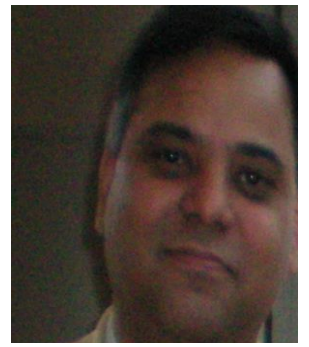


Short CV



GENERAL

- i. Syed Habib Bukhari (Commonwealth & Fulbright Fellow)
- ii. Professor of Microbiology & Immunology/Chairman Department of Biosciences
- iii. University: COMSATS University, Islamabad

Web Link- Google Scholar: <https://scholar.google.com.pk/citations?user=DAVq1VsAAAAJ&hl=en/http://ww3.comsats.edu.pk/faculty/FacultyDetails.aspx?Uid=793>

ORCID: [habib bokhari \(0000-0002-2171-6062\) \(orcid.org\)](https://orcid.org/0000-0002-2171-6062)

2. Professional Training/Education/Qualifications

Education/Training	Degree/Year/Specialization		
Institution & Location	Degree	Year(s)	Field
Quaid-i-Azam University Islamabad	MSc.	1995	Biochemistry
Quaid-i-Azam University Islamabad	M.Phil.	1997	Biotechnology
University of Glasgow, UK	Ph.D.	2002	Microbiology & Immunology/Infection & Immunity
George Mason University, U.S.A.	Postdoc	2005-2006	Environmental Complexities
London School of Hygiene & Tropical Medicine, UK & Sanger Centre, UK	Postdocs Commonwealth Fellow)	2009- 2010/2013	Microbial Pathogenesis/Glycoengineering Microbial Genomics
Dept. Microbiology, Perelman School of Medicine, UPENN	Postdoc (Fulbright Fellow)	2017-2017	Gene Regulation/Microbiome

Employment

1996-1999	Lecturer, Islamia University Bahawalpur,
2002-2010	Assistant Professor, Department of Biosciences, CU, Islamabad
2010-2013	Associate Professor & HOD, Department of Biosciences, CU, Islamabad
2012-2015	Professor & Chairman, Department of Biosciences, CU, Islamabad
2015-Present	Professor, Department of Biosciences, CU, Islamabad
2018-Mar-2021	Professor & Chairman, Department of Biosciences, CU, Islamabad
2021-Present	Vice Chancellor, Kohsar University Murree (Professor Biosciences Department)

RESEARCH Profile.	General Research Publications or Activity/Research & Out Reach Activity wrt Proposed Project			
	a.	International publication	>130 research papers	
Research supervision.	2006 till to date			
	a.	Supervised	Ph.D.	8 Completed; 4 Under Supervision
			M.Phil./ MS	>70 Completed
			M.Sc. or equivalent	>50
		PhD- International Students	2 (Nigeria & Egypt)	
Research Funded Projects International National	Competed Ongoing Competed Ongoing	British Council, EU H2020 Project) PSF-TUBITAK; Ubiome; ANSO 2 HEC, 1 PSF 1HEC		
Ongoing Research Activity	Diarrheagenic Pathogens, Pertussis, Molecular Pathogenesis; Microbial Genomics, Molecular Diagnostics, Vaccines, MDR pathogens. Therapeutic Bacteriophages,			

	Malnourished gut & associated microbiota, Colorectal cancer & associated microbiota; Novel fluorescent proteins based Educational Tool Kit	
Total Impact Factor publications	>110	H Index: 24 I-10 Index: 53 Citations (Google Scholar): >2150 Impact factor ~400
Previous Relevant Grants	Source Tracking and Surveillance System Of Diarrhea causing Bacterial Pathogens In Pakistan: As PI, In collaboration with London School of Hygiene & Tropical Medicine , Keppel Street, London, WC1E 7HT (British Council: Pak-UK linkage) Campylobacter control in poultry through training for commercial poultry farm workers: As PI, In collaboration with Prof. Brendan Wren, London School of Hygiene & Tropical Medicine (British Council: "STRATEGIC PARTNERSHIP EXTENSION: KNOWLEDGE EXCHANGE": OUTCOME: >10 JOINT RESEARCH IMPACT FACTOR PUBLICATIONS JOINT MEETINGS & DISSEMINATION	
TEACHING PROFILE	Graduate/Undergraduate Courses Taught: Microbial Forensics; Advances in Microbiology; Advanced Topics in Microbiology; Medical Microbiology; Research Techniques; Fundamentals of Genomics & Proteomics; Microbial Pathogenesis; Microbiology & Immunology; Fundamentals of Bioinformatics; Cell Biology; Introduction to Genomics	

AWARDS & HONORS/ACHIEVEMENTS/AFFILIATIONS

1. As Pioneering faculty-to set up and strengthened Department preparing PC-1 documents (2003-2006)- Student strength from first intake of 18 students rose to current strength in Biosciences is ~2000 students (Islamabad (~1800)& Sahiwal: ~200)
2. As Pioneering faculty-Designed curriculum for Bioinformatics and Biosciences undergraduate degree program (CIIT) and started this program at COMSATS in 2003
3. Affiliate Faculty Bioinformatics and Computational Biology College of Science, George Mason University, Manassas, Virginia since 2007
4. USEP-Fulbright-Fellowship Award: @ UPENN-2017-2017 (PENN-MED)
5. Shortlisted as Candidate for the Position of VC, University of Punjab, 2016;219
6. Recipient of Commonwealth Fellowship. 2013
7. Recipient of Commonwealth Scholarship for Ph.D. 1999-2002
8. COMSATS Science Ambassador (Microbiology), COMSATS Science Diplomacy Program
9. British Council: Strategic Partnership Extension: Knowledge Exchange Award 2012
10. British Council: Pak-UK linkage/INSPIRE Award, 2009-2012
11. PCST Productive Scientist 2008, 2012-2017
12. CIIT Productive Scientist 2008-2016
13. Nominated for the Best Teacher Award From CIIT in 2011
14. Higher Education Commission NRPU Grant 2008-2011
15. Higher Education Commission NRPU Grant 2008-2010
16. Pakistan Science Foundation Grant, 2008-2010
17. Higher Education Commission PORC Grant, 2005
18. Obtained foreign fundings as well as 4 National fundings to improve the Lab facilities
19. Selected for Fulbright Scholarship for Ph.D 1998-1999 (did not pursue)

20. Roll of Honor for standing first in B.Sc. in Botany, Zoology, Chemistry group
21. President Talent Scholarships at B.Sc. and M.Sc. levels
22. Infaq Foundation Scholarship (HEC) at M. Phil. Level
23. French Scholarship for Ph.D. 1998-99 (did not pursue)
24. Selected for cultural scholarship for Ph.D. 1998-1999 (did not pursue)
25. Contributed Significantly in Developing first National Bioinformatics Policy Document for HEC in 2004
26. Examiner/Subject Specialist (Biology)-Federal Public Service Commission
27. I have played a pivotal role for the past 16 years in strengthening the Department in different roles; as Incharge, HOD, Chairman and faculty.

MEMBERSHIPS IN ACADEMIC SOCIETIES

1. Member Academic Council, Emerson University Multan
2. Member/Convener Accreditation Inspection Committees (National Computing Education Accreditation Council & Higher Education Commission)
3. Member/Convener Higher Education Commission-Quality Assurance Agency
1. Member, Zoological Society of Pakistan
2. Member, HEC curriculum committee for Bioinformatics
3. Expert Member, HEC Project Reviewer's committee
4. Expert Member, PSF Project Reviewer's committee
5. Member, Society for General Microbiology, UK
6. Member, General Council, University of Glasgow
7. Member, American Nano Society
8. Member, Board of Studies, Department of Microbiology, QAU, Islamabad
9. Member, Board of Studies, Department of Biochemistry, QAU, Islamabad
10. Editor, "Journal of Integrative Computational Biosciences"
11. Editor, journal "Advances in Infectious Diseases"
12. Editor, "Journal of Integrative Computational Biosciences"
13. Editor, journal "Remote Sensing"
14. Editor Current Proteomics
15. Public Health Frontier (PHF)
16. Member International Microbial Forensic Consortium
17. Member Evaluation Team of Science Projects (INTEL) for school/college students

ADMINISTRATIVE PROFILE

1.	AS CHAIRPERSON (2012-2015 & 2018-2021-March)	
	Developing New Programs	Advising HR for Recruiting suitable Faculty
	Developing New Courses for existing Programs	Chairing Board of Studies Meetings
	Member of Board Faculty & Academic Council	Reviewing/Evaluation of Faculty Performance at the end of each term
	Taking steps to enhance Faculty Research output	Looking after two campuses where Departments are functional with more than 100 PhD faculty for all above mentioned activities

	Preparing documents for accreditation of programs & Quality Assurance	Coordination with University administration and Dean's office
2.	AS Head of Department of Biosciences, Islamabad (2008-2008; 2011-2013)	
	Looking after Day to Day affairs of students (Undergraduate + Graduate >1500)	Admission Campaign & Selection
	Faculty Evaluations and Assessments	Managing Timetable and Resources

TEACHING PROFILE

Introduced Problem based learning strategies while teaching various Molecular and Microbiology Courses. In addition taught various courses such as

1.	Graduate Courses Taught	
	Microbial Forensics	Advances in Microbiology
	Research Techniques	Advanced Topics in Microbiology
	Fundamentals of Genomics & Proteomics	Medical Microbiology
	Microbial Pathogenesis	Advances in Biosciences Research
2.	Undergraduate Courses Taught	
	Cell Biology	Fundamentals of Bioinformatics
	Introduction to Genomics	Microbiology & Immunology

RESEARCH PROFILE

	Research Publications	
a.	International Publications	>130
b.	Impact Factor	~400
c.	Total Citations	>2100
d.	H Index	24
e.	I-10 Index	>50
	Research Supervision	
	2006 till to date	
a.	Supervised	
	Ph.D.	8
	M.Phil./ MS	>70
	BS/M.Sc. or equivalent	>60

Research Grants AS PI

	International	
a.	British Council-INSPIRE	Source Tracking & Surveillance of Diarrheagenic Bacterial Pathogens in Pakistan With -Prof. Brendan W. Wren LSHTM, UK
b.	British Council-SPEKE/ Strategic Partnership Extension: Knowledge Exchange	CIIT-Campylobacter Control in Poultry Through Training for Commercial Poultry Farm Workers- With -Prof. Brendan W. Wren LSHTM, UK
c.	EU H2020	Advanced bioinformatics for genome and metagenome analyses with discovery of novel

			biocatalysts from extremophiles: implications for improving industrial bioprocesses- With Italy-UK-Turkey
	d	TUBITAK	Developing Protocols for multiplex PCR based Screening and Computational Models for Virulence Factors Associated with <i>H. pylori</i> and colibactin (genotoxin) producing <i>E. coli</i> – With Acibadem, Istanbul. Turkey
	e	uBiome	Analyzing the Gut Microbiota of Pediatric Patients Showing Stunted Growth under Prevailing Environmental Stress Conditions- With US Company
	f	Eastern Mediterranean Health Genomics & Biotechnology Network (EMGEN)	Molecular detection of all clinically relevant Bordetella spp during one year (2013)- Iranian researcher with Iran Dr. Fereshteh Shahcheraghi
	g	ANSO (Alliance of International Science Organizations)	“Mosquitome of Flying Syringes-Aedes aegypti and Aedes albopictus & their Fitness vis a vis their Competency to Transmit Infection With Changing Climate” with China, Turkey & Thailand
National			
	a	Higher Education Commission (HEC), Pakistan	Strengthening Biotechnology Industry in the Country: Developing an educational tool kit for training undergraduate students as well as for research purposes: Lab to Commercialization
	b	Higher Education Commission (HEC), Pakistan	Development of an integrated system comprising of engineered bacteria based Biosensors for the detection of bioavailable toxic metals from environment
	c	Higher Education Commission (HEC), Pakistan	Development of an integrated whole-cell based biosensors to detect bioavailable organophosphates from environment.
	d	Pakistan Science Foundation (PSF)	Epidemiological investigation of Pertussis infection in Pakistan: With RIVM, Bilthoven, Netherlands
		POCR, HEC	Joint COMSATS Institute of Information Technology-George Mason University Initiative in Bioinformatics” (Completed).
		Ongoing Research Activity	Molecular Pathogenesis; Microbial Genomics and Gene Regulation, Molecular Diagnostics,, MDR pathogens. Bacteriophages, Members of ESKAPE group, Microbiota associated with Colorectal Cancer, Preterm birth and Surveillance and Monitoring toxic environmental pollutants. Nanodiagnostics and Glycoconjugate vaccines

Research Grants AS CO-PI

National	
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a	Higher Education Commission (HEC), Pakistan (2015)	Sequencing and mapping of Mycobacterium tuberculosis from Patients in Pakistan by using next generation sequencing (20-3658)
b	Higher Education Commission (HEC), Pakistan (2015)	Development of Serology Based Diagnostic Tool for the Detection of Foot & Mouth Disease Virus (20-3727)
c	Higher Education Commission (HEC), Pakistan (2015)	Nano Active Packaging for food Biosafety: 3 Bios Strategy for Milk & Meat Industry (20-4260)
d	IPFP, Higher Education Commission	Sampling, Isolation & Characterization of Proteorhodopsin containing bacterial strains from competitive aquatic environments (21-679/SRGP)
	IPFP, Higher Education Commission	Evaluation of NPS & NPY Activities & their Genetic Variations in Obese Pakistani Individuals (21-583/SRGP)
	IPFP, Higher Education Commission	Development of Lateral Flow Dipstick Device for differential diagnosis of Endemic <i>Vibrio cholerae</i> Subclades in Pakistan (21-302/SRGP)
	IPFP, Higher Education Commission	Risk Mapping & Source Tracking of <i>Helicobacter pylori</i> strains (IPFP-2014-1635)

Some Selected Publications: (32 of total >130)

1. **Bokhari H, Shah MA, Asad S, Sania A, Akram M and Wren BW. 2013.** *Escherichia coli* pathotypes in Pakistan from consecutive floods in 2010 and 2011. **Am J Trop Med Hyg**, 88(3):519-525.
2. Syed M Shah, Ankur Mutreja, Nick Thomson, Stephen Baker, Julian Parkhill, Gordon Dougan, **Habib Bokhari** and Brendan W. Wren **2014.** Genomic Epidemiology of *Vibrio cholerae* O1 associated with Floods, Pakistan, 2010. **Emerging Infectious Diseases** 20 (1): 13-20.
3. James W. Harrison , Tran Thi Ngoc Dung , Fariha Siddiqui , Sunee Korbrisate , **Habib Bukhari**, My Phan Vu Tra , Nguyen Van Minh Hoang , Juan Carrique-Mas, Juliet Bryant , James I. Campbell , David J. Studholme , Brendan W. Wren, Stephen Baker, Richard W. Titball, Olivia L. Champion. **2014.** Identification of Possible Virulence Marker from *Campylobacter jejuni* Isolates. **Emerging Infectious Diseases**, 20(6):1026-9.
4. Siddiqui F, Champion O, Akram M, Studholme D, Eqani SAMAS, Wren BW & **Bokhari H.** (2015). Molecular detection identified a type six secretion system in *Campylobacter jejuni* from various sources but not from human cases. *Journal of Applied Microbiology*, 118(5), 1191-1198. doi: 10.1111/jam
5. Fariha Masood Siddiqui, Muhammad Akram, Nighat Noureen, Zobia Noreen, **Habib Bokhari.** 2015. Antibiotic Susceptibility profiling and virulence potential of *Campylobacter jejuni* isolates from different sources in Pakistan. **Asia Pacific Journal of Tropical Medicine.** 8(3):197-202.
6. Fariha Massod Siddiqui, Muhammad Ibrahim, Nighat Noureen, Zobia Noreen, Richard W. Titball, Olivia L. Champion, Brendan W. Wren, David Studholme, **Habib Bokhari.** 2015. Draft Genome Sequence of the Enteropathogenic Bacterium *Campylobacter jejuni* Strain cj255. **Genome Announcement.** (Available online)
7. Noreen Zobia, Abrar Mohammad, Siddiqui Fariha, Rani Faryal, Haroon Hamid, **Bokhari Habib.** 2016. Antibiotic Susceptibility and Molecular Characterization of *Campylobacter jejuni* Strain Isolated from a Child with Guillain Barre Syndrome- First Case Report from Pakistan. **The Indian Journal of Pediatrics.** 83(7), 728.
8. Mahwish Younas, Fariha Siddiqui, Zobia Noreen, Syeda Sadia Bokhari, Oscar G. Gomez-Duarte, Brendan W. Wren, **Habib Bokhari.** 2016. Characterization of enteropathogenic *Escherichia coli* of clinical origin from pediatric population in Pakistan. **Trans. Royal Soc of Trop. Med. Hyg.** 110(7):414-20. doi: 10.1093/trstmh/trw047.
9. Sundus Javed, Farzana Gul, Kashaf Javed, **Habib Bokhari.** 2017. *Helicobacter pullorum*: an emerging zoonotic pathogen. **Frontiers in Microbiology.** . 8: 604; doi:10.3389/fmicb.2017.00604

10. Bostan Nazish; Javed, Sundus; Amen, Nabgha; Eqani, SAMAS; Tahir, Faheem; **Bokhari, Habib**. 2017. Dengue Fever Virus in Pakistan: Effects of seasonal Pattern and Temperature change on Distribution of Vector and Virus. *Reviews in Med. Virology*. 27(1). doi: 10.1002/rmv.1899.
11. **Habib Bokhari**. 2018. Exploitation of microbial forensics and nanotechnology for the monitoring of emerging pathogens. *Critical Reviews in Microbiology*. DOI 10.1080/1040841X.2018.1444013-
12. Noreen, Zobia; Chacko, Jobichen; Abbasi, Rashda; Seetharaman, Jayaraman; Sivaraman, Jayaraman; **Bokhari Habib**. 2018. Structural basis for the pathogenesis of *Campylobacter jejuni* Hcp1, a structural and effector protein of the type six secretion system: *The FEBS Journal*. 285(21):4060-4070
13. Kanwal S, Noreen Z, Aalam V, Akhtar J, Masood F, Javed S, **Bokhari H**. 2019. Variation in antibiotic susceptibility and presence of type VI secretion system in *Campylobacter jejuni* isolates from various sources. *Comparative Immunology, Microbiology & Infectious Diseases*:. 25;66:101345. doi: 10.1016/j.cimid.2019.101345
14. Noreen Z, Siddiqui F, Javed S, Wren BW, **Bokhari H**. 2019. Transmission of multidrug resistant *Campylobacter jejuni* to children from different sources in Pakistan. *Journal of Global Antimicrobial Resistance*. S2213-7165(19)30184-5. doi: 10.1016/j.jgar.2019.07.018
15. Asma Sadiq, Nazish Bostan, **Habib Bokhari**, Jelle Matthijnsens, Kwe Claude Yinda, Saqlain Raza, Tayyab Nawaz. 2019. Molecular characterization of Human group A Rotavirus genotypes circulating in Pakistan during 2015-2016. *Plos One*. 14(7):e0220387. doi: 10.1371/journal.pone.0220387. eCollection
16. Asma Sadiq, Nazish Bostan, **Habib Bokhari**, Kwe Claude Yinda, Jelle Matthijnsens. 2019. Whole genome analysis of selected human group A rotavirus strains revealed evolution of DS-1-like single-and double-gene reassortant rotavirus strains in Pakistan during 2015-2016. *Frontiers in Microbiology*. 10:2641. doi: 10.3389/fmicb.2019.02641.
17. Asma Sadiq, **Habib Bokhari**, Zobia Noreen, Rai Muhammad Asghar and Nazish Bostan. 2019. Magnitude of rotavirus a and campylobacter jejuni infections in children with diarrhea in twin cities of Rawalpindi and Islamabad, Pakistan. *BMC Infectious Diseases*. DOI: 10.1186/s12879-019-4575-1.
18. Zeb S, Shah MA, Yasir M, Awan HM, Prommeenate P, Klanchui A, Wren BW, Thomson N, **Bokhari H**. 2019. Type III secretion system confers enhanced virulence in clinical non-O1/non-O139 *Vibrio cholerae*. *Microbial Pathogenesis*. 135:103645. doi: 10.1016/j.micpath.2019.103645.
19. Zobia Noreen, Fariha Masood Siddiqui, Ghunva Zaman, Nighat Noureen, Annam Hussain, Muhammad Ibrahim, **Habib Bokhari**. 2019. Comparative Genomic Analysis of *Campylobacter jejuni* cj255 Reveals Diverse Genetics, Pathogenicity, Determinants and Variation in T6SS. *Pakistan Veterinary Journal*. 39 (2), 145-150.
20. Javed K, Gul F, Abbasi R, Zaidi RA, Noreen Z, **Bokhari H**, Javed S 2019. Prevalence and role of type VI secretion system in pathogenesis of emerging zoonotic pathogen *Helicobacter pullorum* from retail poultry. *Avian Pathology*. 1-7. doi: 10.1080/03079457.2019.1643450
21. Samia Zeb, Sardar Muhammad Gulfam, **Habib Bokhari**. (2020) Comparative core/pan genome analysis of *Vibrio cholerae* isolates from Pakistan. *Infection, Genetics and Evolution* 82;https://doi.org/10.1016/j.meegid.2020.104316
22. Ahmed Donia, Sammer-ul Hassan, Xunli Zhang, Lamiaa Al-Madboly, Habib Bokhari. COVID-19 Crisis Creates Opportunity towards Global Monitoring & Surveillance" has been published in Pathogens as part of the Special Issue SARS-CoV-2 in the Water Environment. *Pathogens* 2021, 10(3), 256; https://doi.org/10.3390/pathogens10030256
23. Hussain, Z., Abbasi, A.Z., Ahmad, R. **Bokhari H**, Shahzad M, Sultan F, Ali M. 2020. *Vibrio cholerae* dynamics in drinking water; mathematical and statistical analysis. *Appl Nanosci*. https://doi.org/10.1007/s13204-020-01292-3
24. Arbab Saddique , Muhammad Suleman Rana , Muhammad Masroor Alam , Aamer Ikram , Muhammad Usman , Muhammad Salman , Rani Faryal , Umair Massab , **Habib Bokhari**, Muhammad Sufian Mian , Israr Asiya , Safiullah. Emergence of co-infection of **COVID-19 and dengue**: A serious public health threat. *Journal of Infection*. https://doi.org/10.1016/j.jinf.2020.08.009
25. Arbab Saddique, Shahzada Adnan, Habib Bokhari, Asima Azam, Muhammad Suleman Rana, Muhammad Mujeeb Khan, Muhammad Hanif, and Shawana Sharif. 2021. Prevalence and Associated Risk Factor of COVID-19 and impacts of meteorological and social variables on its propagation in Punjab, Pakistan", *Earth Syst Environ*. 1–14.; doi: 10.1007/s41748-021-00218-5
26. Ahmed Donia, Muhammad, Furqan Shahid, Sammerul Hassan, Ramla Shahid, Aftab Ahmad, Aneela Javed, Muhammad Nawaz, Tahir Yaqub, Habib Bokhari. Integration of RT-LAMP and Microfluidic Technology for Detection of SARS-CoV-2 in Wastewater as an Advanced Point-of-care Platform. bioRxiv. DOI: 10.1101/2021.08.18.456880
27. Humaira Amin, Syed Habib Bokhari, Khuram Shahzad. Comparative Transcriptome Analysis of Preterm Placental Tissue with Maternal Diabetes, Obesity and Periodontitis Diseases Using Integrated Bioinformatics Approach. DOI: 10.21203/rs.3.rs-853009/v1

28. Sammer-ul Hassan, Aamira Tariq, Zobia Noreen, Ahmed Donia, Syed Zohaib Javaid Zaidi, **Habib Bokhari**, Xunli Zhang. **2021**. Capillary-driven flow microfluidics: An emerging technique for point-of-care diagnostics.: *Diagnostics.*,10(8), 509;<https://doi.org/10.3390/diagnostics10080509>
29. Sammer-ul Hassan, Ahmed Donia, Usman Sial, Xunli Zhang, **Habib Bokhari**. **2020**. Glycoprotein and Lectin-Based Approaches for Rapid Detection of Pathogens. *Pathogens*; 9(9):694 doi:10.3390/pathogens9090694
30. Rafique S, Idrees M, **Bokhari H**, Bhatti AS. **2019**. Ellipsometric-based novel DNA biosensor for label-free, real time detection of *Bordetella parapertussis*. *Journal of Biological Physics*. 45(3):275-291. doi: 10.1007/s10867-019-09528-2
31. Muhammad Ali Syed, Arshad Saleem Bhatti, Chen-zhong Li, **Habib Ali Bokhari**. **2016**. SPR immunosensor for the detection of *Staphylococcus aureus*. *Proceedings of 2016 International 13th Bhurban conference on Applied sciences & Technology*, **IEEE**. DOI: 10.1109/IBCAST.2016.7429861
32. Ahmad A, Yang W, Chen G, Shafiq M, Javed S, Ali Zaidi SS, Shahid R, Liu C, **Bokhari H**. **2019**. Analysis of gut microbiota of obese individuals with type 2 diabetes and healthy individuals. *PLoS One.*;14(12):e0226372. doi: 10.1371/journal.pone.0226372. eCollection.