himac APPLICATION
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Centrifugal separation methods and rotor selection

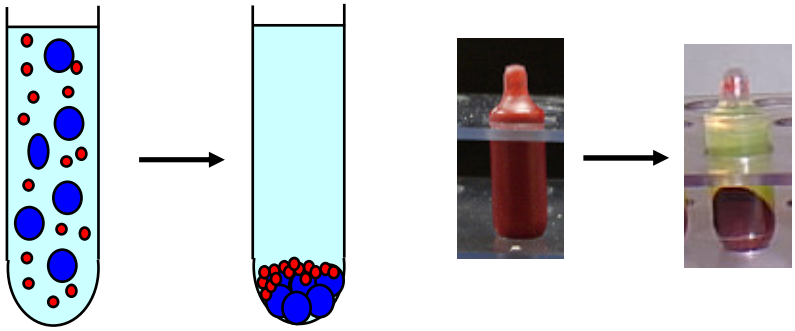
Various rotor types (angle, swing, vertical rotor, etc.)

The centrifugal separation methods employ centrifugal acceleration (up to one million times higher than the gravitational acceleration on earth) resulting from rotation in order to separate particles in a solution, as based on differences in sedimentation. The sedimentation of particles is influenced by both particle size and density, as well as by solution density and viscosity. The three available centrifugal separation methods are:

(1) Differential pelleting
(2) Rate zonal centrifugation
(3) Isopycnic centrifugation

(1) Differential pelleting

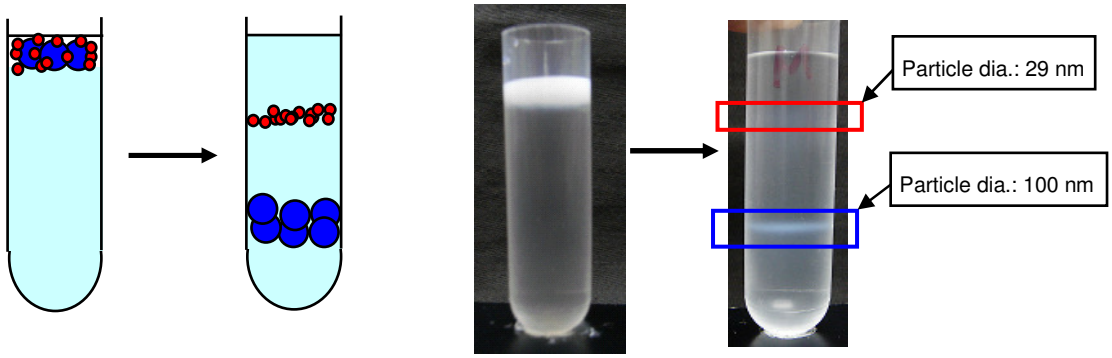
- A sample solution is subjected to centrifugal separation to allow particles to sediment.
- Phased centrifugal separation from low to high rotating speeds enables gradual fractionation from large particles down to mid-size particles and then to small particles.



Separated sample name	himac APPLICATION	Centrifuge	Rotor
Rice dwarf virus	137	Ultracentrifuge	Angle rotor
Ink	134	Ultracentrifuge	Angle rotor
Paint	135	Ultracentrifuge	Angle rotor
India ink	136	Ultracentrifuge	Angle rotor
Metallic nanocolloid	145	Ultracentrifuge	Angle rotor

(2) Rate zonal centrifugation

- This method employs a density gradient solution that is layered with a sample solution having about 5% of the centrifuge tube capacity on the density gradient solution, in order to separate particles based on differences in their sedimentation coefficient, mainly in terms of particle diameter. Particles that vary 20 to 30% in sedimentation coefficient can be separated.



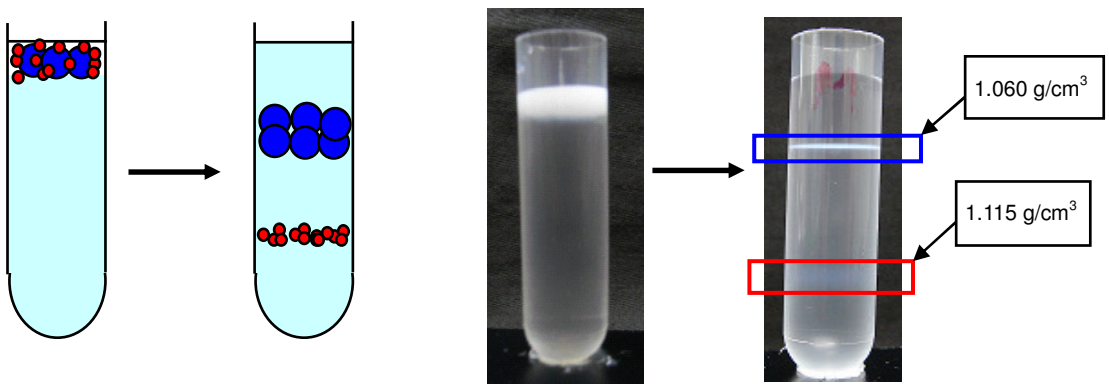
Separated sample name	himac APPLICATION	Centrifuge	Rotor
Ribosome	19	Ultracentrifuge	Swing rotor
Influenza virus	140	Ultracentrifuge	Angle rotor
Single-wall carbon nanotube	129	Ultracentrifuge	Swing rotor

(3) Isopycnic centrifugtion

- This method employs a density gradient solution to separate particles based on density differences. Particles that vary 0.01 to 0.02 g/cm^3 in density can be separated.
- A density gradient solution may be prepared beforehand (preforming) or produced automatically in a centrifugal fashion (self-forming).

① Pre-forming (typical density gradient solution: sucrose)

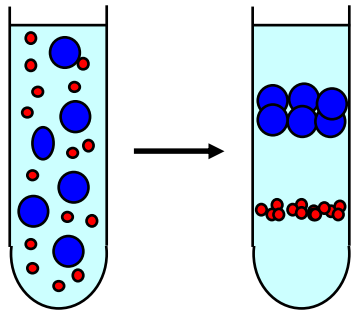
- A sample solution is layered on the density gradient solution which prepared beforehand. The sample volume is usually 10 to 20% of the centrifuge tube capacity.
- The particles can be separated by floating or sediment, because the sample solution may be placed at an intermediate position in the density gradient solution or at the bottom position in the centrifuge tube.

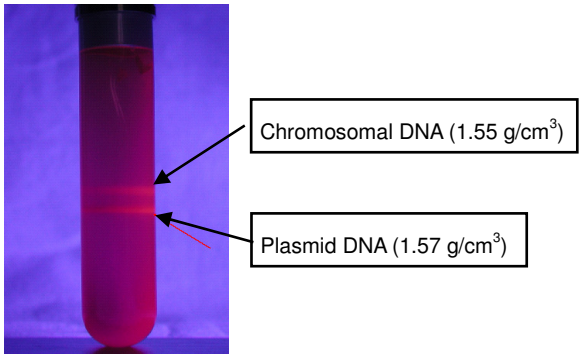


Separated sample name	himac APPLICATION	Centrifuge	Rotor
Single-wall carbon nanotube	129	Ultracentrifuge	Swing rotor
Latex particle	138	Ultracentrifuge	Swing rotor
Latex particle	148	Ultracentrifuge	Continuous rotor
Carbon nanotube	150	Ultracentrifuge	Swing rotor

② Self-forming (typical density gradient solution: cesium chloride)

A sample is suspended in a density gradient solution to prepare a solution of uniform density, which is then subjected to centrifugal acceleration in order to automatically form a density gradient associated with centrifugal separation.

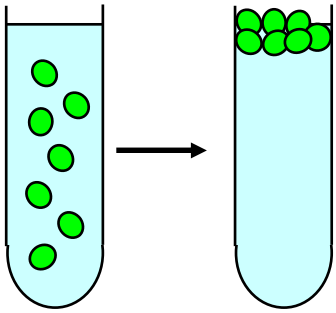


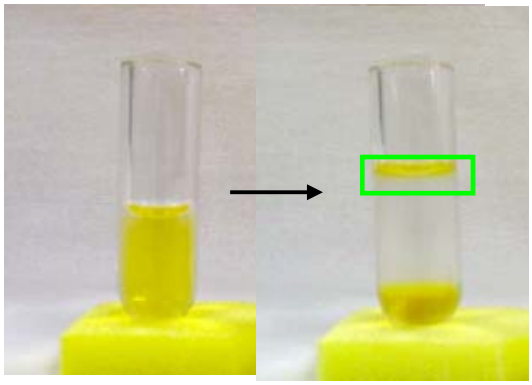


Separated sample name	himac APPLICATION	Centrifuge	Rotor
Plasmid DNA	133	Ultracentrifuge	Angle rotor
Adenovirus	149	Ultracentrifuge	Angle rotor

③ Fractional floatation (typical density solution: sodium bromide, potassium bromide)

Used to fractionate lipoproteins. A solution of higher density than that of the targeted particle is used to float particles on the density gradient solution.





Separated sample name	himac APPLICATION	Centrifuge	Rotor
Lipoprotein (LDL, HDL)	103	Ultracentrifuge	Angle rotor

☆ Features of the centrifugal separation methods

(1) Sample-friendly separation

- Samples can be handled in solution form and separated simply based on differences in physical properties, without the need to apply chemical actions.

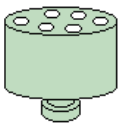
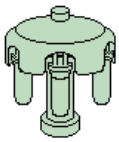
(2) Compatible with a broad range of centrifugal forces

- Centrifugal acceleration: 100 x g to 1,000,000 x g
  (enabling the separation of particles ranging from several dozens of μm to several nm)
- Particles can also be separated based on differences in density, as well as in diameter.

(3) Adaptable to broad sample quantities

- Samples ranging in quantity from microliters to several tens of liters can be separated.

Centrifugal separation methods and rotor selection

Rotor type	Summary and features	Centrifugal separation methods		
		Differential pelleting	Rate zonal centrifugation	Isopycnic centrifugation
Angle rotor 	• Most commonly used type of rotor with its tube holes angled at about 0 to 30°. • Ideally suited for pelleting.	◎	△	○
Neoangle rotor 	• Tube holes are angled at about 10° to combine the features of both the angle and vertical rotors. • Faster separation than that using the angle rotor.	△	△	◎
Vertical rotor 	• Centrifugal separation is conducted with the centrifuge tubes set in a vertical position. • Shorter sedimentation distances enable faster separation. • Suited for density gradient centrifugal separation.	×	○	◎
Swing rotor 	• Centrifuge tubes are kept level during centrifugal separation. • Longer sedimentation distances optimize separation accuracy. • Ideally suited for sucrose density gradient centrifugal separation.	○	◎	◎ (sucrose)

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