

## Index

### a

- accuracy, qualitative model 463
- adsorption chromatography 12
- affinity chromatography 13, 42, 313
- agricultural animal and derived food
  - elemental speciation and state analysis 135–137
  - inductively coupled plasma–mass spectrometry (ICP-MS) 132–133
  - inductively coupled plasma optical emission spectroscopy (ICP/OES) 134
  - instrumental neutron activation analysis (INAA) 135
  - laser ablation inductively coupled plasma mass spectrometry (LA-ICP-MS) 137–138
  - laser-induced breakdown spectroscopy (LIBS) 139
  - ultrasonic slurry sampling electrothermal vaporization inductively coupled plasma mass spectrometry (USS-ETV-ICP-MS) 138
  - X-ray fluorescence (XRF) technique 134–135
- agrimetallome 51
- agrometallomics 2
  - agricultural animal and derived food 131–139
  - agricultural plants and fungi and derived food 127–131
- atomic spectrometry
  - low temperature plasma atomic spectrometry 119–120
  - optical emission spectrometry 119
- chromatographic hyphenation for atomic spectrometry/mass spectrometry 121–122
- concept 51–52
- electrothermal vaporization hyphenation technique 125
- energy spectroscopy based on X-ray 123–124
- instrumental neutron activation analysis (INAA) 120
- laser ablation inductively coupled plasma mass spectrometry (LA-ICP-MS) 124–125
- laser-induced breakdown spectroscopy (LIBS) 125–126
- logical diagram of agricultural system 49–50
- mass spectrometry
  - glow discharge mass spectrometry (GD-MS) 118
  - inductively coupled plasma mass spectrometry (ICP-MS) 52–117
  - laser ionization mass spectrometry (LIMS) 118
  - secondary ion mass spectrometry (SIMS) 118–119
  - thermal ionization mass spectrometry (TIMS) 118
- single cell and micro particle analysis 126–127
- soil, water, fertilizer 139–143
- summarization and comparison of analytical methodologies 52–53
- synchrotron radiation (SR) analysis 122–123
- X-ray fluorescence spectrometry (XRF) 120–121
- alpha-fetoprotein (AFP) 165
- Alzheimer's disease (AD)
  - application of metallomics in the predication and diagnosis of 321–322
  - dysregulation of metal homeostasis in 315–320
  - metal-associated dysfunction in 320–321
  - metal ionophores as AD therapeutics 322

- amyotrophic lateral sclerosis (ALS) 209  
 dysregulation of metal homeostasis in 333–334  
 metal-associated dysfunction in 334–336  
 anode dissolution voltammetry 467  
 anodic stripping method 198  
 archaeometallomics 2  
 atomic absorption spectroscopy (AAS) 267  
 in studying the aging mechanism of painting cultural relics 276–278  
 in studying the authenticity identification of Painting cultural relics 278–279  
 in studying the color mechanism and firing technology of ancient ceramics 271–272  
 in studying the corrosion of metal cultural relics 275  
 in studying the manufacturing technology of metal cultural relics 274–275  
 in studying the origin and dating of ancient ceramics 269–271  
 in studying the origin of metal cultural relics 273–274  
 laser ablation inductively coupled plasma mass spectrometry (LA-ICP-MS) 267  
 laser-induced breakdown spectroscopy (LIBS) 267  
 neutron activation analysis (NAA) 266  
 neutron diffraction 268–269  
 X-ray absorption fine structure spectroscopy (XAFS) 267–268  
 X-ray diffraction (XRD) 268  
 X-ray fluorescence analysis (XRF) 266–267  
 arsenic and lung cancer 291–292  
 artificial crystal materials 257–258  
 As and related diseases 222  
 asymmetric flow-field flow fractionation (AF4) 13, 17  
 atomic absorption spectrophotometer/  
 spectroscopy (AAS) 120–122, 125, 127, 130, 132, 196, 198, 200, 201, 266, 267, 350, 351, 353, 384  
 atomic emission spectrometry 125, 131, 197, 200, 250–251  
 atomic fluorescence spectrometry 120, 135, 197, 250  
 atomic spectrophotometry 196  
 atomic spectroscopy detection technology 196–197, 200–201  
 autism spectrum disorders (ASD) 312, 336–338, 368
- b**  
 beneficial rebalancing hypothesis for hormesis effect 370–371  
 bias 205, 206, 430, 431, 462  
 bimetallic/polymetallic doping 239, 241  
 bio-elementomics  
 biological fractionation 366–367  
 concept 363  
 development history of 363–364  
 diversity of 366  
 Hormesis beneficial rebalancing hypothesis 374  
 interactions with proteins, genes, and small molecules 373  
 limitations of 371–373  
 multi-element analysis of immortalized lymphocytes 374  
 omes 367  
 orderliness of 366  
 organizational selectivity of 365  
 rare earth elementome 367–371  
 research scope 364  
 review of 364  
 single-cell analysis 374  
 speciation analysis of elements 373  
 specific correlation of 365  
 biological fractionation 366–367  
 biometals 285–287, 377–378, 381–387  
 research on 377–378  
 biomolecular quantification at single cell level 417–418  
 bonded phase chromatography 12–13  
 breast cancer 162, 214, 351–352, 417
- c**  
 cadmium (Cd), epigenetic effects of 292–294  
 calcium-based-magnetic biochar (Ca-MBC) 141  
 Canadian Health Measures Survey (CHMS) 205  
 cancer  
 clinimetallomics 213–214  
 diagnostic methods 349  
 capillary electrophoresis (CE) 13, 40, 122, 128, 141, 200, 201, 313, 385  
 carbon-containing gaseous species (CCGS) 171  
 carbon containing particles (CCP) 171  
 Carboplatin 226, 355, 417  
 cardiovascular disease 217–219, 223, 293, 464, 465  
 case-control medimetallomics 205  
 Cd and related diseases 222–223  
 CdSe@ZnS core/shell QDs 19  
 cell heterogeneity 391, 417, 435  
 certified reference material (CRM) 125, 153, 159, 168, 246, 434  
 ceruloplasmin 331, 332, 337  
 cervical cancer 351, 354

- chemotoxicity 294–296
- chromatography 12  
 adsorption 12  
 affinity 13, 42, 313  
 hyphenation for atomic spectrometry/  
 mass spectrometry 121–122
- chronic kidney disease (CKD) 216, 217
- circular dichroism (CD) spectroscopy 16, 17,  
 221
- cisplatin 225, 226, 355, 357, 380, 416
- clinical element morphology and valence  
 analysis technology 199–203
- clinimetalloomics 195  
 atomic spectroscopy detection technology  
 196–197  
 cancer 213–214  
 cardiovascular disease 217–218  
 combined toxicity of multiple heavy metal  
 mixtures 223–224  
 electrochemical analysis 198  
 genetic diseases associated with metalloomics  
 224  
 ischemic heart disease 221  
 kidney disease 216–217  
 liver diseases 215–216  
 mass detection technology 197–198  
 metabolic diseases 211–212  
 neurodegenerative diseases 209–211  
 obesity 214–215  
 toxic element related diseases 221–222
- Clioquinol 322–323
- cobalt nanoparticle (CoNP) 14, 18
- colorectal cancer 214, 351, 353, 355
- comparative nanometalloomics 11, 12, 20–21
- confusion matrix 462–463
- convolution operation 452, 459, 460
- copper, Parkinson's disease (PD) 330–331
- Cr and related diseases 223
- cross-validation 456, 462, 465
- Cu specific chelators 323
- cytometry time of flight (CyTOF) 36, 37, 432
- d**
- data dimensionality reduction  
 independent component analysis (ICA)  
 453–454  
 local preserving projection (LPP) 454  
 multidimensional scaling (MDS) 454  
 principal component analysis (PCA) 453  
 T-Stochastic Neighbor Embedding (T-SNE)  
 454
- data mining methods in metalloomics  
 data dimensionality reduction 452–453  
 data preprocessing 450  
 model evaluation 461–463  
 predictive model building method 457–461  
 sample set division 455–457
- data preprocessing  
 convolution operation 452  
 Fourier transform 451  
 normalization 450–451  
 smoothing process 450  
 wavelet transform 451–452
- DBiT-seq 441
- Decision Tree 458, 465
- deep learning (DL) 351, 459–461, 465–469
- deferiprone (DFP) 322, 333
- deferoxamine (DFO) 322, 333
- desorption electrospray ionization (DESI)  
 185, 186
- determination coefficient 461
- dielectrophoresis 402
- direct current plasma (DCP) 251
- droplet based single cell separation 402
- droplet encapsulation based single cell  
 separation 403–406
- droplet-chip-TRA-ICP-MS single cell analysis  
 system 415
- dynamic light scattering (DLS) 13, 14
- dynamic reaction cell (DRC) system 171, 251,  
 252
- dyslipidemia 219–221
- e**
- electrochemical analysis 196, 198, 200
- electron-probe micro-analysis (EPMA) 247,  
 253
- electron spectroscopy for chemical analysis  
 (ESCA) 123, 129, 142
- electrophoresis 12, 13  
 capillary 13  
 gel 13
- electrospray ionization mass spectrometry  
 (ESI-MS) 40–42, 128, 135–137, 154,  
 163, 164, 186, 200, 202, 203
- electrothermal atomic absorption spectrometry  
 (ETAAS) 196, 197
- electrothermal vaporization (ETV) 119, 120,  
 125, 130, 138–140, 142  
 hyphenation technique 125
- elemental homeostasis 12, 20, 349, 463
- elemental speciation and state analysis  
 121–124, 135–137
- element coded affinity tags (ECAT) method  
 163
- endogenous elements in single cells 409
- energy dispersive spectrometer (EDS) 15, 17
- energy dispersive X-ray fluorescence (EDXRF)  
 39, 121, 269, 271
- energy spectroscopy based on X-ray 123–124
- enhanced green fluorescent protein (EGFP)  
 417

- environmental protection policy 194  
 environmentalomics 2, 194  
 environment-independent biomarkers 372  
 environmetallome 34–35, 51  
   defined 34–35  
 environmetallomics  
   concept of 33–34  
   environmental science and ecotoxicological science 43–44  
   metal distribution and mapping for 37–39  
   metalloprotein analysis 41–43  
   metal speciation 39–41  
   quantitative analysis 35–37  
   requirements for 34–35  
   scope of 34, 35  
 enzyme-linked immunosorbent assay (ELISA) 164, 467  
 esophageal cancer 214, 351, 353, 355, 357  
 ex vivo culture 381  
 exogenous metal exposure to single cells 409–414  
 external calibration 125, 159, 166, 167, 171, 174–182, 185, 257, 441
- f**  
 $\alpha$ -fetoprotein 434  
 field-flow fractionation (FFF) 12, 13, 40  
 flame atomic absorption spectroscopy (FAAS) 119, 140, 196, 197, 250, 449  
 Fourier transform 278, 451, 452
- g**  
 gallbladder cancer (GBC) 214  
 gas exchange device (GED) 171  
 gastric cancer 214, 351–353, 355  
 Gauss filtering 450  
 GD mass spectrometry (GD-MS) 118, 140, 253–255  
 GD optical emission spectroscopy (GD-OES) 253–256  
 gel electrophoresis (GE) 13, 40, 42, 135, 155, 184, 200, 313, 380, 385, 430  
 genetic diseases associated with metallomics 224  
 glow discharge mass spectrometry (GD-MS) 118, 140, 253–255  
 Gold Immune Colloidal Technique (GICT) 467  
 gold nanoparticles (AuNPs) 13, 38, 165, 166  
 graphite furnace atomic absorption spectrophotometer (GF-AAS) 198
- h**  
 hepatocellular carcinoma (HCC) 353  
 Hg and related diseases 222  
 high energy resolution fluorescence detected (HERFD) XAS 16, 17  
 high-performance liquid chromatography  
   isotope dilution inductively coupled plasma mass spectrometry (HPLC-ID-ICP-MS) 168  
 high-resolution double-focusing sector-field ICP-MS (HR-ICP-SF-MS) 252  
 high-temperature furnace atomic absorption spectrometry 196  
 Hormesis beneficial rebalancing hypothesis 374  
 Hormesis effect of REEs 369–371  
 Huntington's disease (HD) 209, 311  
 hydrodynamic capture based single cell separation 407–408  
 hydrodynamic chromatography (HDC) 12, 13, 17, 40  
 hydrodynamic method-based cells capture 402  
 hypertension 33, 215, 217–219, 293, 368, 369  
 hyperthyroidism 212  
 hypothyroidism 212
- i**  
 imaging mass cytometry (IMC) 442, 443  
 imaging tools for metallomics 383, 386–387  
 immobilized metal affinity chromatography (IMAC) 42, 313  
 immortalized lymphocytes 372–374  
 Independent Component Analysis (ICA) 453–454  
 inductively coupled plasma (ICP), elemental or molecular ions 154  
 inductively coupled plasma atomic emission spectrometry (ICP-AES) 2, 134, 140, 197, 198, 200, 201, 250–251, 257, 273, 364  
 inductive coupled plasma optical emission spectroscopy (ICP-OES) 2, 35, 36, 119, 121, 125–128, 130, 132–134, 139, 140, 200, 350–352  
 inductively coupled plasma mass spectrometry (ICP-MS) 2, 13, 35, 52, 132, 139, 156, 198, 251, 312, 350  
   applications of 409, 410  
   based metallomics  
     single cell analysis 435–441  
     single particle analysis 433–435  
     spatial metallomics 441–442  
   based method 164, 167, 420, 430, 435  
   biomolecular quantification at single cell level 417–418  
   biomolecules analysis 160, 161  
   endogenous elements in single cells 409  
   exogenous metal exposure to single cells 409  
   laser ablation (LA) 399–400, 432–433  
   mass analyzer and detector 400–401

- metal-containing drugs uptake by single cells 416–417
  - metalloproteins 167–168
  - microfluidic platform for single cell analysis 401–408
  - nanoparticles uptake by single cells 415–416
  - other applications 418–419
  - pneumatic nebulization 392, 399
  - solution introduction system and plasma source 430–431
  - time-of-flight mass analyzer 431–432
  - instrumental neutron activation analysis (INAA) 120, 132, 134–135, 139, 199
  - integrated biometal science 1, 50, 311, 364
  - internal standardization
    - calcium 172
    - carbon 170–171
    - sulfur 171–172
  - ion chromatography 12, 121
  - iron, Parkinson's disease (PD) 324, 330
  - ischemic heart disease (IHD) 221
  - isothermal circular strand-displacement polymerization reaction (ICSDPR) 165
  - isotope dilution 163, 166–168, 182–185, 384, 441
  - isotope-dilution analysis (IDA) 155
  - isotope dilution mass spectrometry (IDMS) 125, 138, 155, 159, 166, 182, 184
- k**
- Kennard-Stone sampling 455
  - kidney disease 216–217, 293, 365
  - K-means clustering technique 458–459
- l**
- large research infrastructures (LRIs) 2, 3
  - laser ablation (LA) 124, 155, 399, 432–433, 442
    - system 155
    - LA-ICP-MS 13, 36
  - laser ablation inductively coupled plasma mass spectrometry (LA-ICP MS) 17, 37, 124–125, 137, 142, 155, 158, 165, 243, 246–247, 266, 267, 386
  - laser-induced breakdown spectroscopy (LIBS) 21, 125–126, 131, 138, 139, 142, 243, 247, 255, 266, 267, 270
  - laser ionization mass spectrometry (LIMS) 118, 124, 140
  - Leave-One-Out Cross Validation 457
  - limit of detection (LOD) 36, 37, 118, 119, 123, 126, 129, 142, 160, 164, 165, 173, 179, 418
  - liquid chromatography (LC) 12, 40–42, 119, 121–122, 126–128, 140, 155, 313, 380, 384–385
  - liver cancer 222, 351, 353, 355–357
  - liver diseases 215–216
  - Local Preserving Projection (LPP) 453, 454
  - low temperature plasma atomic spectrometry 119–120
  - lung cancer (LC) 207, 213, 222, 291–292, 351, 352, 355–356
- m**
- machine learning for data mining in metallomics
    - agricultural science 466–467
    - environmental science 467–469
    - medical science 463–466
  - magnetic separation 402–403, 418
    - based single cell capture 408
  - mass analyzer and detector 197, 400–401
  - mass detection technology 197–198
  - mass spectrometry 13
    - based technique 12, 13, 36, 37
    - detection technology 201–203
  - Materials Genome Initiative (MGI) 237–238, 242
  - maternal metallomics 2
    - artificial crystal materials 257–258
    - GD mass spectrometry (GD-MS) 253–254
    - GD optical emission spectroscopy (GD-OES) 253
  - Inductively Coupled Plasma Atomic Emission Spectrometry (ICP-AES) 250–251
  - Inductively Coupled Plasma Mass Spectrometry (ICP-MS) 251–252
  - Laser Ablation Inductively Coupled Plasma Mass Spectrometry (LA-ICP-MS) 246–247
  - laser-induced breakdown spectroscopy (LIBS) 247
  - metallic elements as crosslinkers 242–243
  - metallic elements as dopant 239–241
  - metallic elements as impurities 241–242
  - Raman spectroscopy 254–255
  - secondary ion mass spectrometry (SIMS) 247–248
  - semiconductor materials 256–257
  - Synchrotron Radiation X-ray Fluorescence Spectrometry (SR-XRF) 249
  - techniques providing depth information 255–256
  - TEM/X-EDS 248–249
  - X-ray fluorescence (XRF) spectrometry 252–253
  - X-ray photo electron spectroscopy (XPS) 255

- medimetalloomics 195
    - atomic spectroscopy detection technology 196–197
    - Canadian Health Measures Survey (CHMS) 205
    - clinical element morphology and valence analysis technology 199–203
    - electrochemical analysis 198
    - longitudinal study 208
    - mass detection technology 197–198
    - National Health and Nutrition Examination Survey (NHANES) 204–205
    - neutron activation analysis (NAA) 198–199
    - speciation analysis of trace metal element 208
    - study design 205–206
    - study population/recruitment criteria 206
    - susceptible population 207–208
  - metabolic diseases 211–212
  - metal-associated-proteins, Parkinson's disease (PD) 331
  - metal-binding protein profiles 41
  - metal-containing drugs uptake by single cells 416–417
  - metallic elements
    - as crosslinkers 242–243
    - as dopant 239–241
    - as impurities 241–242
  - metallome, defined 1
  - metallome signature 20
  - metalloomics 1, 193
    - application of metal-containing clinical drugs 225–226
    - different branches of 5
    - exploiting intermetallic interactions 224–225
    - ex vivo culture 381–382
    - goal of 378–379
    - in silico 383
    - in vitro testing 382–383
    - in vivo 381
    - key issues and challenges in 3–4
    - performing 379–380
    - perspectives 226
    - research on biomaterials 377–378
    - tools for 383–387
  - metalloomics in toxicology
    - arsenic and lung cancer 291–292
    - biomaterials 285–287
    - cadmium (Cd) 292–294
    - knowledge gaps, challenges and perspectives 297–298
    - mercury, oxidative stress and cell death 287–291
    - nephrotoxicity of uranium in drinking water 294–297
  - metalloproteins 323
    - absolute quantification of 168
    - analysis 41–43
    - directly protein tagging 162–164
    - elemental labeling 160–161
    - ICP-MS 167–168
    - immunological tagging 164–165
    - LA-ICP-MS 165–166
    - naturally present elements 159–160
  - metal-related nanomaterials 11, 12, 19, 21
  - metrometalloomics 153
    - CRMs 174, 177
    - external calibration 174–176
    - in-house prepared standard 177–180
    - isotope dilution 182–185
    - LA-ICP-MS 168–170
    - metalloproteins in
      - absolute quantification of 168
      - directly protein tagging 162–164
      - ICP-MS 167–168
      - LA-ICP-MS 165–166
      - naturally present elements 159–160
      - elemental labeling 160–161
      - immunological tagging 164–165
      - online addition standard 181–182
      - protein quantification in 154–155
      - quantitative in-situ analysis in 155–159, 185–186
      - internal standardization 168–170
    - micro droplet generator ( $\mu$ DG) 403, 404
    - microfluidic platform for single cell analysis
      - droplet encapsulation based single cell separation 403–407
      - hydrodynamic capture based single cell separation 407–408
      - magnetic separation based single cell capture 408
    - microwave induced plasma (MIP) 251
    - monodisperse droplets 431
    - monomethylarsonous acid (MMA<sup>III</sup>) 41
    - multi-collector (MC)-ICP-MS 16, 52, 252, 434
    - multidimensional scaling (MDS) 454
    - multi-element analysis of immortalized lymphocytes 374
    - multiple-reaction monitoring (MRM) 154
- n**
- nanometalloomics 2
    - application in nanotoxicology 17–21
    - concept of 11–12
    - high-throughput quantification in biological system 14
    - metabolism of nanomaterials in biological system 16–17
    - size characterization of nanomaterials in biological system 12–14
    - spatial distribution of nanomaterials in the biological system 15
  - nanoparticles uptake by single cells 415–416

- nanoparticle tracking analysis (NTA) 13, 17  
 nanosafety evaluation 11, 19–21  
 nano secondary ion MS (NanoSIMS) 15, 119, 386, 387  
 National Health and Nutrition Examination Survey (NHANES) 204–206, 215–217, 220  
 nephrotoxicity of uranium in drinking water 294–297  
 neurodegenerative diseases 209–211, 288, 311, 312, 314–338  
 neutron activation analysis (NAA) technique 14, 17, 35, 40, 198, 199, 266, 274, 449  
 neutron diffraction 266, 268–269, 274, 275  
 non-flammable electrothermal atomic absorption spectrometry (ETAAS) 196, 197  
 non-human mammal model 381  
 normalization 170–173, 450–451
- o**  
 obesity 211, 214–215, 220  
 oncometallomics 349–351  
   application of 351  
   breast cancer 351–352  
   cancer treatment 354–355  
   cervical cancer 354  
   colorectal cancer 353  
   esophageal cancer 353  
   gastric cancer 352–353  
   liver cancer 353  
   lung cancer 352  
   occurrence and development 355–356  
   ovarian cancer 354  
   prostate cancer 351  
   thyroid cancer 354  
 optical capture 403  
 optical emission spectrometry 35, 119, 255  
 optical tweezers 403  
 ovarian cancer 351, 354–355  
 oxaliplatin 226, 355, 357  
 oxidative stress, mercury-binding sites in 288, 290
- p**  
 pancreatic cancer (PaC) 213–214  
 Parkinson disease (PD) 209  
   application of metallodrugs and metalloproteins in the treatment of 333  
   application of metallomics in the predication of 332–333  
   and metallomics 324–333  
 partial least squares discriminant analysis (PLS-DA) 351, 464  
 partial least squares regression 457, 469  
 partition chromatography 12  
 pathometallomics  
   Alzheimer's disease (AD) 314–324  
   in amyotrophic lateral sclerosis (ALS) 333–336  
   autism spectrum disorders (ASD) 336–338  
   concept and scope of 311–312  
   introduction to methodologies for 312–314  
   perspectives of 338  
 Pb and related diseases 222  
 pleural effusion (PE) 213, 352  
 pneumatic nebulization 181, 392, 399, 419  
 polymethylmethacrylate (PMMA) 172  
 positron emission tomography (PET) 15  
 precision, qualitative model 463  
 predictive model building method 457–461  
 principal component analysis (PCA) 351, 453, 454, 457, 464–465, 467  
 prostate cancer (PC) 213, 351, 356, 357  
 proteolysis targeting chimera (PROTAC) 43  
 proton-induced X-ray emission (PIXE) 15, 253, 266, 315, 330
- q**  
 quadrupole ICP-MS 251–252, 432, 434  
 qualitative metallomics, tools for 384–386  
 quantitative metallomics, tools for 383–384
- r**  
 radiometallomics 2  
 Raman spectroscopy 254–255, 270, 278, 465, 466  
 Random Sampling (RS) 205, 455  
 rare earth elementome 367–371  
 rare earth elements (REEs) 3, 121, 127, 133, 172, 239, 274, 367–371, 400, 417  
 red fluorescent protein (mCherry) gene 417  
 relative standard deviation (RSD) 139, 165, 171, 173, 434  
 reversed-phase high-performance liquid chromatography (RP-HPLC) 40, 127  
 rhodamine-based mercury probe 39  
 root mean square error of calibration set (RMSEC) 461  
 root mean square error of cross validation (RMSECV) 462  
 root mean square error of prediction set (RMSEP) of the validation set 462
- s**  
 sample introduction system combined with TRA-ICP-MS for single-cell analysis 393–398  
 Sample Set Partitioning Based on Joint x-y Distances (SPXY) method 455–456  
 scanning electron microscope (SEM) 12, 17, 124, 255  
 scattered light imaging (SLi) technique 38



- secondary ion mass spectrometry (SIMS) 15, 37, 118–119, 243, 247–248
- sensitivity, qualitative model 463
- separation neutron activation analysis 199
- silicon nanoparticles (SiNPs) 20
- single cell analysis 374, 435  
 droplet-chip-TRA-ICP-MS 415  
 and micro particle analysis 126
- single-cell ICP-MS (SC-ICP-MS/scICP-MS) 36, 126, 435, 438, 441
- single particle analysis 430–431, 433–435, 443
- single-photon emission computed tomography (SPECT) 15
- single-pulse response (SPR) 432–433
- size characterization of nanomaterials in biological system 12–14
- size exclusion chromatography (SEC) 12–13, 40, 164, 385
- small-angle neutron scattering (SANS) 14, 18
- smoothing process 450
- solution introduction system and plasma source 430–431
- sound capture 402
- spatial metallomics 4, 429, 430, 441–443
- species-specific isotope dilution mass spectrometry (SS-IDMS) 166
- specificity, qualitative model 463
- SR X-ray fluorescence (SRXRF) 128
- stable isotope probing (SIP) 140
- stable isotope tracing 16
- superoxide dismutase (SOD) 224, 225, 296, 332, 352–353
- support vector machine (SVM) 351, 457–458, 464–466, 468, 469
- synchrotron-based X-ray fluorescence (SXRF) 243, 249, 255, 386, 387
- synchrotron radiation (SR)  
 analysis 122–123  
 techniques 128
- synchrotron radiation based CD (SRCD) 15–17, 37, 129, 135, 249, 449, 464
- synchrotron radiation-based SAXS 14, 18
- synchrotron radiation based XRF (SR-XRF) 15, 313
- synchrotron radiation X-ray absorption spectroscopy (SR-XAS) 37
- synchrotron radiation X-ray fluorescence (SR-XRF) 37, 249, 266, 351, 449  
 analysis 351  
 spectrometry 249
- t**
- TEM/X-EDS 243, 248–249, 386
- tetraazacyclododecane tetraacetic acid (DOTA) 163, 164, 417
- thermal ionization mass spectrometry (TIMS) 118, 140
- three-dimensional (3D) cell culture systems 382
- thyroid cancer 212, 351, 354
- time-of-flight mass analyzer 37, 431–432
- time-of-flight SIMS (TOF-SIMS) 38, 119, 140
- time-resolved analysis (TRA) mode 13, 391
- trace metals/metalloids 377–379, 381, 391
- transmission electron microscope (TEM) 12, 13, 17, 18, 243, 248–249
- transmission electron microscopy coupled with energy-dispersive X-ray spectroscopy (TEM/X-EDS) 243, 386
- triple-quadrupole ICP-MS 252
- T-Stochastic Neighbor Embedding (T-SNE) 453, 454
- two-dimensional (2D) cell culture system 382
- tyramide signal amplification (TSA) 165
- u**
- ultrasonic slurry sampling electrothermal vaporization inductively coupled plasma mass spectrometry (USS-ETV-ICP-MS) 138
- uranium, nephrotoxicity in drinking water 294–297
- v**
- visualized 3D droplet microfluidic device 415
- volatile species generation (VSG) 197, 201
- w**
- wavelet transform 451–452
- weak anion exchange chromatography (WAX) 42
- x**
- X-ray absorption fine structure spectroscopy (XAFS) 266–268, 271, 276
- X-ray absorption spectroscopy (XAS) 16, 17, 37, 41, 123, 128, 141, 249, 314, 443, 449
- X-ray diffraction (XRD) 249, 266, 268
- X-ray fluorescence (XRF) 14  
 analysis 266, 350  
 based technique 37  
 spectrometry 120–121, 252  
 technique 134
- X-ray photo electron spectroscopy (XPS) 123, 124, 129, 142, 254, 255
- z**
- zinc, Parkinson's disease (PD) 331