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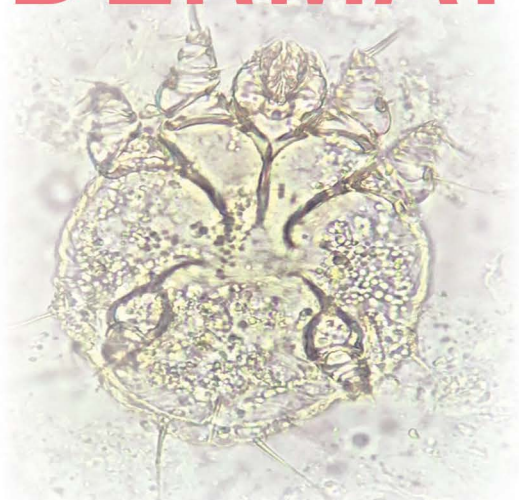

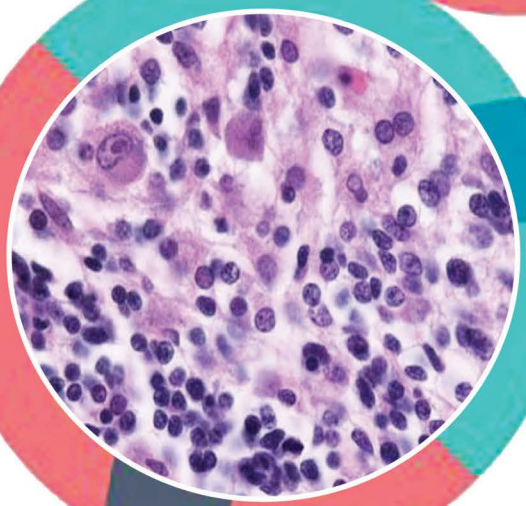

Sanjeev Gupta
Rohit Batra
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CONTENTS

1. Cyto-histopathological Examination, Wood's Lamp and Patch Test.....1

Chapter 1A: Cyto-histopathological Investigations in Dermatology 1
Sanjeev Gupta, Arushi Gakhar, Sumit Gupta, Sumeet Pethe, Rohit Batra, Ajinkya Gujrathi, Anuradha Yadav

- **Microscopy 1**
  Sanjeev Gupta, Arushi Gakhar
- **Skin Biopsy 12**
  Sumit Gupta, Sumeet Pethe
- **Immunofluorescence Test 14**
  Rohit Batra, Ajinkya Gujrathi

Chapter 1B: Wood's Lamp Examination and Patch Test 16
Sanjeev Gupta, Anuradha Yadav

- **Patch Test 17**
  Sanjeev Gupta, Anuradha Yadav

2. Hematology.....21
Sunita Gupta, Sumit Gupta, Jasleen Kaur, Rohit Batra, Namya Gupta, Meghna Khatri

- **Blood Cells 21**
  Sunita Gupta, Sumit Gupta
- **Red Cell Indices 24**
  Sumit Gupta, Jasleen Kaur
- **Hemoglobin 25**
  Rohit Batra, Namya Gupta
- **Erythrocyte Sedimentation Rate 27**
  Sumit Gupta, Meghna Khatri
- **Reticulocyte Count 29**
  Sumit Gupta, Rohit Batra

3. Blood Glucose.....30
Sunita Gupta, Sanjeev Gupta

4. Glycosylated Hemoglobin.....32
Sunita Gupta, Sanjeev Gupta

5. Urine Examination....34
Aneet Mahendra, Sanjeev Gupta

6. Urinary Protein....39
Sanjeev Gupta, Aneet Mahendra

7. Renal Function Tests....42
Rohit Batra, Ajinkya Gujrathi

8. Liver Function Tests....49
Sanjeev Gupta, Deeksha Goyal, Akriti Gakhar

9. Hepatitis Markers....57
Sunita Gupta, Amit Soni

10. Lipid Profile....62
Sunita Gupta, Rohit Batra

11. Glucose-6-phosphate Dehydrogenase....67
Sanjeev Gupta, Aastha Sharma

12. Thiopurine-S-methyltransferase....70
Sanjeev Gupta, Aastha Sharma, Udya Chauhan

13. Thyroid Function Tests....72
Sunita Gupta, Sanjeev Gupta

14. Human Immunodeficiency Virus....76
Sanjeev Gupta, Narinder Kaur

15. Venereal Disease Research Laboratory....85
Rohit Singla, Narinder Kaur

16. Semen Analysis....94
Ajinkya Gujrathi, Sanjeev Gupta, Rohit Singla

17. Antibodies in Autoimmune Connective Tissue Disease....101
Sunita Gupta, Sanjeev Gupta

18. C-reactive Protein....112
Rohit Batra, Nidhi Jindal

19. Rheumatoid Factor 115
Rohit Batra, Sanjeev Gupta

20. Anti-cyclic Citrullinated Peptide 117
Rohit Batra, Sanjeev Gupta

21. Hormonal Investigations 118
Aneet Mahendra, Ajinkya Gujrathi, Sumit Gupta, Sanjeev Gupta, Meghna Khatri, Sunita Gupta, Rohit Batra

- **Luteinizing Hormone and Follicle-stimulating Hormone (LH, FSH) 118**
  Aneet Mahendra, Ajinkya Gujrathi
- **Prolactin 121**
  Sumit Gupta, Sanjeev Gupta
- **Dehydroepiandrosterone 122**
  Sanjeev Gupta, Meghna Khatri
- **Testosterone 124**
  Sumit Gupta, Sanjeev Gupta
- **Cortisol 127**
  Sanjeev Gupta, Sunita Gupta
- **Anti-müllerian Hormone 130**
  Sanjeev Gupta, Meghna Khatri
- **Insulin Resistance 131**
  Sunita Gupta, Rohit Batra

22. Serum Vitamin D 135
Saurabh S Gupta, Rohit Batra, Anuradha Yadav

23. Serum Immunoglobulin E 140
Saurabh S Gupta, Anuradha Yadav

24. Serum Ferritin 145
Rachita Dhurat, Sunita Gupta

25. Serum Calcium 149
Saurabh S Gupta, Ajinkya Gujrathi

26. Serum Magnesium 152
Saurabh S Gupta, Ajinkya Gujrathi, Anuradha Yadav

27. Serum Zinc 156
Saurabh S Gupta, Sanjeev Gupta, Udya Chauhan

28. Radiology 162

Amit Mittal, Himanshu Singla, Sanjeev Gupta, Vivek Singh, Saurabh S Gupta, Pradhuman

- **Ultrasound in Dermatology 162**
  Amit Mittal, Himanshu Singla
- **Doppler Ultrasound 166**
  Sanjeev Gupta, Amit Mittal
- **Penile Ultrasonography/Doppler 167**
  Sanjeev Gupta, Vivek Singh
- **CT Scan 168**
  Saurabh S Gupta, Amit Mittal
- **Magnetic Resonance Imaging 170**
  Pradhuman, Saurabh S Gupta, Amit Mittal

Index **..... 173**

CHAPTER

4

Glycosylated Hemoglobin

Sunita Gupta, Sanjeev Gupta

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INTRODUCTION

Glycosylated hemoglobin or glyco hemoglobin (HbA1c, hemoglobin A1c, A1c or less commonly HbA1c, HgbA1c, Hb1c, etc.) is a form of hemoglobin that is chemically linked to a sugar. Red blood cells live for 3 months, so this test shows the average level of glucose in your blood for the past 3 months.

Adult hemoglobin is made up of three different forms of Hb namely: HbA1, HbA2, HbF. Out of these HbA1 predominates and consists of three subforms namely: HbA1a, HbA1b and HbA1c, out of these HbA1c predominates.

The term glycation or glycosylation means attachment of sugar molecules with Hb, which is an irreversible process. Once the sugar molecules enter RBC and attach with Hb molecule, it cannot be detached until RBC is hemolysed.

The high levels of HbA1c diffuses through vessel wall and binds with nitric oxide which is otherwise needed for acetylcholine—induced endothelium-dependent relaxation and so, causing prevention of its normal function. This in turn may lead to vessel damage, narrowing and atherogenic plaque formation.

The 2010 American Diabetes Association Standards of Medical Care in Diabetes added the HbA1c ≥ 48 mmol/mol (≥6.5%) as another criterion for the diagnosis of diabetes.

Normal ranges for HbA1c:

- <5.7 = Normal
- 5.7–6.4 = Prediabetic
- >6.5 = Diabetic
- HbA1c values can help in determining the mean plasma glucose levels of the patient (**Table 1**).

Important notes:

- *Hemolytic anemia* decreases HbA1c levels because of increased production of

TABLE 1: HbA1c and corresponding mean plasma glucose levels.

HbA1c (%)	Mean plasma glucose (mg/dL)
6	126
7	154
8	183
9	212
10	240
11	269
12	298

(HbA1c: glycosylated hemoglobin)

younger red blood cells, which contains hemoglobin with less exposure to ambient glycemia.
- Aplastic and/or iron deficiency anemia increases the average age of circulating erythrocytes, leading to increased concentration of HbA1c independent of glycemia.
- The HbA1c level is increased by approximately 0.1% with a decrease of 2 g/dL in the hemoglobin level at the same fasting glucose level in people without anemia. Therefore, for HbA1c to be reliable, the patient should not be anemic.

CONDITIONS CAUSING FALSE HIGH/LOW HbA1c LEVELS

- Conditions causing inappropriately low HbA1c are hemoglobinopathies and hemolytic disease, pregnancy, blood transfusion, hypertriglyceridemia, acute blood loss, drugs and chronic liver disease
- Conditions causing inappropriately high HbA1c—iron deficiency, vitamin B12 deficiency, uremia, alcoholism and hyperbilirubinemia
- Variable effect on HbA1c—fetal hemoglobin and methemoglobin

DRUGS CAUSING INAPPROPRIATELY LOW OR HIGH HbA1c

Falsely low levels of HbA1c:
- Due to increased erythrocyte destruction—dapsone, ribavirin and trimethoprim-sulfamethoxazole, etc.
- Due to altered hemoglobin—hydroxyurea
- Due to altered glycation—vitamin A, vitamin C and aspirin in low doses

Falsely high levels of HbA1c: Caused due to interference with assays opiates, aspirin in high doses.

Methods of measuring HbA1c:
- Iron exchange chromatography: High-performance liquid chromatography (HPLC)
- Electrophoretic methods
- Immunoturbidimetric methods
- Chemical methods
- Mass spectroscopy

The mean plasma glucose (MPG) can be calculated by HbA1c by following formula:

$$MPG = (33.3 \times HbA1c\%) - 86$$

Current uses of HbA1c:
- Diagnosis of diabetes
- Monitor long-term glycemic control
- Adjustment or titration of dosage for better control of blood glucose
- Predict the risk of development of complications

Glycosylated hemoglobin correlates directly with retinopathy. The glycemic levels at which prevalence of retinopathy begins to rise above the rest of the population is around 6.5%.

Importance in Dermatology

- Multiple studies have shown a linear relationship between HbA1c and dyslipidemia.
- HbA1c values can be of diagnostic and prognostic significance in patients with dyslipidemic and diabetic skin complications.

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- Elaborates usefulness and limitation of all diagnostic procedures used in dermatology and internal medicine
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Sanjeev Gupta MD DNB is working as Professor and Head, Department of Dermatology, MM Institute of Medical Sciences and Research, Mullana, Ambala, India. He is a young, dynamic, academically oriented teacher with an experience of 22 years and utmost commitment to patient care. He is a member of almost all national and international academic societies. He has presented many papers and chaired sessions at many National and International conferences. He has around 150 publications to his credit in most reputed national and international indexed journals. He has contributed 17 book chapters in different National and International Dermatology books. He has invented many dermatosurgical techniques and instruments to simplify the procedures and reduce the cost. Twenty-six of such inventions have been published in the most prestigious journal of Dermatology—Journal of the American Academy of Dermatology USA. He was awarded with "Making a Difference" award by the American Academy of Dermatology, USA. He is the first Indian to be honored with this prestigious award. He was the Scientific Secretary for the Annual National Conference of Dermatologists, Venereologist, Leprologists (DERMACON) Gurgaon 2011. He has made tremendous contributions to his professional association [Indian Association of Dermatologists, Venereologists and Leprologists (IADVL)] as Executive Committee Member at the state level as Treasurer, Secretary, Vice President, and President, and also at the national level as Joint Secretary and Vice President. Based on his contributions to the field of Dermatology, the IADVL has honored him with LN Sinha Award in 2013, and ACSI Innovation Award 2021 by the Association of Cutaneous Surgeons of India (ACSI). He is the Associate Editor of the Textbook of Innovations in Dermatosurgery by IADVL 2022.



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