ZAMBIA COLLEGE OF MEDICINE & SURGERY

Advancing Specialist Care & Professional Growth

Specialty Training Programme

Curriculum & learning guide

for

OPHTHALMOLOGY

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GENERAL INTRODUCTION

This Curriculum and Learning Guide describes the work-based competence-based professional training programme for the Specialty Training Programme (STP) in Ophthalmology (OPTH) in Zambia. The intended readership for the curriculum and guideline include the following:

- Trainees, host departments and managers of OPTH healthcare services;
- STP OPTH trainers, which includes all those involved in supervising, coordinating, assessing and delivering specialist education and training in Ophthalmology;
- Academic, administrative and professional staff within Higher Education Institutions (HEIs), the Higher Education Authority (HEA), and the Zambia Qualifications Authority (ZAQA);
- Strategic partners involved in supporting eye care and the training of healthcare practitioners in these related fields.

Zambia College of Medicine and Surgery (ZACOMS) advances professional training of medical specialists using the professional competence-based certification model beyond traditional university-based specialist training. It promotes specialist training as a vital pursuit for a successful professional medical career. The ZACOMS also promotes the increase of universal health coverage (UHC) by promoting equitable access to cost-effective quality specialist care as close to the family as possible for people in Zambia at all levels of socioeconomic status and geographical location. The ZACOMS certifies and admits members and/or fellows as specialists in a medical and/or surgical specialty in any of the various specializations of medicine and surgery.

The Zambia College of Medicine and Surgery (ZACOMS) oversees the training of Ophthalmology specialists working through the Zambia Ophthalmological Society (ZOS). The ZOS is a member of the College of Ophthalmology for East, Central and Southern Africa (COECSA). Whereas, ZOS is independent of COECSA the curriculum of ZACOMS STP OPTH training is aligned to that of COECSA so as to facilitate recognition by the regional body.

The STP OPTH training provides specialist training in ophthalmology. This is a relevant programme because of the critical shortage of Ophthalmologists. The STP OPH will equip trainees with core competencies in eye care and eye surgery. This will mean for every trainee who completes this programme, the population they serve will have gained access to the trainees' competencies. Furthermore, the graduate of this programme will offer support to the various surgical subspecialties, improving outcomes in the management of a broad spectrum of medical and surgical pathology.

Vision

Our vision is to be innovative in providing a teaching and support structure that will empower every trainee to excel in Ophthalmology knowledge, skills and research through internal and external collaboration.

Mission Statement

The mission of the STP OPTH training in Zambia is to train specialists who shall endeavour to improve the ophthalmological health care services to all by providing safe, evidence-based, humanistic specialist care in the field of ophthalmology in an efficient and proficient manner to meet the needs of the Zambian community, and contribute to the field of ophthalmology in the region and globally.

Values:

- Professional excellence
- Integrity
- Sensitivity to reproductive health needs
- Interdisciplinary, inter institutional collaboration
- Continuous professional development
- Innovation
- Academic Excellence
- Self and peer review

RATIONALE FOR THE SPECIALTY TRAINING PROGRAMME IN OPHTHALMOLOGY

The STP OPTH aims to train specialists in Ophthalmology in order to prepare them for specialist service in the healthcare system. The curriculum is informed by the training requirements of the Health Professions Council of Zambia (HPCZ) and the professional creed of the Zambia Ophthalmological Society (ZOS). The training programme encourages self-directed learning, life-long learning, and student-centred approaches while providing robust and structured guidance. The key outcomes are twofold as stipulated in Outcomes 1 and 2.

Outcome 1. Apply, at mastery level, Biomedical Sciences, Behavioural & Sociology, and Scientific Principles to the Practice of Ophthalmology

1. The graduate should be able to apply to Ophthalmology practice biomedical scientific principles, method and knowledge relating to anatomy, biochemistry, cell biology, genetics, immunology, microbiology, nutrition, pathology, pharmacology and physiology. The graduate should be able to:
   a) Explain normal human structure and function relevant to Ophthalmology.
   b) Explain the scientific bases for common diseases and conditions' signs, symptoms and treatment relevant to Ophthalmology.

c) Justify and explain the scientific bases of common investigations for diseases and conditions relevant to Ophthalmology.
d) Demonstrate knowledge of drugs, drug actions, side effects, and interactions relevant to Ophthalmology.

2. Apply Behavioral and Sociology Principles to the Practice of Ophthalmology
   a) Explain normal human behavior relevant to Ophthalmology.
   b) Discuss psychological and social concepts of health, illness and disease relevant to Ophthalmology.
   c) Apply theoretical frameworks of psychology and sociology to explain the varied responses of individuals, groups and societies to disease relevant to Ophthalmology.
   d) Explain psychological and social factors that contribute to illness, the course of the disease and the success of treatment relevant to Ophthalmology.

3. Apply Population Health to the Practice of Ophthalmology
   a) Discuss population health principles related to determinants of health, health inequalities, health risks and surveillance relevant to Ophthalmology.
   b) Discuss the principles underlying the development of health and health service policy, including issues related to health financing, and clinical guidelines relevant to Ophthalmology.
   c) Evaluate and apply basic principles of infectious and non-communicable disease control at community and hospital level relevant to Ophthalmology.
   d) Discuss and apply the principles of primary, secondary, and tertiary prevention of disease relevant to Ophthalmology.

4. Apply Scientific Method and Approaches to Ophthalmology Research.
   a) Evaluate research outcomes of qualitative and quantitative studies in the medical and scientific literature relevant to Ophthalmology.
   b) Formulate research questions, study designs or experiments to address the research questions relevant to Ophthalmology.
   c) Discuss and apply appropriate research ethics to a research study relevant to Ophthalmology.

Outcome 2. <u>Competence, at mastery level, in Ophthalmology Clinical Practice. On successful completion of the work-based STP trainees:</u>

1. The trainees should have clinical and specialist expertise in Ophthalmology, underpinned by broader knowledge, skills, experience and professional attributes necessary for independent practice;
2. The trainees should be able to undertake complex clinical roles, defining and choosing investigative and clinical options, and making key judgements about complex facts and clinical situations.

3. The trainees should contribute to reduction of blindness and improve eye health in the context of the national health priorities, by means of outstanding scientific research and application of safe, high quality, cost effective, evidence based practice within the Zambian health system.
4. The trainees should possess the essential knowledge, skills, experience and attributes required for their role and should demonstrate:
    - A systematic understanding of clinical and scientific knowledge, and a critical awareness of current problems, future developments, research and innovation in Ophthalmology practice, much of which is at, or informed by, the forefront of their professional practice in a healthcare environment;
    - Clinical and scientific practice that applies knowledge, skills and experience in a healthcare setting, places the patient and the public at the centre of care prioritizing patient safety and dignity and reflecting outstanding professional values and standards;
    - Clinical, scientific and professional practice that meets the professional standards defined by the Health Professions Council of Zambia (HPCZ);
    - Personal qualities that encompass self-management, self-awareness, acting with integrity and the ability to take responsibility for self-directed learning, reflection and action planning;
    - The ability to analyze and solve problems, define and choose investigative and scientific and/or clinical options, and make key judgments about complex facts in a range of situations;
    - The ability to deal with complex issues both systematically and creatively, make sound judgements in the absence of complete data, and to communicate their conclusions clearly to specialist and non-specialist audiences including patients and the public;
    - The ability to be independent self-directed learners demonstrating originality in tackling and solving problems and acting autonomously in planning and implementing tasks at a professional level;
    - A comprehensive understanding of the strengths, weaknesses and opportunities for further development of ophthalmology as applicable to their own clinical practice, research, innovation and service development which either directly or indirectly leads to improvements in clinical outcomes and scientific practice;
    - Conceptual understanding and advanced scholarship in their specialism that enables the graduate to critically evaluate current research and innovation methodologies and develop critiques of them and, where appropriate, propose new research questions and hypotheses;
    - Scientific and clinical leadership based on the continual advancement of their knowledge, skills and understanding through the independent learning required for continuing professional development.
5. Once registered as a specialist in Ophthalmology, a range of career development options will be available including sub-specialist training. Alternatively, others may opt to undertake further career development in post, as specialist, through

structured Continuing Professional Development (CPD), provided by Accredited CPD providers. Specialist ophthalmologists who have successfully completed the STP OPTH will be eligible to compete for available Consultant positions in Ophthalmology.

The outcomes of the STP OPTH training are affiliated to the following curriculum outcome categories:

Category I: Scientific foundations

Goal 1: Understand the normal structure and function of the human body, at levels from molecules to cells to organs, to the whole organism.
Goal 2: Understand the major pathological processes and their biological alterations.
Goal 4: Understand how the major pathologic processes affect the organ systems.
Goal 5: Integrate basic science and epidemiological knowledge with clinical reasoning.
Goal 6: Understand the principles of scientific method and evidence-based medicine including critical thinking.

Category II: Clinical Skills

Goal 7: Obtain a sensitive, thorough medical history.
Goal 8: Perform a sensitive and accurate physical exam including mental state examination.
Goal 9: Establish and maintain appropriate therapeutic relationships with patients.

Category III: Communication and Interpersonal Skills

Goal 11: Develop the knowledge, skills, and attitudes needed for culturally-competent care.
Goal 12: Participate in discussion and decision-making with patients and families.
Goal 13: Work effectively with other providers in the health system.
Goal 14: Clearly communicate medical information in spoken and written form.

Category IV: Prevention

Goal 15: Develop knowledge, skills, and attitudes to practice the basic principles of prevention.
Goal 16: Practice personalized health planning for long-range goals.
Goal 17: Understand the planning for communities and populations.

Category V: Diagnosis

Goal 18: Elicit and correctly interpret symptoms and signs of ophthalmological conditions.

Goal 19: Diagnose and demonstrate basic understanding of common disease and conditions.
Goal 20: Appropriately use testing to help guide diagnostic and therapeutic decisions.
Goal 21: Demonstrate sound clinical reasoning.

Category VI: Treatment, Acute and Chronic.

Goal 22: Understand therapeutic options and participate in the multidisciplinary care of patients with complex problems.
Goal 23: Recognize acute life-threatening medical problems and initiate appropriate care
Goal 24: Acquire the knowledge and skills necessary to assist in the management and rehabilitation of chronic diseases.
Goal 25: Participate in care in a variety of settings; including knowledge about palliative care.

Category VII: Patient Safety

Goal 26: Identify and remove common sources of medical errors.
Goal 27: Understand and apply models of Quality Improvement.
Goal 28: Appreciate the challenges associated with reporting and disclosure.

Category VIII: Information Management

Goal 29: Use information and educational technology to facilitate research, education, and patient care.

Category IX: Ethics, Humanities, and the Law

Goal 30: Develop a commitment to carrying out professional responsibilities, adherence to ethical principles, and sensitivity to diversity.
Goal 31: Develop a critical understanding of the multiple factors that affect the practice of medicine, public health and research.
Goal 32: Incorporate ethical principles in clinical practice and research.

Category X: Professionalism

Goal 33: Develop healthy self-care behaviours and coping skills.
Goal 34: Model service to patients and community.

Category XI: Leadership & Management

Goal 35: Develop interpersonal and communication skills that result in leadership in patient health service delivery and health human resource management.

ADMISSION CRITERIA TO THE SPECIALTY TRAINING PROGRAMME IN OPHTHALMOLOGY

Applicants to the STP OPTH must possess a primary qualification in medicine, that is, Bachelor of Medicine and Bachelor of Surgery (MB ChB) or equivalent, from a recognized university. Additionally, they must have completed internship or equivalent and retain full registration and a practising licence issued by the Health Professions Council of Zambia. Other Ministry of Health policies and directives, for example, completion of rural posting, may apply.

CURRICULUM DESIGN/MODEL OF THE SPECIALTY TRAINING PROGRAMME IN OPHTHALMOLOGY

The STP OPTH Curriculum is a work-based professional competence-based training situated in an accredited training facility managed by specialists in Ophthalmology with oversight by the Zambia College of Medicine and Surgery (ZACOMS) working through ZOS. This curriculum is based on a process model of curriculum and is designed to be flexible and open ended rather than predetermined; maximizing the potential for growth and development.

During the STP OPTH programme the specialty registrar is an integral member of the clinical work of the department in which they are training to gain the required clinical experience and competence. The STP OPTH programme is a work based professional competence-based training leading to the award of the Certificate of Completion of Specialty Training (CCST) by the Zambia College of Medicine and Surgery (ZACOMS). Graduates are then eligible to apply to the Health Professions Council of Zambia to enter the Specialist Registers in Ophthalmology.

TEACHING METHODS IN THE SPECIALTY TRAINING PROGRAMME IN OPHTHALMOLOGY

The STP OPTH training is a work-based professional competence-based programme and should encompass diverse teaching and learning approaches that are appropriate for the target educational domain, i.e., cognitive (knowledge), psychomotor (practical), or affective (attitude) domain. The teaching methods may include, but not limited to, the following: expository lectures, tutorials, seminars, practical classes, skills laboratories, clinical demonstrations, clinical clerkships (bedside teaching, ward rounds, ambulatory care teaching, operating theatre experience, post-mortem, and on-call duties), field and community based learning, and ICT supported learning experiences.

The Health Professions Specialty Training Guidelines for Zambia and Zambia College of Medicine and Surgery Society Objectives and By-Laws provide detailed guidance to the trainee about the STP and ZACOMS, respectively.

SPECIALTY TRAINING PROGRAMME IN OPHTHALMOLOGY CURRICULUM STRUCTURE AND MAP

Curriculum Map for the STP OPTH Programme

STP YEAR 1 OPH 1070	ZACOMS PT 1 ARCP	**STP YEAR 2** OPH 2070	ARCP	**STP YEAR 3** OPH 3070	ARCP	**STP YEAR 4** OPH 4070	ZACOMS CCST Exams
Applied Basic Ocular Sciences & Principles of OPTH (3 months)		Principles & Practice of General Ophthalmology & Public Eye Health (3 months)		High Volume Surgical Skills Attachment (3 months)		Advanced Surgical Skills Development (3 months)	
Clinical Research Methods (3 months)		Advanced Public Eye Health & Research Methodology (3 months)		High Volume Surgical Skills Attachment (3 months)		Advanced Surgical Skills Development (3 months)	
Rotation 1: General OPTH Rotation (3 months)		Stepwise OPTH Surgical Skills (3 months)		Ophthalmological Research and Ophthalmology Subspecialties (3 months)		Research Project Write-up & Peer-Reviewed Publication (3 months)	
Rotation 2: OPTH and Related Specialties (3 months)		High Volume Surgical Skills Attachment (3 months)		Ophthalmological Research and Ophthalmology Subspecialties (3 months)		Leadership and Management (3 months)	
Part 1: Generic Education & Training **(1 year)**		Part 2: Themed & Specialist Education & Training **(3 Years)**					

N.B. The total number of years, in particular, the themed specialist education and training may vary between different specialties.

1. ARCP = Annual Review of Competence Progression
2. CCST = Certificate of Completion of Specialty Training Examination;
3. STP = Specialty Training Programme;
4. ZACOMS PT 1 = Zambia College of Medicine and Surgery Part 1 Examinations in Basic Sciences, Behavioural Sciences, Health Population Studies, and Professionalism & Ethics; ZACOMS CCST Examinations = Certificate of Completion of Specialist Training in Obstetrics & Gynaecology Examinations

ASSESSMENT IN THE SPECIALTY TRAINING PROGRAMME IN OPHTHALMOLOGY

Progression to the next level of training is NOT automatic and is dependent on the trainee satisfying all the competency requirements of each defined level as per this curriculum and learning guide. Progression is based on passing both clinical and written examinations. The assessment framework is designed to provide a coherent system of assessing both formative and summative assessment which are workplace based and in examination settings.

Each training site must ensure that they use valid, reliable and appropriate methods for assessing the knowledge, clinical skills and attitude domains. The continuous assessments and final annual assessments are weighted at 40% and 60% of the final mark of Annual Review of Competence Progression, respectively. Assessment methods may include, but are not limited to, the following: Log of experiences and procedures completed, case reports, portfolios, project reports, multiple choice questions, essay questions, short answer questions, modified essay questions, short and long cases, objective structured clinical examinations (OSCE), practical examinations, objective structured practical examinations (OSPE), Mini-clinical Examination (MiniCEX), and Viva Voce, etc.

It is emphasized that marks from theory examinations **may not** compensate for poor scores in the clinical examinations; Students **MUST** pass the clinical examinations in order to progress to the next stage of training or completion.

Assessment	Knowledge, Skill and Attitude Domain	Examining Body
Formative Workplace Based Assessments	Outcome 1 & 2	Training Site
Annual Review of Competence Progression	Outcome 1 & 2	Training Site in conjunction with ZACOMS
ZACOMS Part 1 Examination	Outcome 1	ZACOMS working through ZOS

ZACOMS Certificate of Completion of Specialist Registration Examinations	Outcome 2	ZACOMS working through ZOS

A candidate shall be allowed a maximum of three attempts for ZACOMS Part 1 and/or Part 2 Examinations. Candidates must have submitted a completed log book to eligible to attempt the ZACOMS Part 2 Examination.

For ease of tracking progress and planning for Ophthalmology care, all STP OPTH trainees will be registered with ZACOMS and ZOS for the duration of their training and will be allocated a Health Professions Council of Zambia Specialty Registrar Index Number.

Grading Scheme

The STP OPTH Curriculum and Guide are the basis for all specialty training which contextualize the standards of proficiency set down by the Zambia College of Medicine and Surgery (ZACOMS) in consultation with the Zambia Ophthalmological Society (ZOS) in a way that is accessible to the profession and the public. The Certificate of Completion of Specialist Training (CCST) is not graded. Separate assessments and examinations may be graded to show the level of achievement of the trainee in a particular course or assignment.

Assessment of Attainment of Competence in an Academic Subject

Status & Level	Description of Competence Features	% Range
Outright Fail [D]	Has poor and inaccurate command of the subject vocabulary Has poor and inaccurate command of the concepts (knowledge, skills and attitudes) of the subject across a broad range of topics.	44.9% & Below
Bare Fail [D+]	Has the basics of subject vocabulary Has the basics of concepts (knowledge, skills and attitudes) of the subject across a broad range of topics Unable to transfer and apply knowledge, skills and	45 – 49.9

	attitudes of the subject in a range of situations. Unable to exercise independent judgement in a range of situations	

Clear Pass [C]	• Has sound command of subject vocabulary • Has sound command of concepts (knowledge, skills and attitudes) of the subject across a broad range of topics • Able to formulate responses and demonstrate skill and exhibit appropriate attitude in well-defined and abstract problems/professional settings across a broad range of topics of the subject	50 – 64.9
Meritorious Pass [B]	All of above in level 3 and: □ Able to transfer and apply knowledge, skills and attitudes and exercise significant independent judgement in a broad range of topics of the subject	65 – 74.9
Distinction Pass [A]	All of the above in level 4 and: □ Displays masterly of complex and specialised areas of knowledge, skills and attitudes in a broad range of topics of the subject.	75% & Above

PART 1: COURSES FOR OPHTHALMOLOGY SPECIALTY TRAINING PROGRAMME

Applied Basic Ocular Sciences and Principles of Ophthalmology

Course Name Code ***STP OPTH 1***	***Applied Basic Ocular Sciences and Principles of Ophthalmology***
Aim/Purpose:	This Course aims at consolidating the applied basic scientific principles underlying the clinical practice of Ophthalmology, including functional and applied aspects and understanding of normal structure and function of the eye, related illnesses and threats for the patient, as well as the foundation for problem solving in applied situations and clinical practice. The course also aims at preparing the trainees for the Clinical Practice in Ophthalmology. This course also aims at developing the trainee as a scientific researcher, making them aware of the importance of evidence based practice by accessing scientific literature and by developing a research project proposal that can contribute to evidence based practice in Zambia in the field of Ophthalmology.

Learning Outcomes:	At the completion of the course students will be able to: 1. Explain and describe the anatomy and embryology of the eye and adnexae; anatomy of head and neck, central nervous system. 2. Demonstrate understanding of the principles of ocular physiology and biochemistry. 3. Apply and explain the principles of optics and refraction and application in ophthalmic practice. 4. Demonstrate understanding of the basic principles of ocular pathology, pharmacology and microbiology. 5. Apply the basic principles of ophthalmology. 6. Demonstrate basic surgical skills in Ophthalmology, including performing minor surgery independently and managing common eye conditions. 7. Demonstrate leadership and role modelling to junior doctors and medical trainees. 8. Function as senior house officers (SHO) within the department with clinical duties including: ▪ Participation in daily ward work ▪ Participating in outpatient clinics ▪ Taking on-calls at SHO level ▪ Supervision of interns and other junior health workers ▪ Teaching of undergraduates, interns and junior health workers ▪ To take a part in all academic activities in the department and also to join in postgraduate activities of the department such as Journal Club, clinical meetings and respective departmental unit's Grand Rounds

	9. Portrait as a role model and demonstrate professional behaviours, including understanding one's professional limitations. 10. Demonstrate understanding of the importance and principles of scientific research skills and to emphasize the importance of an evidence-base for contemporary ophthalmological practice. 11. Access and analyse scientific publications and research in the field of eye health care. 12. Present the developed research Project proposal with an appropriate topic in the field of ophthalmology relevant to Zambia.

Course Content	**PRINCIPLES OF BASIC OCULAR SCIENCES** *A. Introduction to Ocular Embryology* **A1 Ocular embryology** • Neuroectoderm • Surface ectoderm • Cranial neural Crest • Vascular System • Vitreous and Lens • Uvea • Cornea and Sclera • Anterior chamber angle • Retina • Realignment of the globe • Orbit and adnexae • Orbit and paranasal sinuses • Eyelids and conjunctiva • Lacrimal apparatus **A2. Congenital anomalies** • Anophthalmos, microphthalmos, nanophthalmos • Cyclopia and cryptophthalmos • •Corneal dystrophies • •Aniridia • •Syndromes and systemic disorders associated with • Ocular congenital anomalies *B. Introduction to Ocular Histology and Gross Anatomy* **B1. Dimensions and topography of the eye** **B2. Ocular tissues**:

Sclera

- Dimensions
- Histology
- Blood supply Nerve supply
- Applied anatomy

Cornea

- Dimensions
- Histology
- Blood supply
- Nerve supply
- Applied anatomy

Limbus

- Anatomical limbus
- Surgical limbus
- Surgical incisions

Drainage System

- Anterior chamber
- Posterior chamber
- Applied anatomy

Uvea

- Iris
- Ciliary body
- Choroid
- Blood supply
- Applied anatomy

Lens

- Structure of the lens
- Zonules
- Applied anatomy

B3. ORBIT

Vitreous Body

Structure

1. Hyaloid membrane
2. Cortical vitreous
3. Medullary vitreous
4. Attachments
5. Vitreous base

	6. Applied anatomy **Retina** • Gross anatomy • Histology • Blood supply • Blood – retinal barrier **Pupil** • Light reflex • Near reflex • Darkness reflex • Psychosensory reflex • Applied anatomy **Vessels and Nerves** • Arterial blood supply • Venous drainage • Lymphatic drainage • Nerves • Applied anatomy **Bony Orbit and Paranasal Sinuses** **Orbital contents (muscles, fascia, blood vessels, fats, nerves)** Applied anatomy **B4. OCULAR ADNEXAE** • Eyelids • Eyelashes • Eyebrows • Extraocular muscles • Conjunctiva • Lachrymal apparatus • Applied anatomy **B5. HEAD AND NECK** • Anatomy of head and neck related to the eye **B6. CENTRAL NERVOUS ORGANIZATION OF VISION** **Visual Pathway** • Motor system

- Sensory system
- Autonomic system
- Applied anatomy

B7. POSTNATAL DEVELOPMENT AND AGEING OF THE EYE

- Anatomical changes
- Physiological changes
- Refractive changes
- Applied aspect

C. INTRODUCTION TO PHYSIOLOGY AND BIOCHEMISTRY OF THE EYE

C1. OCULAR PHYSIOLOGY

Ocular Circulation

- Intra-ocular blood flow
- Permeability of capillaries
- Oxygen saturation
- Factors affecting vascular circulation

Application to ophthalmic practice

Aqueous humour

- Chemical composition
- Formation, circulation and drainage of aqueous Humour

Application to ophthalmic practice

Vitreous Body

- Physical properties and chemical composition
- Diffusion of fluid and direction of flow

Application to ophthalmic practice

Intra-Ocular Pressure (IOP)

- Determinants of intra-ocular pressure

	Factors contributing to physiological variation Regulation of intra-ocular pressure Measurement techniques of intra ocular pressure **Application to ophthalmic practice** **Cornea** Chemical and physical properties Corneal deturgescence Nutrition and metabolism

	Application to ophthalmic practice **Lens** Chemical composition Nutrition and metabolism Transparency **Application to ophthalmic practice** **Retina** Nutrition and metabolism Carbohydrate metabolism Vitamin A metabolism Others (lipids, proteins neurotransmitters, melanin) Application to ophthalmic practice **Protective mechanism of the eye** Orbit Brow Eyelids Eye lashes Blinking Tear film

	Bell's phenomenon **Ocular motility** Actions of the extra ocular muscles Physiology of the extra ocular muscle fibres Neurological control of extra ocular motility **Application to ophthalmic practice** **C2. PHYSIOLOGY OF VISION** **Colour Vision** **Contrast and after-images** Monocular vision **Binocular single vision** **Entoptic phenomenon** **Visual pathway and cerebral integration** **Retino-geniculo-cortical pathway** Visual field defects

	Structure and function of the lateral geniculate body Primary visual cortex Extra striate visual cortex **Physical effect stimulation** Photochemistry of Vision Physiological principles of assessment of visual Function Adaptation **Application to ophthalmic practice** *D. INTRODUCTION TO OPTICS AND REFRACTION* **Physical Optics**

- Properties of light

Geometric Optics

- Reflection
- Refraction
- Prisms
- Spherical lens
- Astigmatic lenses

Notation of lenses

Identification of lenses

Aberrations of lenses

Clinical Optics

- Ametropia
- Accommodative problems
- Refractive errors
- Correction of ametropia

<u>Low Vision</u>

Clinical refraction

- Objective refraction
- Subjective Refraction
- Cycloplegic refraction
- Measurement of back vertex distance
- Muscle balance tests
- Accommodative power
- Measurement of inter pupillary distance
- Decentration of lenses and prismatic effect

- Best form lens

- Prescribing for children

Application to ophthalmic practice

E. INTRODUCTION TO BASIC OCULAR PATHOLOGY, PHARMACOLOGY AND MICROBIOLOGY

E1 BASIC OCULAR PATHOLOGY

- Inflammation
- Trauma and wound healing
- Pathology of the eyelids and eye lashes
- Pathology of cornea and sclera
- Pathology of the conjunctiva
- Pathology of the uvea
- Pathology of the retina
- Pathology of the optic nerve
- Glaucoma
- Intra ocular tumours
- Orbital tumours o Non-tumourous orbital conditions
- Metastatic eye disease
- Genetic related eye diseases

E2 OCULAR PHARMACOLOGY

General principles including:

- Mechanisms of drug actions (including receptor pharmacology and biochemical pharmacology) o Absorption, distribution, metabolism and excretion of drugs
- Mechanisms of drug toxicity
- Preparation and routes of administration of ophthalmic drugs

	Agents/drugs commonly used in ophthalmology o Miotic agents • Mydriatic agents • Antimicrobials • Antiglaucoma drugs • Anti-inflammatory agents • Cytotoxic drugs • Anaesthetic agents • Viscoelastic agents • Ophthalmic dyes • Ophthalmic preservatives

	E3. OCULAR MICROBIOLOGY **General Principles of Ocular Microbiology:** Common microorganism affecting the eye o Bacteria o Viruses o Fungi o Parasites microbial pathogenesis o Principles of immunology Asepsis in ophthalmology Disinfection Sterilization Universal Infection Prevention and Control Practices Clinical waste management

F. PRINCIPLES AND PRACTICE OF GENERAL OPHTHALMOLOGY

F1. INTRODUCTION TO OPHTHALMIC INSTRUMENTS AND EQUIPMENT

- Instruments o Direct ophthalmoscope
  - Indirect ophthalmoscope (monocular and binocular) o Retinoscope o Focimeter
  - Simple magnifying glass (Loupe)
  - Lensmeter o Automated refractor o Slit-lamp microscope o Stereo-tests o Keratometer o Applanation tonometer o Specular microscope o Operating microscope o Zoom lens principle o Corneal pachymeter o Lees screen/Hess chart o Synoptophore o Lenses used for fundus bio-microscopy
  - Fundus camera o Gonioscope o Laser lenses o Humphrey's visual field analyzer

	○ Goldman visual field analyzer o Visual acuity charts ○ Optical Coherence Tomography (OCT) ○ AB Scan ○ Prism Bar **F2. INTRODUCTION TO CLINICAL OPHTHALMOLOGY** **BASIC TECHNIQUES OF CLINICAL EXAMINATION OF THE EYE** Under this component of the course the students will be expected to perform the following activities: • Visual acuity o Near vision o Distant vision o Color vision • Slit-lamp examination o Anterior o Posterior • Fundoscopy ○ Direct and indirect ophthalmoscopy • Gonioscopy • Tonometry o Applanation o Schiotz o Pulse o Tonopen • Perimetry o Subjective o Objective • A / B – sonography • Refraction o Objective o Subjective • Keratometry • Exophthalmometry (Hertel's technique *G. INTRODUCTION TO EYE CARE PLANNING* • Needs assessment • Priority setting • Strategy for control of visual impairment • Monitoring and evaluation of eye care programmes

	H. ELEMENTARY BIOPHYSICS • The basic principles of: • Ionising radiation • Diagnostic radiology • Ultrasonography • CT Scan • Radiotherapy. *I. HEALTH CARE ETHICS AND PROFESSIONALISM* ▪ Philosophical bases of healthcare ethics ▪ Principles and values in healthcare ethics ▪ International and national ethical codes.
Contact Hours:	Bedside/patient centred teaching - 10 hours/week Student led presentations -7 hours/week Major rounds - 8 hours/week Journal clubs and case presentations - 2 hour/week Tutorials - 5 hours/week Operative surgery- 6 hours/week Self - study - 2hours/week Clerkship Rotations (as per department's work schedule).
Teaching Methods:	The teaching methods may include, but not limited to, the following: expository lectures, tutorials, seminars, practical classes, skills laboratories, clinical demonstrations, clinical clerkships (bedside teaching, ward rounds, ambulatory care teaching, operating theatre experience, postmortem, and on-call duties), field and community based learning, and ICT supported learning experiences.
Assessment Methods and Weighting:	Log of experiences and procedures completed, case reports, portfolios, project reports, multiple choice questions, essay questions, short answer questions, modified essay questions, short and long cases, objective structured clinical examinations (OSCE), practical examinations, objective structured practical examinations (OSPE), Mini-clinical Examination (MiniCEX), and Viva Voce. **Annual Review of Competence Progression** (a) Continuous Assessment - 40% (b) Final Examinations - 60% **ZACOMS Administered Examinations** Taken according to ZACOMS Examinations Schedule

CLINICAL RESEARCH METHODS

Course Name Code ***STP OPTH 2***	***CLINICAL RESEARCH METHODS***
Aim/Purpose:	This course is designed to provide the trainee with a basic understanding of clinical research through a stepwise overview of the research process. The course will introduce trainees to the concepts and principles of epidemiology, research methods, and biostatistics in the context of protocol development. It will equip trainees with the skills to design and implement a clinical research study, and analyze, interpret, and present their results.
Learning Outcomes:	At the completion of the course students will be able to: 1. Demonstrate understanding and utilizing basic epidemiologic principles for research. 2. Identify a research problem and formulate an appropriate question/hypothesis. 3. Identify an appropriate study design and necessary data for answering the question. 4. Gain familiarity with aspects of data management. 5. Identify and apply appropriate analytical methods to a data set, including computer-aided statistical analysis. 6. Synthesize and interpret study results. 7. Effectively present research methods and results both orally and in writing.

Course Content	A. Epidemiology 1. Introduction to epidemiology 1.1 Definitions of epidemiology 1.2 Common epidemiological terms 1.3 History of epidemiology 1.4 Application and importance 2. What is causation? 2.1 Cause and effect relationship 2.2 Causal pie model/Multicausality 2.3 Strength of causes 2.4 Causal criteria 3. Measure of Disease Occurrence 3.1 Incidence 3.2 Prevalence 3.3 Case fatality rates 3.4 Risk Ratio and Odds Ratio 3.5 Attributable risk/PAR 4. Types of epidemiological studies 4.1 Overview of the study designs 4.2 Cross-sectional studies 4.3 Cohort studies

	4.4 Case control 4.5 Clinical controlled trials 5. Bias and Confounders in study design 5.1 Definition of Bias and confounders 5.2 Types of errors (systematic and random) 5.3 Sources of bias in epidemiological studies 5.4 Properties of confounders 5.5 Control of bias and confounders 6. Data collection tools 6.1 Quantitative (open and closed questionnaire) 6.2 Qualitative (IDI, FGD) B. Biostatistics 1. Medical statistics 1.1What is statistics? 1.2 Importance of statistics 1.3 Descriptive statistics 1.4 Inferential statistics 1.5 Variables 2. Central Tendency 2.1 What is central tendency? 2.2 Measures of central tendency 3. Variability 3.1 What is variability? 3.2 Measures of variability 3.3 Estimating variance 4. Graphing Distribution 4.1 Histogram 4.2 Bar charts 4.3 Line graphs 5. Probability 5.1 Basic Concepts 5.2 Non Conditional probability 5.3 Conditional probability 6. Normal Distribution 6.1 Varieties of normal distribution 6.2 Areas of normal distribution 6.3 Standard normal 7. Sampling Distribution 7.1 Sampling distribution of mean 7.2 Sampling distribution of difference between means 7.3 Sampling distribution of Pearson's r

	7.4 Sampling distribution of a proportion 8. Estimation 8.1 Introduction 8.2 Degrees of Freedom 8.3 Characteristics of estimators

	9. Confidence Interval 9.1 confidence interval for the mean 9.2 Confidence interval for the difference between the means 9.3 Confidence interval for the Pearsons correlation 9.4 Confidence interval for the proportion 10. Logic of hypothesis testing 10.1 Significance testing 10.2 Type 1 and type 2 errors 10.3 One and two tailed test 10.4 Significance testing and confidence interval 11. Power 11.1 Power and sample size calculation

	11.2 Factors affecting power 12. Predictions 12.1 Simple logistic regression 12.2 simple linear regression 13. ANOVA 13.1 ANOVAs designs 14. Chi-square 14.1 One way table 14.2 Contingency tables 15. Validity and reliability of diagnostic tests a. Sensitivity, Specificity, PPV, NPV b. ROC curves c. Inter observer variation C. Proposal Development 1. Identification of the research problem 1.1 Formulation of the Title 1.2 How to write the Introduction/Background 2. Review of literature 2.1 The main purpose of reviewing literature 2.2 How to search for literature 2.3 Reference and referencing 3. Justification/rationale 4. Statement of the problem and Hypothesis formulation 5. Objectives 5.1 Main objectives 5.2 Specific objectives 6. Methodology 6.1 Study design 6.2 Site 6.3 Sampling 6.4 Sample size

	6.5 Data collection techniques 7. Data management and Analysis 7.1 Introduction to SPSS 7.2 Entering Data in SPSS 7.2.1. Starting SPSS 7.2.2. Output viewer 7.2.3. Importing data from the other files

	7.3 Data processing 7.3.1. Creating and defining data 7.3.2. Inserting cases and variables 7.3.3. Computing new variables 7.3.4. Recording variables 7.3.5. Sorting cases 7.3.6. Selecting cases 7.4 Data Summaries 7.4.1. Descriptive statistics 7.4.2. Frequencies 7.4.3. Cross-tabulations 7.5 Inferential statistics 7.5.1. Measure of association (statistics, chi-square linear correlation) 7.5.2. Testing for difference between two groups (t-tests) 7.5.3. One-way Analysis of Variation (ANOVA) 7.5.4. Nonparametric tests 7.5.5. Logistic regression 7.5.6. General Linear models 7.6 Displaying of Data 7.6.1. Tables 7.6.2. Bar Graphs 7.6.3. Scatter plots 7.6.4. Interactive charts 7.7 Data manipulation 7.7.1. Splitting files 7.7.2. Merging files 7.7.3. Aggregating data 8. Timeline 9. Research ethics 10. Budgeting 11. Presenting with PowerPoint 12. Techniques of writing a scientific paper
Contact Hours:	Lectures 1hr/week Tutorial 1hr/week Clerkship Rotations (as per department's work schedule).
Teaching	Lectures/ Seminars/discussions/tutorials and self-directed student-centred
Methods:	learning.

Assessment Methods and Weighting:	Log of experiences and procedures completed, case reports, portfolios, project reports, multiple choice questions, essay questions, short answer questions, modified essay questions, short and long cases, and Viva Voce. **Annual Review of Competence Progression** (a) Continuous Assessment - 40% (b) Final Examinations - 60% **ZACOMS Administered Examinations** Taken according to ZACOMS Examinations Schedule

PART 2 COURSES FOR OPHTHALMOLOGY SPECIALTY TRAINING PROGRAMME

Principles & Practice of General Ophthalmology & Public Eye Health

Course Name Code ***STP OPTH 3***	***PRINCIPLES & PRACTICE OF GENERAL OPHTHALMOLOGY & PUBLIC EYE HEALTH***
Aim/Purpose:	This Course describes principles and practice of general ophthalmology and functions of ophthalmic instruments and equipment. Students specializing in ophthalmology are expected to have core knowledge on how to use and maintain eye equipment. The course aims to equip trainees with knowledge, skills and attitudes in general ophthalmology and ophthalmic equipment.

Learning Outcomes:	At the completion of the course students will be able to: 1. Demonstrate proficiency in the use of ophthalmic instruments and equipment. 2. Recognize ocular diseases and demonstrate understanding of the principles of how to manage the conditions. 3. Demonstrate competence in animal eye/model surgical skills. 4. Manage conditions in clinical ophthalmology. 5. Perform the basic ocular surgeries and basic diagnostic procedures under supervision. 6. Plan and undertake independent scientific research activities, literature searches, critical appraisal of scientific literature, process and analyze statistics, interpret epidemiology data. 7. Function as senior registrars within the department with clinical duties including: ▪ Participation in daily ward work ▪ participating in outpatient clinics ▪ Taking on-calls at senior registrar level ▪ Supervision of interns and other junior health workers ▪ Teaching of undergraduates, interns and junior health workers 8. Take a full part in all academic activities in the department and also to join in postgraduate activities of the department such as Journal Club, clinical meetings and respective departmental units Grand Rounds. 9. Portrait as a role model and demonstrate professional behaviours. 10. Contribute to evidence-base knowledge for ophthalmology practice and improve the Health Systems in Zambia with regards to eye health, women and reproductive, holistic health care standards, including prevention and health promotion. 11. Collect and analyze scientific research data for their research project in the field of Ophthalmology health care

Course Content	**A. Applied Ocular Pathology, Pharmacology and Microbiology** • Disorders of the Ocular adnexa • Disorders of the Orbit • Disorders of paranasal sinuses • Disorders of lacrimal system Disorders of the sclera Disorders of the cornea. • Disorders of the uveal tract • Disorders of the lens • Disorders of the vitreous • Disorders of the retina • Glaucoma and hypotony • Neuro - ophthalmology **B. Advanced Clinical Ophthalmology I Management of:** **Eye trauma in all of the tissues below.** **Disorders of ocular adnxea** 1. Developmental anomalies 2. Dermatosis of varied aetiology 3. Inflammation of eyelids 4. The eyelid in systemic diseases 5. Atrophies, Hypertrophies, degeneration pigmentation 6. Cysts and tumors 7. Motor disorders and deformation of the eyelids 8. Disorders of eye brows and eye lashes • Developmental anomalies • Disturbances of growth • Anomalies of direction • Anomalies of pigmentation ▪ Disorders of conjunctiva ▪ Development anomalies • Inflammatory (infectious and non-infectious). • Degenerations and atrophies • Dystrophies • Pigmentation • Cysts and tumors • The conjunctiva in systemic disease **Disorders of lacrimal system** • Developmental anomalies • Diagnosis of Lacrimal gland disorders • Disorders of secretion

- Inflammation of the lacrimal gland and lacrimal passages
- Lacrimal gland and systemic disease
- Atrophies of the lacrimal gland
- Cysts/tumors of the lacrimal gland
- Fistulae, dacrylid, prolapse of lacrimal gland
- Epiphora and insufficiency of lacrimal passage
- Tumors, Pseudotumours, cysts and diverticulum of the lacrimal passage.

Disorders of orbit

- Developmental anomalies
- Disturbance of Circulation
- Inflammation of the Orbit
- Orbital involvement in Systemic diseases
- Degeneration/atrophies
- Tumors/Cysts

Disorders of the Paranasal sinuses

- Developmental anomalies
- Diagnosis of the nose and paranasal sinus
  - Infection
  - Inflammation
  - Tumors
  - Trauma

Disorders of the cornea:

- Developmental anomalies
- General aetiology of corneal disease
- Cornea Oedema
- Corneal Vascularization
- Inflammation of the Cornea- Keratitis/ Corneal ulcers
- Corneal degeneration
- Corneal dystrophies
- Corneal pigmentation
- The corneal in systemic disease

Disorders of the Sclera

- Developmental anomalies
- Inflammation (infectious and non- infectious).
- Cysts and Tumors
- Sclera in systemic disease
- Ectasia/ staphyloma
- Degeneration

	Disorders of the uveal tract Developmental anomalies • Disturbance of circulation • Inflammations of uveal tract • Uveal manifestation of systemic diseases • Atrophies and degeneration of uveal tract • Cysts and tumors of Uveal tract • Cilio-choroidal detachment **Disorders of the lens** • Developmental anomalies • Cataracts • Displacement of the lens • The lens and systemic disease
Contact Hours:	Lectures 1hr/week Tutorial 1hr/week Self-Directed Student-Centred Learning 6 hr/week Clerkship Rotations (as per department's work schedule).
Teaching Methods:	The teaching methods may include, but not limited to, the following: expository lectures, tutorials, seminars, practical classes, skills laboratories, clinical demonstrations, clinical clerkships (bedside teaching, ward rounds, ambulatory care teaching, operating theatre experience, postmortem, and on-call duties), field and community based learning, and ICT supported learning experiences.
Assessment Methods and Weighting:	Log of experiences and procedures completed, case reports, portfolios, project reports, multiple choice questions, essay questions, short answer questions, modified essay questions, short and long cases, objective structured clinical examinations (OSCE), practical examinations, objective structured practical examinations (OSPE), Mini-clinical Examination (MiniCEX), Viva Voce, **Annual Review of Competence Progression** (a) Continuous Assessment - 40% (b) Final Examinations - 60% **ZACOMS Administered Examinations** Taken according to ZACOMS Examinations Schedule

Advanced Public Eye Health and Research Methodology

Course Name Code ***STP OPTH 4***	***Advanced Public Eye Health and Research Methodology***

Aim/Purpose:	This Course aims to progress the student to writing up the research project proposal, commence data collection and analysis. The course consolidates research capacity of the trainee.
Learning Outcomes:	At the completion of the course students will be able to: 1. Develop a credible research proposal of sufficient standard set by the department that can satisfy a panel of supervisors. 2. Collect and analyse research data using appropriate collection methods and analysis. 3. Communicate effectively and functions as a productive team member engaged in health care, research and education. 4. Take full part in all academic activities in the department, including supervision of other health professionals. 5. Contribute to evidence-base knowledge for Ophthalmology practice and improve the Health Systems in Zambia with regards to women and reproductive, holistic health care standards, including prevention and health promotion.
Course Content	**<u>Research Methodology</u>** 1. Prevalence, incidence and distribution of visual impairment 2. Epidemiological research methods: an outline 3. Cross sectional studies 4. Case control and cohort studies 5. Genetic epidemiology 6. Clinical trials 7. Screening in ophthalmology
Contact Hours:	Lectures 1hr/week Tutorial 1hr/week Clerkship Rotations (as per department's work schedule).
Teaching Methods:	The teaching methods may include, but not limited to, the following: expository lectures, tutorials, seminars, practical classes, skills laboratories, clinical demonstrations, clinical clerkships (bedside teaching, ward rounds, ambulatory care teaching, operating theatre experience, postmortem, and on-call duties), field and community based learning, and ICT supported learning experiences.
Assessment Methods and Weighting:	Log of experiences and procedures completed, case reports, portfolios, project reports, multiple choice questions, essay questions, short answer questions, modified essay questions, and Viva Voce. **Annual Review of Competence Progression** (a) Continuous Assessment - 40%

	(b) Final Examinations - 60% **ZACOMS Administered Examinations** Taken according to ZACOMS Examinations Schedule

Opthalmogical Research & Ophthalmogy Sub-Specialties

Course Name Code ***STP OPTH 5***	***Ophthalmological Research & Ophthalmology Sub-Specialties***
Aim/Purpose:	This Course aims to progress the student to writing up the research project proposal and publication in a peer-reviewed outlet. Additionally, the trainee receives in-depth skill development in the ophthalmology sub-subspecialties.
Learning Outcomes:	At the completion of the course students will be able to: 1. Complete a credible research project report and/or write up article and have it published in peer-reviewed outlet. 2. Manage the common clinical conditions of sub-specialties of ophthalmology (medical and surgical). 3. Apply to their practice the principles of managing paediatric, retinal, glaucoma, reconstructive and anterior segment eye diseases. 4. Demonstrate competence in the common sub-specialties of ophthalmology. 5. Demonstrate general management skills required for clinical audits and the improvement of ophthalmic practice. 6. Maintain competence and excellent performance through continuing professional education. 7. Implement, appropriately the local and international policies in eye health. 8. Contribute to evidence-base knowledge for Ophthalmology practice and improve the Health Systems in Zambia with regards to women and reproductive, holistic health care standards, including prevention and health promotion.

Course Content	**Sub-specialties and Ophthalmological Research 1** • Sub specialty Ophthalmology 1 • Advanced Community Eye Health & Research Methodology 1 • Research Project Data collection1 • Elective attachment for 8 weeks **Sub specialties and Ophthalmological Research 2** • Sub specialty Ophthalmology 2 • Advanced Community Eye Health & Research Methodology 2 • Research Project Data collection 2 • Elective attachment for 8 weeks **Sub specialties and Ophthalmological Research 3** • Sub specialty Ophthalmology 3 • Advanced Community Eye Health & Research Methodology 3

	• Research Project Data collection 3 • Elective attachment for 8 weeks **PEDIATRIC OPHTHALOMOLOGY** • Embryological abnormalities • Pediatric Eye Infections • Pediatric Visual abnormalities • Pediatric Cataract • Pediatric Tumours - Retinoblastoma

- Abnormalities of ocular motility
  - Anomalies of binocular fixation
  - Strabismus
  - Nystagmus
  - Gaze palsies

RETINAL DISEASE

- Development anomalies
- Inflammatory and Infective Degenerative- age, familial etc.
- Macular disorders
- Vascular disorders
- The retina in systemic disease
- Surgical retina e.g. Retinal detachment, Macular hole etc.
- Benign and Malignant Tumour.
- Tropical Retinopathy e.g. SCD, HIV

OCULOPLASTICS

- Lacrimal drain system disease
- Disorders of the eye lids e.g. entropion, ectropion
- Proptosis e.g. Thyrotoxicosis, Orbital Tumours
- Reconstructive Surgery

ANTERIOR SEGMENT OF THE EYE

- Cornea e.g. infections, autoimmune diseases, corneal graft, degenerative diseases etc.
- Conjunctiva
- Sclera – episcleritis, scleritis
- Cataract – cause, presentation, management, phocoemulsification

GLAUCOMA

- Classification
- Diagnosis
- Management Medical, Surgery and Laser

	NEURO-OPHTHALMOLOGY • Developmental • Inflammatory and Infective - e.g. Optic Neuritis • Nerve Palsy - e.g. 3th , 4th and 6th Nerve ▪ The Visual system ▪ Headache and the Eye ▪ Nystagmus ▪ Optic Neuropathies ▪ Eye Movement disorders **C. Ocular injuries** **Mechanical injuries** ▪ Concussion and contusion ▪ Penetrating injuries ▪ Ocular Foreign bodies ▪ indirect ocular injuries **Non Mechanical injuries** ▪ Thermal injuries ▪ Ultrasonic ▪ Radiation ▪ Chemical and Stress injuries **D. Research and Epidemiology of the Eyes** ▪ General Public ▪ Research Methods ▪ Data Analysis and interpretation ▪ epidemiology
Contact Hours:	Lectures 1hr/week Tutorial 1hr/week Clerkship Rotations (as per department's work schedule).
Teaching Methods:	The teaching methods may include, but not limited to, the following: expository lectures, tutorials, seminars, practical classes, skills laboratories, clinical demonstrations, clinical clerkships (bedside teaching, ward rounds, ambulatory care teaching, operating theatre experience, post-mortem, and on-call duties), field and community based learning, and ICT supported learning experiences.

Assessment Methods and Weighting:	Log of experiences and procedures completed, case reports, portfolios, project reports, multiple choice questions, essay questions, short answer questions, modified essay questions, and Viva Voce. **Annual Review of Competence Progression** (a) Continuous Assessment - 40% (b) Final Examinations - 60%
	ZACOMS Administered Examinations Taken according to ZACOMS Examinations Schedule

INDICATIVE RESOURCES

1. Adlers, Physiology Of The Eye, 2nd Edition
2. American academy (2007) *Basic and Clinical Science course,* San Francisco: California.
3. Andrew T.Raftery,(2008),*Applied Basic Science for Basic Surgical Training*, 2nd edition, Churchill Livingstone, Elsevier London UK, ISBN
4. Bernard Rosner. The Fundamentals of Biostatistics. Duxbury Press, Belmont CA 5th edition 1995
5. Bowling Brad (2016) Kanski's *Clinical Ophthalmology a systematic approach* ELSEIVER ISBN-13: 978-0702055720
6. Brad Bowling Kanski's Clinical Ophthalmology; A Systematic Approach 8th Edition **ebook ISBN:** 9780702055751Saunders Ltd.
7. Browner WS. Publishing a; 2006. nd Presenting Clinical Research. 2nd ed. Philadelphia: Lippincott Williams & Wilkins
8. Collin, J.R.O. *A manual of systemic eyelid surgery second edition(1989),* Churchill Livingstone
9. Daniels, (1991). Biostatistics: A Foundation for Analysis in Health Sciences (6th Edition).
   John Wiley and Sons Inc, New York.
10. David Katz (2014) Preventive Health ISBN 9781455706587
11. Elkington A.R, And Frank H.J. *Clinical Optics 3rd Edition* (1999) Willey Blackwell ISBN: 978-0-632-04989-9
12. Foster A, Johnson G. Magnitude and causes of blindness in the developing world international ophthalmology 1990.
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14. Hulley SB, Cummings SR, Browner WS, et al. Designing Clinical Research. 3rd ed. Philadelphia: Lippincott Williams & Wilkins; 2007.
15. *Jimmy D. Bartlett,* Clinical Ocular Pharmacology (Fifth Edition) ISBN: 978-0-7506-7576-5
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17. Johnson G. J, Minassian D. C, Weale R. A. The epidemiology of eye disease, 2nd Edition, 2003.
18. Kenneth J Rothman: Epidemiology: An introduction Oxford University press 2002
19. Khurana A. K. and Khurana I. Anatomy and Physiology of the Eye 2nd Edition
20. Khuranah A. K. Comprehensive Ophthalmology ISBN10 1905740786
21. Kim E.Barret, Susan M, Barman, Scott Boitano and Heddwen Brooks (2009) *Ganong's Review of Medical Physiology* 23rd edition, McGraw-Hill, *by Mukherjee PK, Bandyopadya Preeti* Ocular Microbiology
22. Walter J.B, Israel M.S,(1970), *General Pathology* ,6th edition, Edinburg, London, Churchill Livingstone
23. Yanoff M. Duker Jay, S. Ophthalmology 3rd Edition