T3109	0	0	27	27	L	3
187N1T0030	T3110	0	0	27	27	L	3
187N1T0030	T3111	0	0	25	25	L	3
177N1T0001	T4101	25	29	24	27	T	4
177N1T0001	T4102	29	29	29	29	T	4
177N1T0001	T4103	30	30	28	30	T	4
177N1T0001	T4104	30	30	30	30	T	4
177N1T0001	T4105	28	29	28	29	T	4
177N1T0001	T4106	26	29	29	29	T	4
177N1T0001	T4107	0	0	29	29	L	4
177N1T0001	T4108	0	0	30	30	L	4
177N1T0001	T4109	0	0	29	29	L	4
177N1T0001	T4110	0	0	29	29	L	4
177N1T0002	T4101	26	28	27	28	T	4
177N1T0002	T4102	27	28	27	28	T	4
177N1T0002	T4103	28	29	27	29	T	4
177N1T0002	T4104	30	30	30	30	T	4
177N1T0002	T4105	25	28	27	28	T	4
177N1T0002	T4106	23	27	29	28	T	4
177N1T0002	T4107	0	0	27	27	L	4
177N1T0002	T4108	0	0	28	28	L	4
177N1T0002	T4109	0	0	28	28	L	4
177N1T0002	T4110	0	0	28	28	L	4
177N1T0003	T4101	27	29	27	28	T	4
177N1T0003	T4102	28	29	28	29	T	4
177N1T0003	T4103	27	28	23	28	T	4
177N1T0003	T4104	28	30	30	30	T	4
177N1T0003	T4105	25	28	28	28	T	4
177N1T0003	T4106	25	26	28	27	T	4
177N1T0003	T4107	0	0	28	28	L	4
177N1T0003	T4108	0	0	28	28	L	4
177N1T0003	T4109	0	0	28	28	L	4
177N1T0003	T4110	0	0	29	29	L	4
177N1T0004	T4101	26	28	23	27	T	4
177N1T0004	T4102	28	28	28	28	T	4
177N1T0004	T4103	27	28	24	28	T	4
177N1T0004	T4104	29	30	30	30	T	4
177N1T0004	T4105	26	27	28	28	T	4
177N1T0004	T4106	23	27	28	28	T	4
177N1T0004	T4107	0	0	27	27	L	4
177N1T0004	T4108	0	0	28	28	L	4
177N1T0004	T4109	0	0	29	29	L	4
177N1T0004	T4110	0	0	28	28	L	4
177N1T0005	T4101	20	24	23	24	T	4
177N1T0005	T4102	0	28	27	28	T	4
177N1T0005	T4103	27	0	25	26	T	4

HTNO	SUBJECT	MID_1	MID_2	MID_3	FINAL	SUB_TYPE	YEAR
177N1T0005	T4104	0	27	27	27	T	4
177N1T0005	T4105	0	22	20	21	T	4
177N1T0005	T4106	0	23	28	26	T	4
177N1T0005	T4107	0	0	27	27	L	4
177N1T0005	T4108	0	0	26	26	L	4
177N1T0005	T4109	0	0	27	27	L	4
177N1T0005	T4110	0	0	27	27	L	4
177N1T0006	T4101	24	27	24	26	T	4
177N1T0006	T4102	28	29	28	29	T	4
177N1T0006	T4103	25	28	18	27	T	4
177N1T0006	T4104	24	30	30	30	T	4
177N1T0006	T4105	25	29	28	29	T	4
177N1T0006	T4106	23	26	27	27	T	4
177N1T0006	T4107	0	0	27	27	L	4
177N1T0006	T4108	0	0	29	29	L	4
177N1T0006	T4109	0	0	28	28	L	4
177N1T0006	T4110	0	0	28	28	L	4
177N1T0007	T4101	23	28	27	28	T	4
177N1T0007	T4102	29	27	28	29	T	4
177N1T0007	T4103	28	29	28	29	T	4
177N1T0007	T4104	24	27	26	27	T	4
177N1T0007	T4105	24	28	27	28	T	4
177N1T0007	T4106	22	27	28	28	T	4
177N1T0007	T4107	0	0	28	28	L	4
177N1T0007	T4108	0	0	27	27	L	4
177N1T0007	T4109	0	0	28	28	L	4
177N1T0007	T4110	0	0	28	28	L	4
177N1T0008	T4101	22	23	24	24	T	4
177N1T0008	T4102	27	25	27	27	T	4
177N1T0008	T4103	25	26	25	26	T	4
177N1T0008	T4104	27	28	30	29	T	4
177N1T0008	T4105	24	22	25	25	T	4
177N1T0008	T4106	22	24	28	26	T	4
177N1T0008	T4107	0	0	27	27	L	4
177N1T0008	T4108	0	0	27	27	L	4
177N1T0008	T4109	0	0	27	27	L	4
177N1T0008	T4110	0	0	27	27	L	4
177N1T0009	T4101	21	27	20	24	T	4
177N1T0009	T4102	25	28	25	27	T	4
177N1T0009	T4103	23	0	24	24	T	4
177N1T0009	T4104	23	0	27	25	T	4
177N1T0009	T4105	22	0	21	22	T	4
177N1T0009	T4106	21	0	27	24	T	4
177N1T0009	T4107	0	0	26	26	L	4
177N1T0009	T4108	0	0	27	27	L	4
177N1T0009	T4109	0	0	27	27	L	4
177N1T0009	T4110	0	0	27	27	L	4
177N1T0010	T4101	22	27	23	25	T	4

HTNO	SUBJECT	MID_1	MID_2	MID_3	FINAL	SUB_TYPE	YEAR
177N1T0010	T4102	26	27	27	27	T	4
177N1T0010	T4103	27	28	24	28	T	4
177N1T0010	T4104	21	21	30	26	T	4
177N1T0010	T4105	23	28	26	27	T	4
177N1T0010	T4106	20	26	28	27	T	4
177N1T0010	T4107	0	0	28	28	L	4
177N1T0010	T4108	0	0	27	27	L	4
177N1T0010	T4109	0	0	27	27	L	4
177N1T0010	T4110	0	0	27	27	L	4
177N1T0011	T4101	26	29	26	28	T	4
177N1T0011	T4102	27	28	28	28	T	4
177N1T0011	T4103	28	30	24	29	T	4
177N1T0011	T4104	30	27	29	30	T	4
177N1T0011	T4105	27	29	28	29	T	4
177N1T0011	T4106	24	26	28	27	T	4
177N1T0011	T4107	0	0	29	29	L	4
177N1T0011	T4108	0	0	26	26	L	4
177N1T0011	T4109	0	0	28	28	L	4
177N1T0011	T4110	0	0	27	27	L	4
177N1T0012	T4101	24	27	25	26	T	4
177N1T0012	T4102	27	28	27	28	T	4
177N1T0012	T4103	25	25	22	25	T	4
177N1T0012	T4104	27	3	26	27	T	4
177N1T0012	T4105	22	26	28	27	T	4
177N1T0012	T4106	22	25	27	26	T	4
177N1T0012	T4107	0	0	27	27	L	4
177N1T0012	T4108	0	0	27	27	L	4
177N1T0012	T4109	0	0	26	26	L	4
177N1T0012	T4110	0	0	27	27	L	4
177N1T0013	T4101	22	28	26	27	T	4
177N1T0013	T4102	17	29	27	28	T	4
177N1T0013	T4103	25	28	22	27	T	4
177N1T0013	T4104	27	30	30	30	T	4
177N1T0013	T4105	23	27	29	28	T	4
177N1T0013	T4106	23	27	28	28	T	4
177N1T0013	T4107	0	0	28	28	L	4
177N1T0013	T4108	0	0	28	28	L	4
177N1T0013	T4109	0	0	27	27	L	4
177N1T0013	T4110	0	0	28	28	L	4
177N1T0014	T4101	21	26	27	27	T	4
177N1T0014	T4102	28	28	30	29	T	4
177N1T0014	T4103	26	27	27	27	T	4
177N1T0014	T4104	29	30	30	30	T	4
177N1T0014	T4105	26	27	28	28	T	4
177N1T0014	T4106	22	26	28	27	T	4
177N1T0014	T4107	0	0	28	28	L	4
177N1T0014	T4108	0	0	28	28	L	4
177N1T0014	T4109	0	0	27	27	L	4

HTNO	SUBJECT	MID_1	MID_2	MID_3	FINAL	SUB_TYPE	YEAR
177N1T0014	T4110	0	0	28	28	L	4
177N1T0015	T4101	21	27	25	26	T	4
177N1T0015	T4102	28	28	27	28	T	4
177N1T0015	T4103	28	29	22	29	T	4
177N1T0015	T4104	27	18	26	27	T	4
177N1T0015	T4105	23	27	27	27	T	4
177N1T0015	T4106	23	28	28	28	T	4
177N1T0015	T4107	0	0	26	26	L	4
177N1T0015	T4108	0	0	27	27	L	4
177N1T0015	T4109	0	0	27	27	L	4
177N1T0015	T4110	0	0	29	29	L	4
177N1T0016	T4101	23	28	26	27	T	4
177N1T0016	T4102	28	29	28	29	T	4
177N1T0016	T4103	26	28	21	27	T	4
177N1T0016	T4104	26	22	28	27	T	4
177N1T0016	T4105	25	28	28	28	T	4
177N1T0016	T4106	24	27	28	28	T	4
177N1T0016	T4107	0	0	27	27	L	4
177N1T0016	T4108	0	0	27	27	L	4
177N1T0016	T4109	0	0	29	29	L	4
177N1T0016	T4110	0	0	27	27	L	4
177N1T0017	T4101	24	28	22	26	T	4
177N1T0017	T4102	27	26	25	27	T	4
177N1T0017	T4103	26	28	19	27	T	4
177N1T0017	T4104	27	25	29	28	T	4
177N1T0017	T4105	22	24	26	25	T	4
177N1T0017	T4106	21	25	27	26	T	4
177N1T0017	T4107	0	0	27	27	L	4
177N1T0017	T4108	0	0	28	28	L	4
177N1T0017	T4109	0	0	28	28	L	4
177N1T0017	T4110	0	0	27	27	L	4
177N1T0018	T4101	0	28	25	27	T	4
177N1T0018	T4102	0	26	28	27	T	4
177N1T0018	T4103	0	25	23	24	T	4
177N1T0018	T4104	0	30	30	30	T	4
177N1T0018	T4105	0	26	26	26	T	4
177N1T0018	T4106	0	25	28	27	T	4
177N1T0018	T4107	0	0	26	26	L	4
177N1T0018	T4108	0	0	27	27	L	4
177N1T0018	T4109	0	0	27	27	L	4
177N1T0018	T4110	0	0	28	28	L	4
177N1T0019	T4101	23	27	26	27	T	4
177N1T0019	T4102	26	28	27	28	T	4
177N1T0019	T4103	27	23	25	26	T	4
177N1T0019	T4104	25	28	30	29	T	4
177N1T0019	T4105	23	26	28	27	T	4
177N1T0019	T4106	24	25	28	27	T	4
177N1T0019	T4107	0	0	26	26	L	4

HTNO	SUBJECT	MID_1	MID_2	MID_3	FINAL	SUB_TYPE	YEAR
177N1T0019	T4108	0	0	27	27	L	4
177N1T0019	T4109	0	0	29	29	L	4
177N1T0019	T4110	0	0	27	27	L	4
177N1T0020	T4101	23	27	25	26	T	4
177N1T0020	T4102	27	28	27	28	T	4
177N1T0020	T4103	25	27	22	26	T	4
177N1T0020	T4104	25	27	30	29	T	4
177N1T0020	T4105	26	20	27	27	T	4
177N1T0020	T4106	22	23	28	26	T	4
177N1T0020	T4107	0	0	26	26	L	4
177N1T0020	T4108	0	0	28	28	L	4
177N1T0020	T4109	0	0	27	27	L	4
177N1T0020	T4110	0	0	27	27	L	4
177N1T0021	T4101	0	20	18	19	T	4
177N1T0021	T4102	0	20	20	20	T	4
177N1T0021	T4103	0	21	20	21	T	4
177N1T0021	T4104	0	22	20	21	T	4
177N1T0021	T4105	0	21	20	21	T	4
177N1T0021	T4106	0	20	20	20	T	4
177N1T0021	T4107	0	0	26	26	L	4
177N1T0021	T4108	0	0	25	25	L	4
177N1T0021	T4109	0	0	25	25	L	4
177N1T0021	T4110	0	0	25	25	L	4
177N1T0022	T4101	23	0	27	25	T	4
177N1T0022	T4102	27	28	26	28	T	4
177N1T0022	T4103	28	29	22	29	T	4
177N1T0022	T4104	30	26	30	30	T	4
177N1T0022	T4105	26	29	28	29	T	4
177N1T0022	T4106	23	26	0	25	T	4
177N1T0022	T4107	0	0	26	26	L	4
177N1T0022	T4108	0	0	29	29	L	4
177N1T0022	T4109	0	0	28	28	L	4
177N1T0022	T4110	0	0	27	27	L	4
177N1T0023	T4101	23	28	26	27	T	4
177N1T0023	T4102	27	26	28	28	T	4
177N1T0023	T4103	26	27	21	27	T	4
177N1T0023	T4104	26	29	30	30	T	4
177N1T0023	T4105	26	26	28	27	T	4
177N1T0023	T4106	24	26	28	27	T	4
177N1T0023	T4107	0	0	26	26	L	4
177N1T0023	T4108	0	0	26	26	L	4
177N1T0023	T4109	0	0	25	25	L	4
177N1T0023	T4110	0	0	27	27	L	4
177N1T0024	T4101	22	27	27	27	T	4
177N1T0024	T4102	27	26	26	27	T	4
177N1T0024	T4103	26	27	24	27	T	4
177N1T0024	T4104	21	26	30	28	T	4
177N1T0024	T4105	23	28	28	28	T	4

HTNO	SUBJECT	MID_1	MID_2	MID_3	FINAL	SUB_TYPE	YEAR
177N1T0024	T4106	23	27	28	28	T	4
177N1T0024	T4107	0	0	26	26	L	4
177N1T0024	T4108	0	0	27	27	L	4
177N1T0024	T4109	0	0	28	28	L	4
177N1T0024	T4110	0	0	27	27	L	4
177N1T0025	T4101	18	26	18	22	T	4
177N1T0025	T4102	25	21	20	23	T	4
177N1T0025	T4103	21	24	21	23	T	4
177N1T0025	T4104	20	23	27	25	T	4
177N1T0025	T4105	23	23	21	23	T	4
177N1T0025	T4106	23	26	25	26	T	4
177N1T0025	T4107	0	0	28	28	L	4
177N1T0025	T4108	0	0	26	26	L	4
177N1T0025	T4109	0	0	27	27	L	4
177N1T0025	T4110	0	0	27	27	L	4
177N1T0026	T4101	24	27	24	26	T	4
177N1T0026	T4102	27	24	26	27	T	4
177N1T0026	T4103	25	26	20	26	T	4
177N1T0026	T4104	17	30	30	30	T	4
177N1T0026	T4105	25	27	26	27	T	4
177N1T0026	T4106	22	26	28	27	T	4
177N1T0026	T4107	0	0	26	26	L	4
177N1T0026	T4108	0	0	26	26	L	4
177N1T0026	T4109	0	0	26	26	L	4
177N1T0026	T4110	0	0	27	27	L	4
177N1T0027	T4101	21	27	26	27	T	4
177N1T0027	T4102	27	25	26	27	T	4
177N1T0027	T4103	26	26	27	27	T	4
177N1T0027	T4104	27	27	30	29	T	4
177N1T0027	T4105	27	27	28	28	T	4
177N1T0027	T4106	23	26	28	27	T	4
177N1T0027	T4107	0	0	28	28	L	4
177N1T0027	T4108	0	0	27	27	L	4
177N1T0027	T4109	0	0	27	27	L	4
177N1T0027	T4110	0	0	27	27	L	4
177N1T0028	T4101	19	24	19	22	T	4
177N1T0028	T4102	19	23	25	24	T	4
177N1T0028	T4103	21	23	15	22	T	4
177N1T0028	T4104	24	0	27	26	T	4
177N1T0028	T4105	15	22	23	23	T	4
177N1T0028	T4106	20	25	26	26	T	4
177N1T0028	T4107	0	0	25	25	L	4
177N1T0028	T4108	0	0	27	27	L	4
177N1T0028	T4109	0	0	27	27	L	4
177N1T0028	T4110	0	0	26	26	L	4
177N1T0029	T4101	20	24	22	23	T	4
177N1T0029	T4102	27	28	28	28	T	4
177N1T0029	T4103	25	26	25	26	T	4

HTNO	SUBJECT	MID_1	MID_2	MID_3	FINAL	SUB_TYPE	YEAR
177N1T0029	T4104	30	27	30	30	T	4
177N1T0029	T4105	27	0	27	27	T	4
177N1T0029	T4106	22	26	28	27	T	4
177N1T0029	T4107	0	0	26	26	L	4
177N1T0029	T4108	0	0	27	27	L	4
177N1T0029	T4109	0	0	28	28	L	4
177N1T0029	T4110	0	0	27	27	L	4
177N1T0030	T4101	24	19	20	22	T	4
177N1T0030	T4102	27	23	23	25	T	4
177N1T0030	T4103	22	23	13	23	T	4
177N1T0030	T4104	15	20	28	24	T	4
177N1T0030	T4105	20	22	20	21	T	4
177N1T0030	T4106	22	23	28	26	T	4
177N1T0030	T4107	0	0	26	26	L	4
177N1T0030	T4108	0	0	26	26	L	4
177N1T0030	T4109	0	0	26	26	L	4
177N1T0030	T4110	0	0	26	26	L	4
207N1T0101	T4101	27	27	17	27	T	4
207N1T0101	T4102	0	27	20	24	T	4
207N1T0101	T4103	0	23	25	24	T	4
207N1T0101	T4104	0	23	25	24	T	4
207N1T0101	T4105	0	27	26	27	T	4
207N1T0101	T4106	0	24	28	26	T	4
207N1T0101	T4107	0	0	26	26	L	4
207N1T0101	T4108	0	0	26	26	L	4
207N1T0101	T4109	0	0	27	27	L	4
207N1T0101	T4110	0	0	28	28	L	4
207N1T0101	T4111	29	26	0	28	T	4
207N1T0101	T4112	0	0	28	28	L	4
207N1T0102	T4101	27	24	19	26	T	4
207N1T0102	T4102	0	27	20	24	T	4
207N1T0102	T4103	25	23	3	24	T	4
207N1T0102	T4104	30	21	25	28	T	4
207N1T0102	T4105	28	27	9	28	T	4
207N1T0102	T4106	18	26	27	27	T	4
207N1T0102	T4107	0	0	26	26	L	4
207N1T0102	T4108	0	0	26	26	L	4
207N1T0102	T4109	0	0	26	26	L	4
207N1T0102	T4110	0	0	26	26	L	4
207N1T0102	T4111	28	28	0	28	T	4
207N1T0102	T4112	0	0	28	28	L	4
207N1T0103	T4101	27	26	15	27	T	4
207N1T0103	T4102	28	27	28	28	T	4
207N1T0103	T4103	5	24	28	26	T	4
207N1T0103	T4104	26	26	15	26	T	4
207N1T0103	T4105	27	26	9	27	T	4
207N1T0103	T4106	28	27	9	28	T	4
207N1T0103	T4107	0	0	26	26	L	4