Supplementary Figures and legends

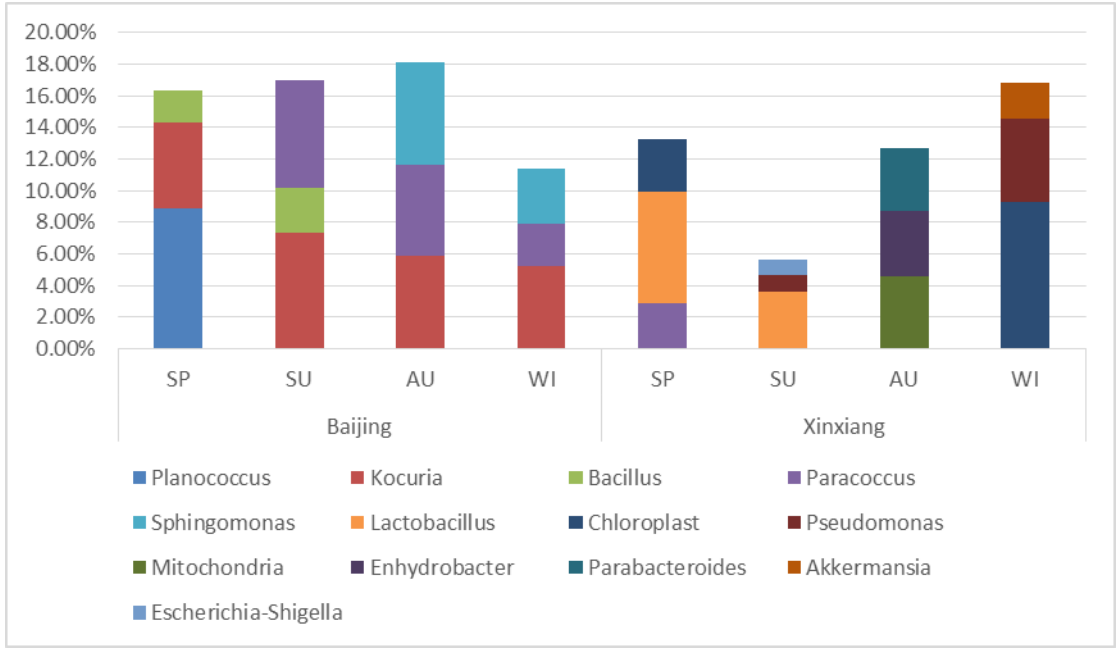

Fig. S1. The relative abundance of $PM_{2.5}$ bacteria during four seasons between samples collected in Xinxiang and that in Beijing at the genus level.

Supplementary tables

Table S1 Bacteria (in the relative abundance) that are significant difference between autumn (AU) and winter (WI) at phylum and genus level

Phylum	Genus	P-value
Cyanobacteria	Phormidium	0.020
Firmicutes	Blautia	0.046
	[Eubacterium]_hallii_group	0.008
	Ruminococcaceae_UCG-010	0.039
	Carnobacterium	0.006
	Erysipelatoclostridium	0.011
	Defluviitaleaceae_UCG-011	0.029
	Solobacterium	0.019
Proteobacteria	Morganella	0.044
	Cupriavidus	0.015
	Azospirillum	0.032
	Commensalibacter	0.037
Tenericutes	Spiroplasma	0.034

Table S2 Bacteria (in the relative abundance) that are significant difference between spring (SP) and autumn (AU) at phylum and genus level

Phylum	Genus	P-value
Acidobacteria	11-24	0.036
	DS-100	0.013
Actinobacteria	Conexibacter	0.027
	Actinomadura	0.020
	Arcanobacterium	0.008
Bacteroidetes	Gillisia	0.004
Chloroflexi	unidentified_TK10	0.029
Cyanobacteria	Phormidium	0.010
Firmicutes	Blautia	0.025
	Ruminococcaceae_UCG-005	0.048
	Trichococcus	0.001
	[Ruminococcus]_torques_group	0.041
	Erysipelothrix	0.008
	Solibacillus	0.005
	Tissierella	0.025
	unidentified_Ruminococcaceae	0.026
	Holdemanella	0.014
	Anaerotruncus	0.029
	Helcococcus	0.025
	Proteocatella	0.033
	Erysipelatoclostridium	0.005
	Brevibacillus	0.041
	Gottschalkia	0.039
	Solobacterium	0.045
	Candidatus_Soleaferrea	0.008
	Lachnospiraceae_FCS020_group	0.008
	[Anaerorhabdus]_furcosa_group	0.020
Gemmatimonadetes	Gemmatimonas	0.015
Planctomycetes	SM1A02	0.034
Proteobacteria	Halomonas	0.021
	Steroidobacter	0.022
	Shewanella	0.011
	Caulobacter	0.022
	Succinivibrio	0.032
	Comamonas	0.009
	Sandaracinobacter	0.011
	Succinivibrionaceae_UCG-001	0.023
Tenericutes	Anaeroplasma	0.038
Verrucomicrobia	Chthoniobacter	0.006
	Opitutus	0.027

Table S3 Bacteria (in the relative abundance) that are significant difference between spring (SP) and summer (SU) at phylum and genus level

Phylum	Genus	P-value
Acidobacteria	DS-100	0.013
Actinobacteria	Brevibacterium	0.036
	Gardnerella	0.025
	Williamsia	0.011
	Thermobifida	0.029
	Aestuariimicrobium	0.038
	Arcanobacterium	0.008
Bacteroidetes	Chitinophaga	0.038
	Arcticibacter	0.023
	Gillisia	0.005
Firmicutes	Lachnospiraceae_NK4A136_group	0.034
	Ruminococcaceae_UCG-005	0.021
	Trichococcus	0.004
	Ruminococcus_2	0.041
	Erysipelothrix	0.018
	Solibacillus	0.027
	Tissierella	0.025
	Aerosphaera	0.011
	Christensenellaceae_R-7_group	0.013
	Facklamia	0.033
	Megasphaera	0.019
	Ruminococcaceae_UCG-008	0.026
	Anaerovibrio	0.007
	Helcococcus	0.033
	[Eubacterium]_eligens_group	0.032
	Proteocatella	0.025
	Ruminococcaceae_UCG-013	0.025
	Weissella	0.004
	Ignavigranum	0.043
	Gallicola	0.029
	Desemzia	0.039
	Mogibacterium	0.026
	Ruminococcaceae_UCG-009	0.035
	Gottschalkia	0.010
	Cellulosilyticum	0.038
	Candidatus_Soleaferrea	0.007
	Lachnospiraceae_FCS020_group	0.015
Fusobacteria	Sneathia	0.035
Planctomycetes	SM1A02	0.034
Proteobacteria	Halomonas	0.021
	Psychrobacter	0.035
	Shewanella	0.016
	Parasutterella	0.000
	Sutterella	0.025
	Succinivibrio	0.030
	Comamonas	0.000
	Erythrobacter	0.021
	Neisseria	0.025
	Marinospirillum	0.010
	Silanimonas	0.038
	Sandaracinobacter	0.017
	Succinivibrionaceae_UCG-001	0.023

Table S4 Bacteria (in the relative abundance) that are significant difference between spring (SP) and winter (WI) at phylum and genus level

Phylum	Genus	P-value
Acidobacteria	unidentified_Subgroup_6	0.036
	DS-100	0.013
Actinobacteria	Bifidobacterium	0.046
	Nocardioides	0.003
	Propionibacterium	0.026
	Collinsella	0.006
	Senegalimassilia	0.049
	Brevibacterium	0.001
	Conexibacter	0.019
	Actinomadura	0.028
	Williamsia	0.020
	Thermobifida	0.029
	Aestuariimicrobium	0.038
	Arcanobacterium	0.008
Bacteroidetes	Prevotella_9	0.032
	Alistipes	0.048
	Flavisolibacter	0.029
	Pedobacter	0.028
	Dyadobacter	0.044
	Gillisia	0.013
Chloroflexi	unidentified_TK10	0.029
Firmicutes	Lactobacillus	0.001
	Lachnospiraceae_NK4A136_group	0.003
	Blautia	0.034
	Faecalibacterium	0.007
	Staphylococcus	0.022
	Ruminococcaceae_UCG-005	0.033
	Ruminococcaceae_UCG-014	0.021
	Trichococcus	0.002
	Megamonas	0.028
	Erysipelothrix	0.019
	Solibacillus	0.002
	Tissierella	0.025
	Aerosphaera	0.011
	Ruminiclostridium_9	0.042
	Coprococcus_2	0.016
	unidentified_Ruminococcaceae	0.045
	[Eubacterium]_hallii_group	0.009
	Christensenellaceae_R-7_group	0.021
	Lachnoclostridium	0.017
	Coprococcus_1	0.024
	Facklamia	0.033
	Lachnospira	0.006
	Ruminococcaceae_NK4A214_group	0.006
	Anaerotruncus	0.035
	Helcococcus	0.033
	Brevibacillus	0.041
	[Ruminococcus]_gnavus_group	0.010
	Ignavigranum	0.043
	Gallicola	0.029
	Defluviitaleaceae_UCG-011	0.029
	Pseudogracilibacillus	0.038
	Candidatus_Soleaferrea	0.007
	Lachnospiraceae_FCS020_group	0.008
	[Anaerorhabdus]_furcosa_group	0.020
Planctomycetes	SM1A02	0.034
Proteobacteria	Sphingomonas	0.017

	Halomonas	0.021
	Shewanella	0.016
	Altererythrobacter	0.026
	Thermomonas	0.048
	Novosphingobium	0.033
	Succinivibrio	0.037
	Morganella	0.045
	Comamonas	0.003
	Defluviicoccus	0.006
	Bilophila	0.016
	Erythrobacter	0.002
	Commensalibacter	0.037
	Marinospirillum	0.010
	Silanimonas	0.038
	Sandaracinobacter	0.017
	Succinivibrionaceae_UCG-001	0.026
Tenericutes	Spiroplasma	0.034
Verrucomicrobia	Chthoniobacter	0.003

Table S5 Bacteria (in the relative abundance) that are significant difference between summer (SU) and autumn (AU) at phylum and genus level

Phylum	Genus	P-value
Actinobacteria	Solirubrobacter	0.027
	Gaiella	0.007
	Mycobacterium	0.044
	Micromonospora	0.033
	Gardnerella	0.025
Bacteroidetes	Chitinophaga	0.037
Cyanobacteria	Phormidium	0.020
Firmicutes	[Ruminococcus]_torques_group	0.034
	unidentified_Ruminococcaceae	0.029
	Christensenellaceae_R-7_group	0.039
	Holdemanella	0.000
	Tumebacillus	0.015
	Ruminococcaceae_UCG-013	0.002
	Solobacterium	0.029
Fusobacteria	Sneathia	0.035
Gemmatimonadetes	Gemmatimonas	0.023
Proteobacteria	H16	0.042
	Parasutterella	0.008
	Phenylobacterium	0.042
	Pseudolabrys	0.040

Table S6 Bacteria (in the relative abundance) that are significant difference between summer (SU) and winter (WI) at phylum and genus level

Phylum	Genus	P-value
Actinobacteria	Gaiella	0.009
	Collinsella	0.035
	Micromonospora	0.031
	Senegalimassilia	0.049
	Gardnerella	0.021
Bacteroidetes	Chitinophaga	0.037
Firmicutes	Enterococcus	0.015
	Megamonas	0.028
	Aerosphaera	0.036
	Ruminiclostridium_9	0.040
	Coprococcus_2	0.022
	unidentified_Ruminococcaceae	0.044
	[Eubacterium]_hallii_group	0.049
	Lachnoclostridium	0.026
	Coprococcus_1	0.015
	Lachnospira	0.012
	Oscillibacter	0.044
	Tumebacillus	0.011
	Ruminococcaceae_UCG-013	0.006
	Weissella	0.007
	Defluviitaleaceae_UCG-011	0.029
Fusobacteria	Sneathia	0.035
Proteobacteria	H16	0.040
	Phenylobacterium	0.048
	Pseudolabrys	0.043
	Aquicella	0.046
	Bilophila	0.017
	Commensalibacter	0.037
Tenericutes	Spiroplasma	0.034

Table S7 Meteorological factors and pollutants concentration for each $PM_{2.5}$ samples

Season	Sample	Sampling Date	Meteorological Factors		Pollutants Concentration (μg/m³)					
			Relative Humidity (%)	Temperature (℃)	$PM_{2.5}$	PM_{10}	O_3	NO_2	SO_2	CO
Spring	SP1	2017/4/7	68.00	17.00	105	153	72	64	35	1.90
	SP2	2017/4/12	50.50	17.50	84	183	69	68	36	2.03
	SP3	2017/4/13	55.50	18.00	62	132	56	53	27	1.63
Summer	SU1	2017/9/12	33.00	26.00	44	85	167	47	13	0.80
	SU2	2017/9/14	65.50	32.50	38	65	156	49	17	0.66
	SU3	2017/9/17	58.50	27.00	68	117	205	67	34	1.52
Autumn	AU1	2017/11/8	59.50	15.50	133	233	36	96	35	1.57
	AU2	2017/11/14	47.00	8.00	44	112	26	64	31	1.20
	AU3	2017/11/19	64.50	7.00	64	121	7	64	22	1.05
Winter	WI1	2018/1/24	38.50	-4.00	55	85	47	45	17	1.07
	WI2	2018/1/10	33.50	0.00	23	50	51	34	12	0.77
	WI3	2018/1/15	60.50	3.60	182	249	22	101	56	2.84