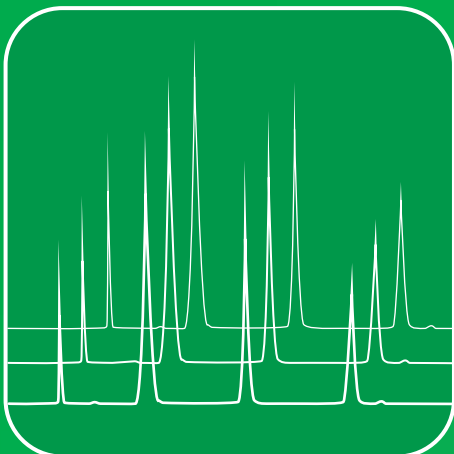
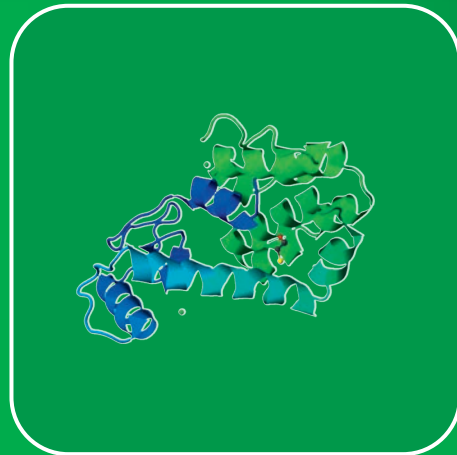


# BioPro IEX Resins



Antibodies  
Oligonucleotides  
Proteins/Peptides

**BioPro IEX:**  
Designed for  
bioseparations



|   |       |
|---|-------|
| Introduction .....                            | 4–9   |
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| Pressure-Flow Characteristics and Scalability |       |
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## Ion exchange chromatography

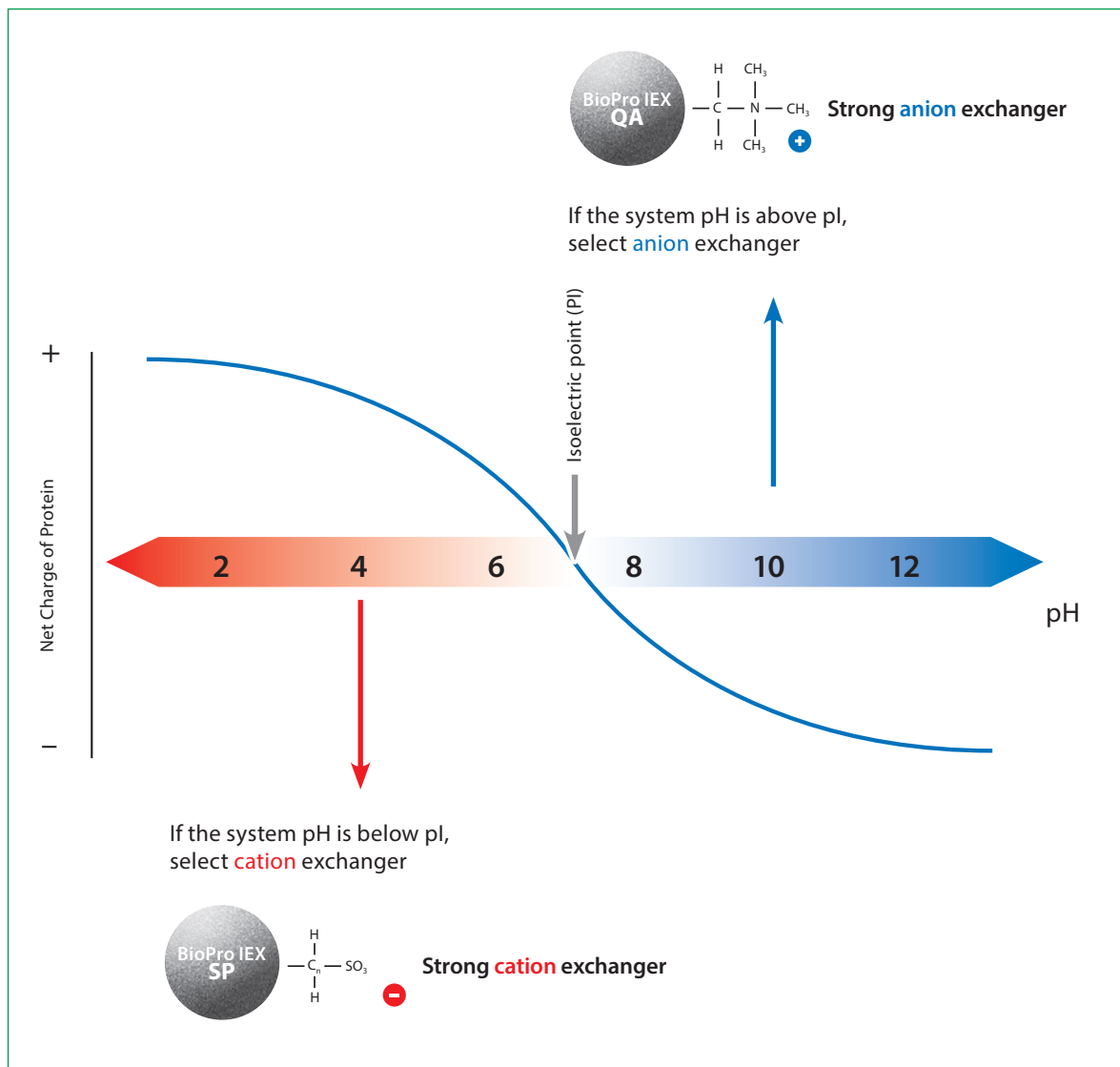
Ion-exchange (IEX) chromatography separates biomolecules according to differences in their overall surface charges. The resin contains charged groups that form reversible interactions with the charged amino acid side chains on a biomolecule's surface. These are then eluted from the column using gradients, either salt concentration or pH.

Salt ions compete with biomolecules for the charged groups on the resins. This means that as the salt concentration in the mobile phase increases, the biomolecules will start to be released from the resin and elute from the column.

The proteins with the lowest net charge will be eluted first, and those with the highest net charge will come off last.

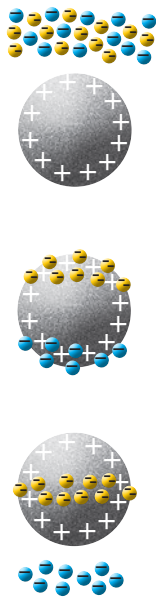
With a pH gradient, the order of elution depends on the isoelectric points (pI) of the biomolecules being separated. The isoelectric point is the pH at which the charged groups on a biomolecule cancel one another out, making the overall charge for that biomolecule zero.

With cationic resins, for example, while the pH of the mobile phase is below the isoelectric point of a biomolecule, its overall charge will be positive and it will bind to the resin. When the pH of the mobile phase rises above the isoelectric point, the overall surface charge of the biomolecule will become negative and it will be released from the resin and will elute from the column.



# Ion exchange chromatography

## Anion exchange



sample application



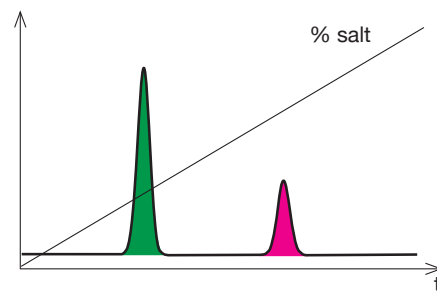
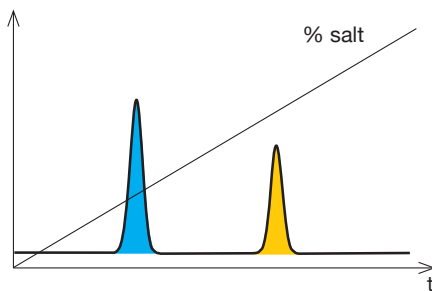
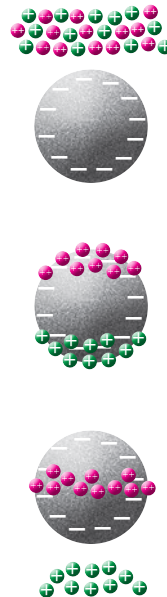
separation



elution



## Cation exchange



## Ion exchange

**Stationary Phase:** Charged surface  
 positive: anion exchange  
 negative: cation exchange

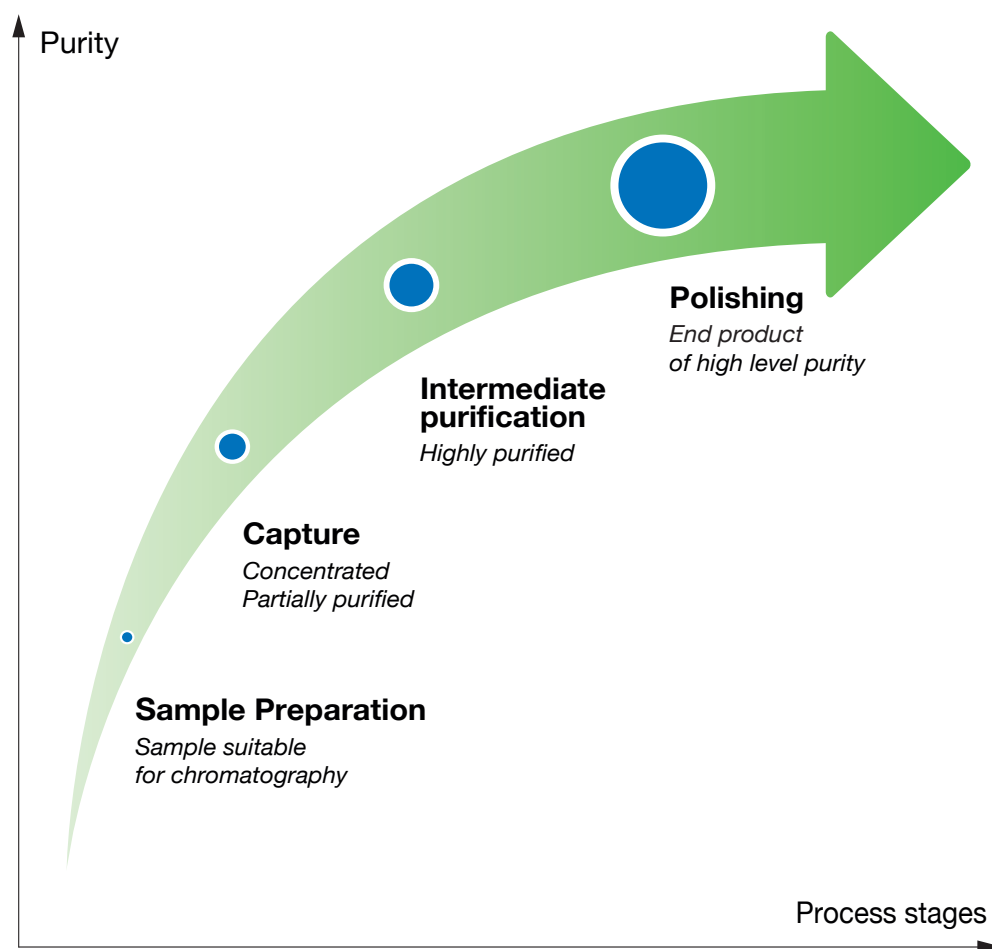
**Mobile Phase:** Buffers for elution with increasing salt concentration.  
 Alternatively, the pH of the mobile phase can be changed for elution.

**Elution order:** First compounds which have the same charge as the surface, last compounds which are oppositely charged to the surface.

## Application of IEX resins in DSP

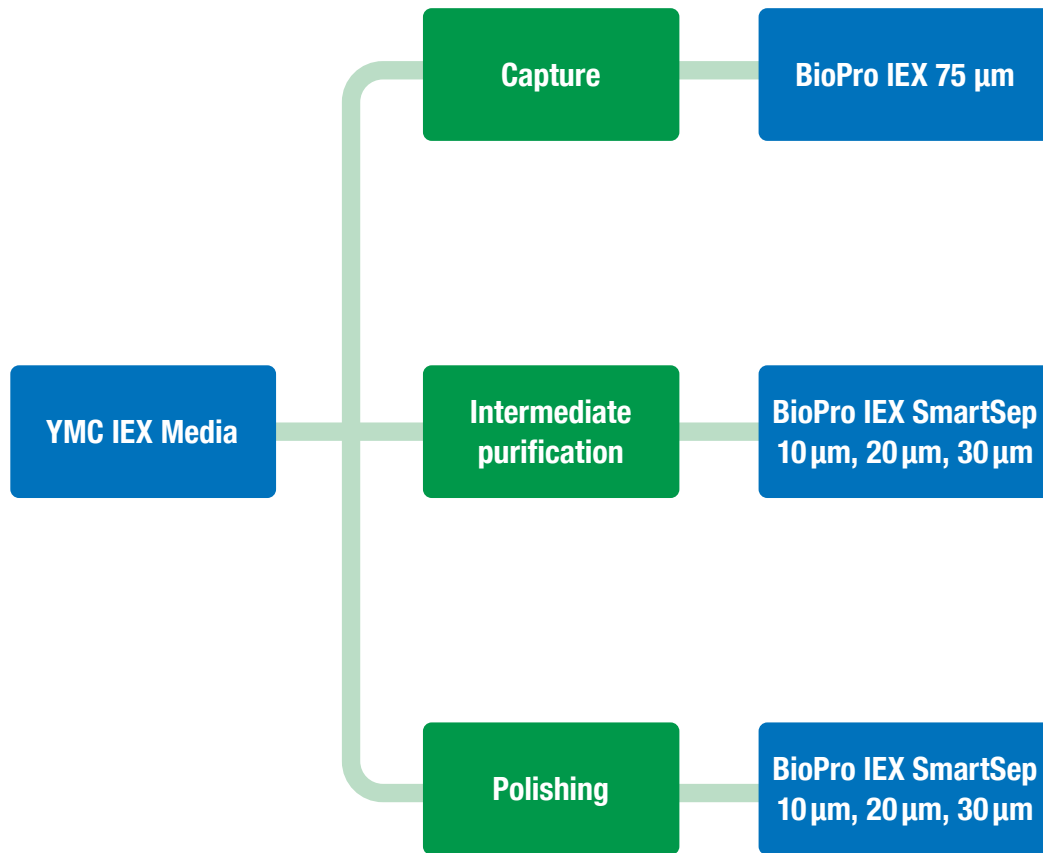
### A purification strategy usually includes three parts:

- initial product capture
- intermediate purification stages
- the final polishing step



The capture step aims at isolating and concentrating the targets. It requires that the media has a high binding capacity even at high flow rates and easy scale-up steps. The intermediate purification is for removing the bulk impurities. The polishing step is used for removing all traces of impu-

rities. The corresponding media should exhibit high resolution and low non-specific adsorption. YMC's IEX resins can be used for all stages during the whole process from the capture to the final polishing.



### YMC resins can be used in:

- Bind/elute-mode
- Flow-through-mode

### YMC resins are used in various applications:

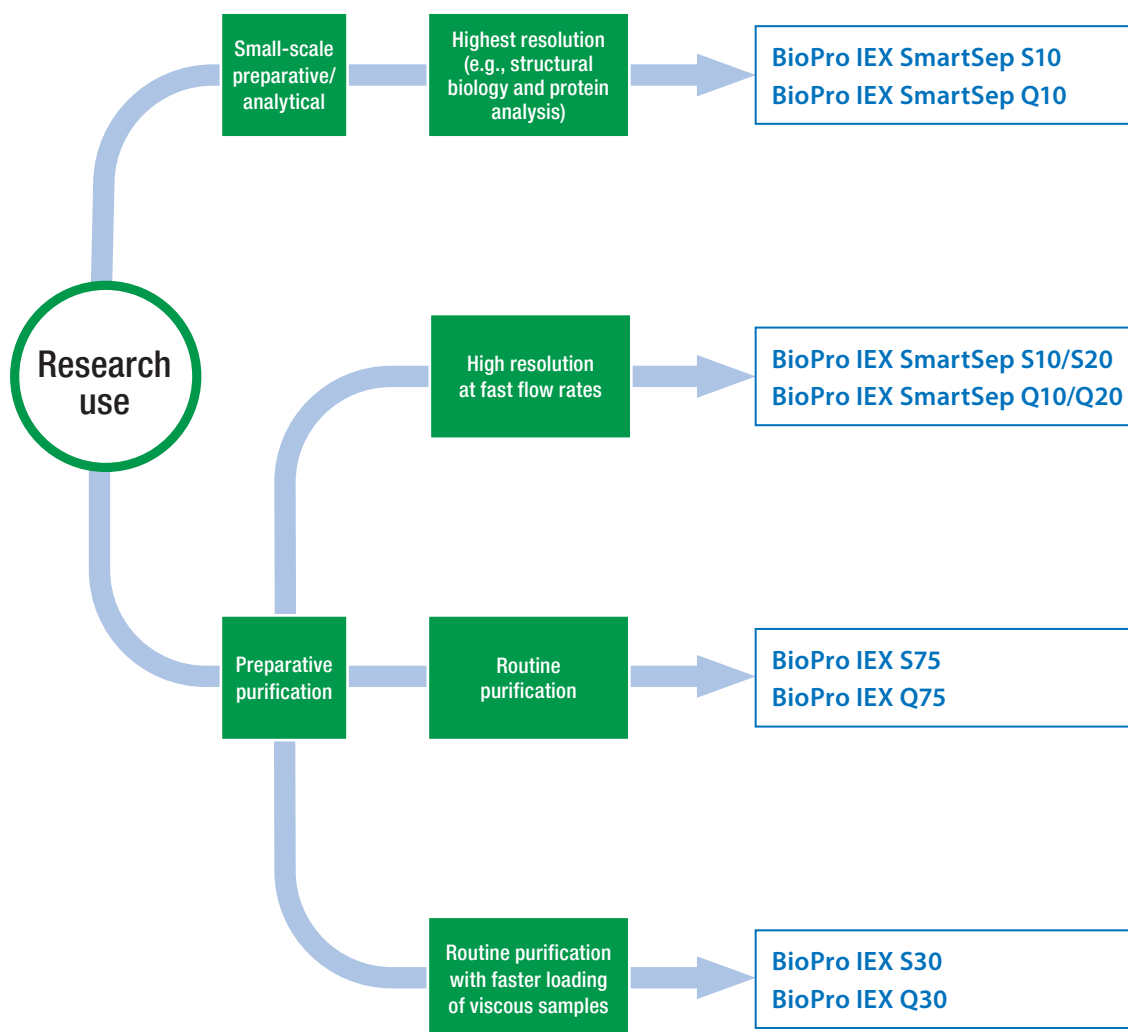
- Antibodies
- Proteins
- Peptides
- Oligonucleotides

### Flow-through-mode for the removal of impurities such as:






- DNA
- Viruses
- Host cell proteins
- Aggregates



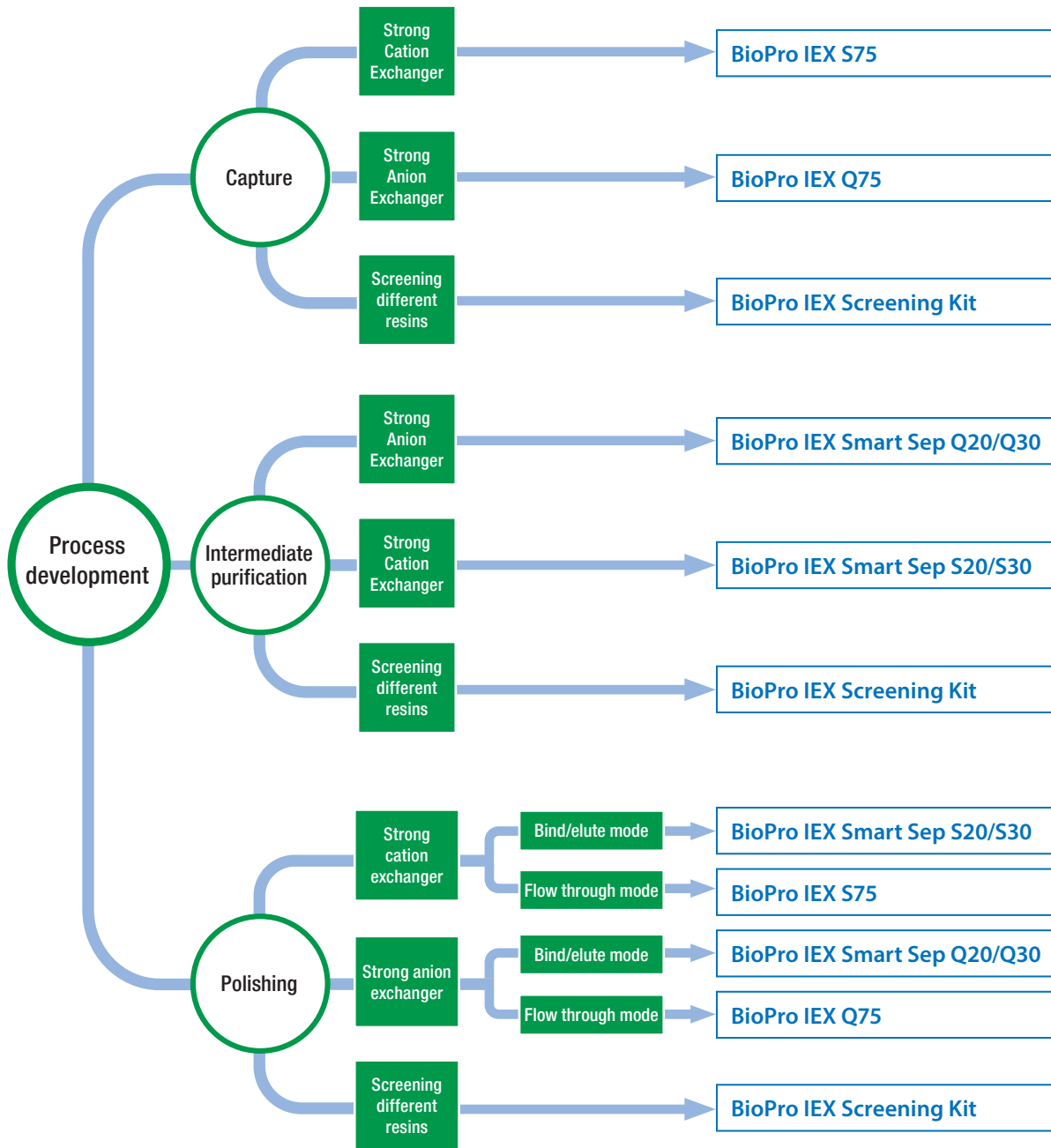
## Guide to IEX media selection



### Screening Guide

|   |   |   |   |   |
|---|---|---|---|---|
|    |  |  |     |                    |
| <p><b>Robocolumn®</b></p> <p>Miniaturized prepacked columns (50 µL, 200 µm and 600 µL)</p> <p>High-throughput process development</p> | <p><b>Bulk pack</b></p> <p>Chromatography resins for self-packing</p>               | <p><b>BioPro Screening Kit</b></p> <p>Prepacked columns (1 mL and 5 mL)</p>         | <p><b>Minichrom™</b></p> <p>Prepacked columns with different dimensions and volumes</p> | <p><b>Packed anal. Columns</b></p> <p>Prepacked PEEK columns<br/>50 x 4.6 mm ID<br/>100 x 4.6 mm ID</p> |





*BioPro IEX Resins  
Screening Kits*

Various types of screening kits available  
**Please contact your YMC representative**

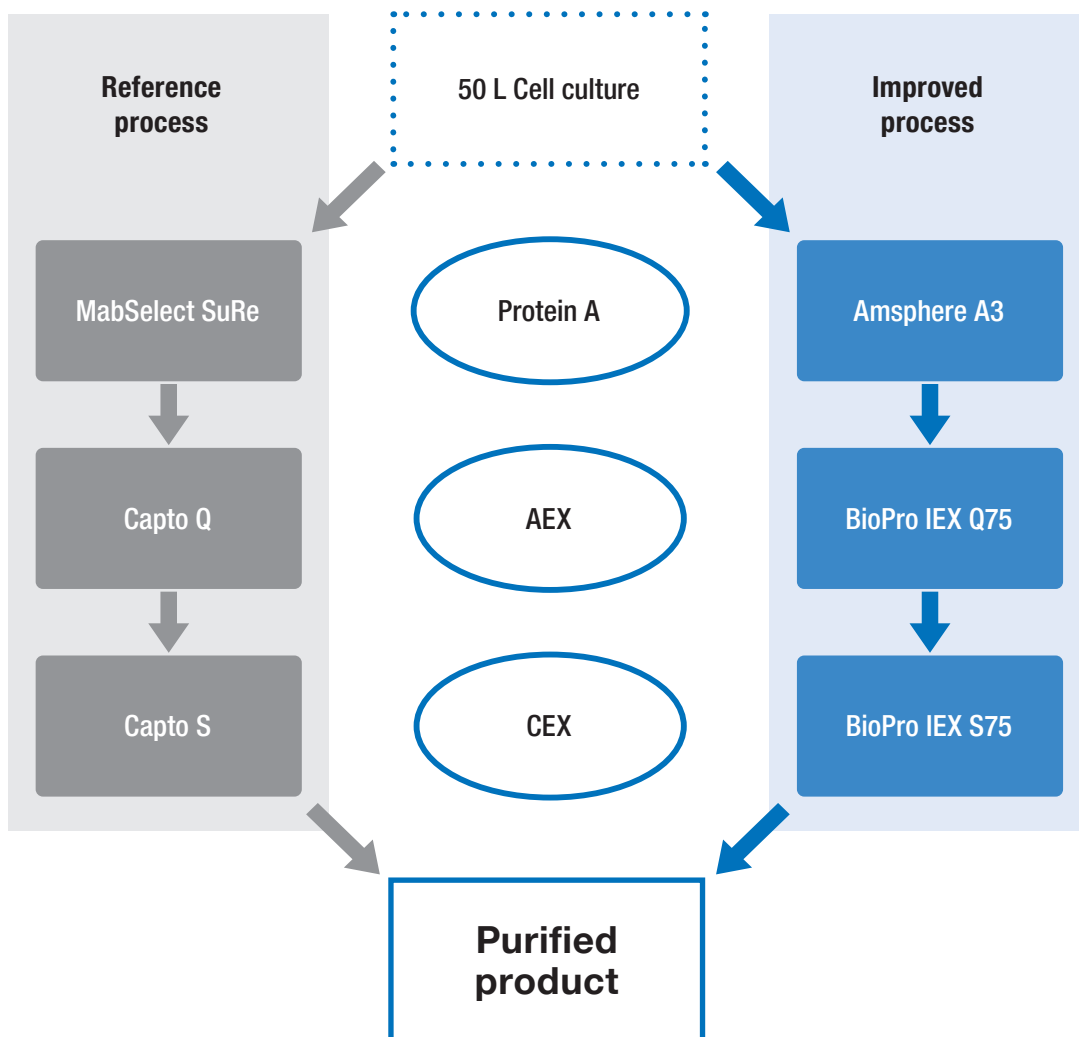


# Purification of monoclonal antibodies

## Purification of monoclonal antibodies

The purification of a mAb from a 50 L CHO cell culture was studied under GMP conditions using BioPro IEX S75 and BioPro IEX Q75 ion exchange resins. The final three-step process succeeded in

producing mAbs with high purity and efficiency. The results were directly compared with those achieved using competitive IEX resins under identical conditions.



### Process flow sheet

This shows the resins used for the three-step reference and the improved process

- Step 1: Affinity chromatography using Amsphere A3 resin from JSR Life Sciences for a first clean-up of the cell culture
- Step 2: Anion exchange chromatography using YMC's BioPro IEX Q75 resin after dilution with 25 mM Tris-HCl buffer
- Step 3: Cation exchange chromatography using YMC's BioPro IEX S75 as the final polishing step

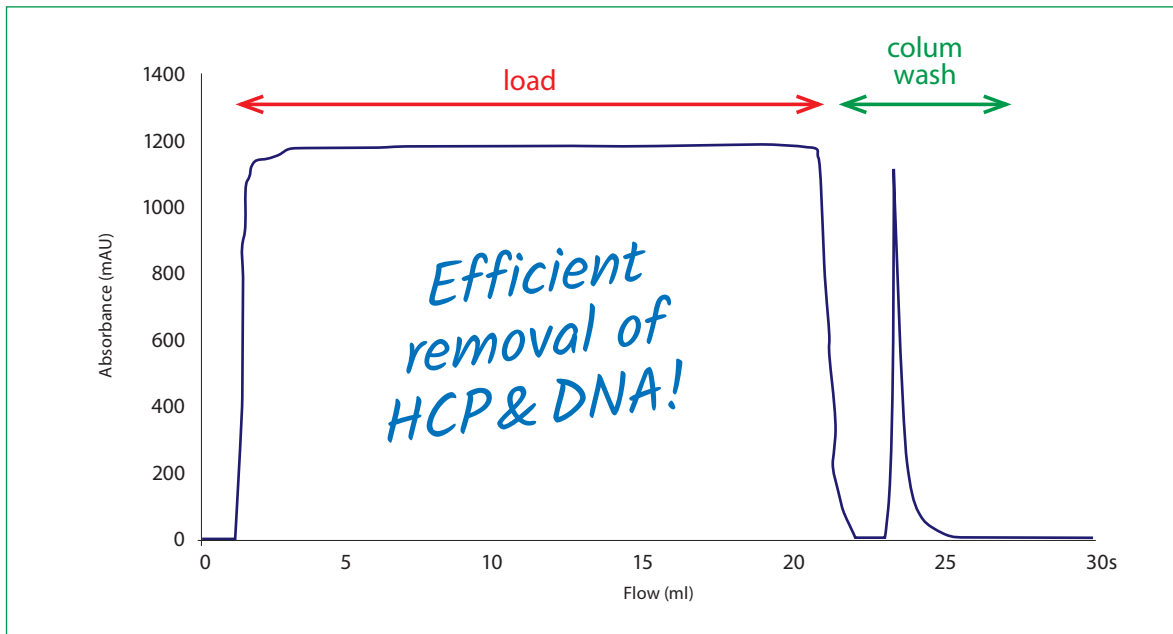
Use of an identical process sequence and identical experimental conditions ensured full comparability of the results

## Purification of monoclonal antibodies

### Anion exchange process conditions

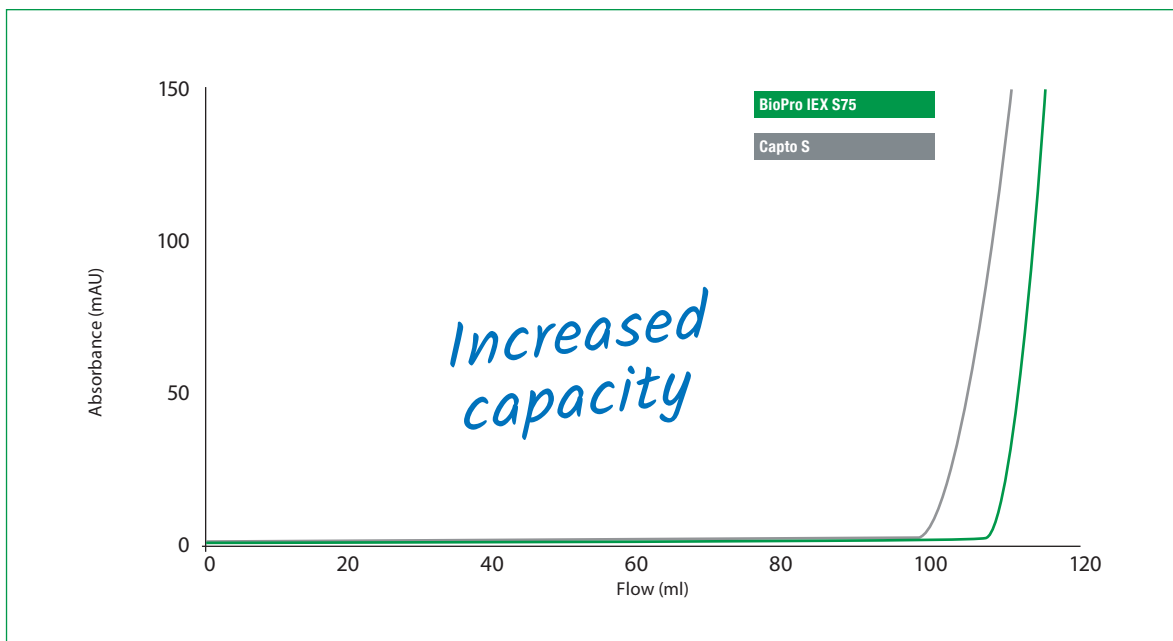
- The highly efficient removal of host cell protein (HCP) and DNA was achieved using YMC's BioPro IEX Q75.
- An optimisation study was carried out to evaluate the influence of pH on this step. Product yield and residual HCP concentration were constant between pH 8.0 and 9.0.

→ **robust & flexible process!**



### Cation exchange process conditions

- Comparison of the DBC breakthrough curves for BioPro IEX S75 and a competitive resin
- An increased capacity is clearly visible and this improves the efficiency of the overall process with a larger amount of product purified with each chromatographic cycle.



## Purification of monoclonal antibodies

An improved purification process was successfully developed. The results shown in the table below clearly indicate the potential for process optimisation achievable using YMC resins. By addressing this potential, purities and yields can be improved to increase the overall productivity and the cost-efficiency of the related processes.

### Results for improved three-step process for the purification of IgG compared to the reference process

| Process step              | HCP (ng / mg IgG) |             | DNA (pg / mg IgG) |                  | mAb Monomer (%) |             |
|---------------------------|-------------------|-------------|-------------------|------------------|-----------------|-------------|
|                           | Ref.              | YMC / JSR   | Ref.              | YMC / JSR        | Ref.            | YMC / JSR   |
| Cell culture fluid (Ref.) | 127,000           |             | 66,900,000        |                  |                 |             |
| Protein A capture         | 194               | 145         | 26,200            | 18,000           | –               | 98.6        |
| AEX                       | 4.57              | <b>0.64</b> | 1.12              | <b>&lt; 0.44</b> | 92.2            | <b>98.5</b> |
| CEX                       | 3.04              | <b>0.46</b> | 1.98              | <b>&lt; 0.12</b> | 93.9            | <b>98.6</b> |

*More efficient removal  
of HCP and DNA*

#### Result summary

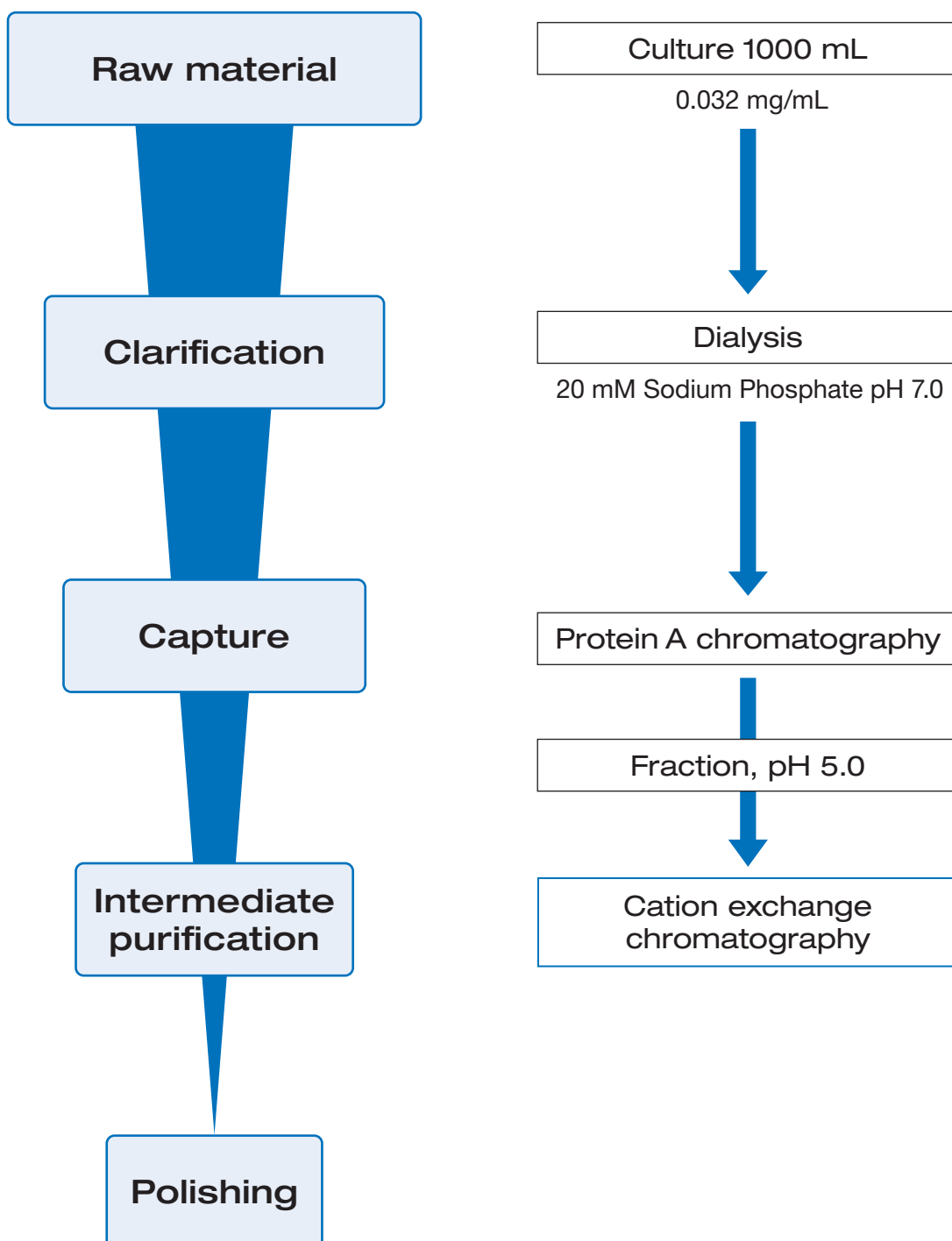
- The highly effective purification of the developed process is apparent
- YMC's BioPro IEX resins are the ideal choice for efficient purification of mAb
- The AEX step was particularly effective in reducing residual impurities
- The CEX step was successful as the last step for polishing, removing the remaining trace contaminants
- With 98.6 % yield the process had a very high recovery of purified mAbs

## Purification of monoclonal antibodies

### Purification Scheme for Adalimumab

For the purification of monoclonal antibodies high demands are required from the resin used. Factors influencing the binding characteristics of IgG are pH, linear velocity and/or salt concentration (conductivity) at the time the sample is load-

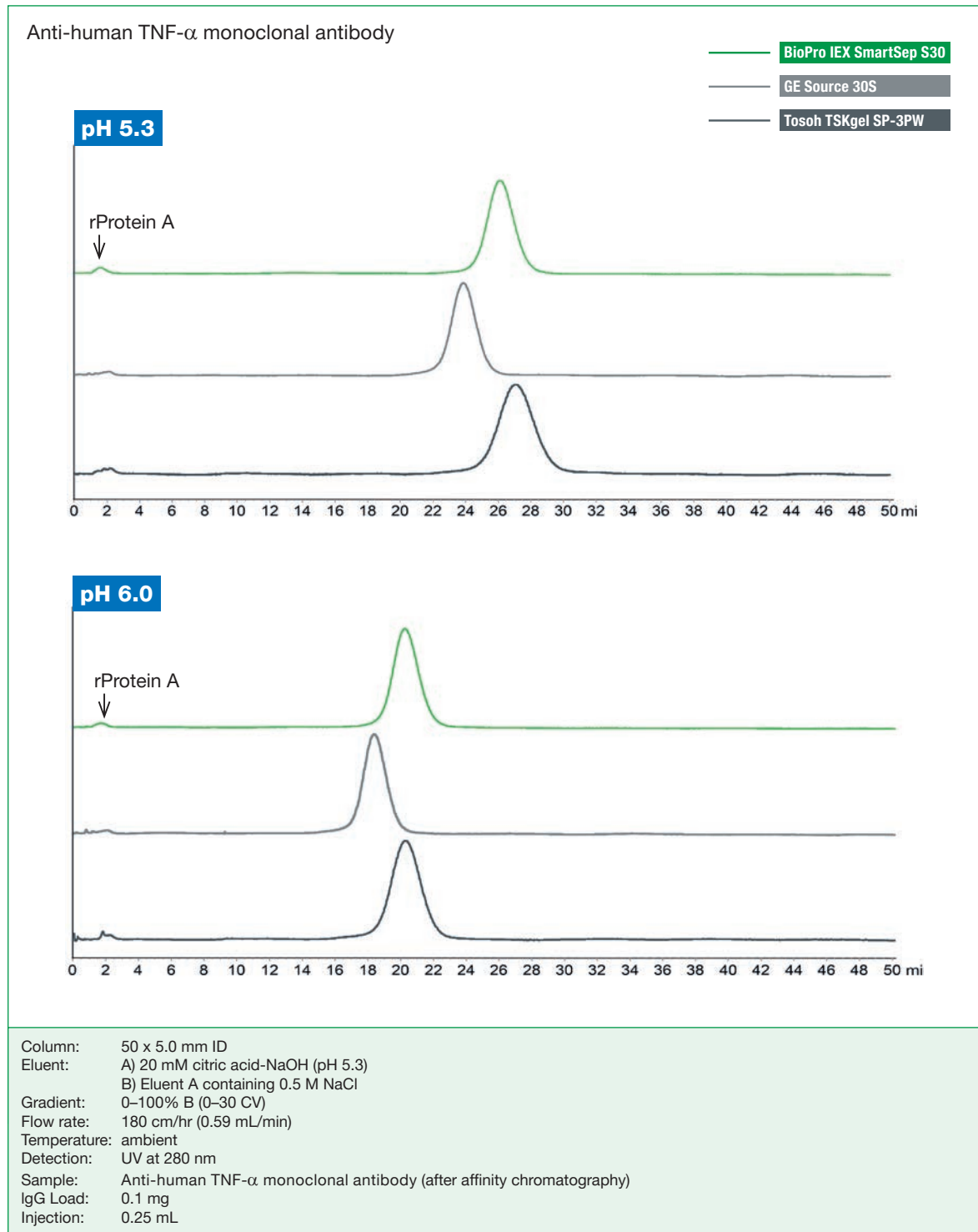
ed onto the column. Therefore, a resin with highly stable performance is required with regard to all those factors. In order to demonstrate the performance of BioPro IEX resins, several studies have been performed.



## Purification of monoclonal antibodies

Purification of anti-human TNF- $\alpha$  monoclonal antibody was performed using BioPro IEX Smart-Sep and the influence of factors such as pH, linear velocity and salt concentration were studied. The BioPro IEX SmartSep material shows good performance in all the tests.

### Comparison of the Performance of BioPro IEX SmartSep and Competitors' Products for the Purification of anti-human TNF- $\alpha$ monoclonal antibody





## Purification of monoclonal antibodies

### Influence of pH, linear velocity and salt concentration on the purification of IgG using BioPro IEX SmartSep

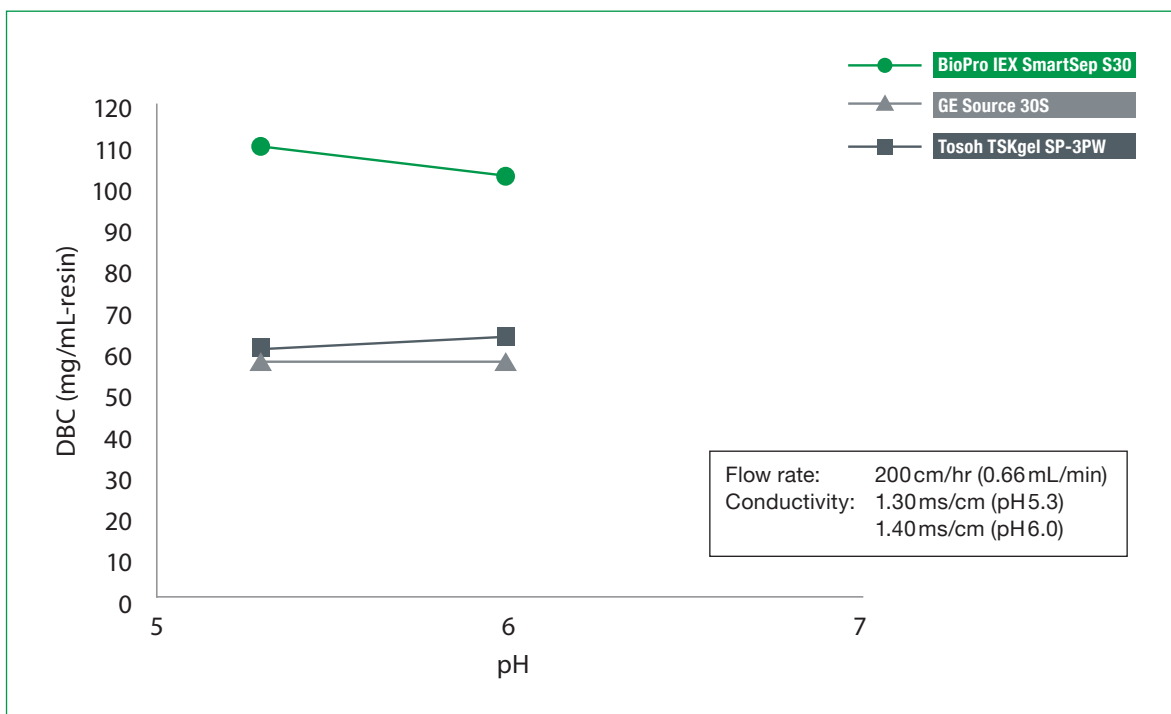
#### Experimental conditions

pH: 6.0 vs. 5.3  
 Linear velocity: 200–800 cm/hr  
 Salt concentration: 0–50 mM NaCl

|            |   |              |  |
|------------|---|--------------|--|
| Column:    | 50 x 5.0 mm ID  | Temperature: | ambient (25 °C)  |
| Eluent:    | A) 20 mM citric acid-NaOH buffer (pH 5.3 or 6.0)<br>B) Eluent A containing 0.5 M NaCl | Detection:   | UV at 280nm  |
| Flow rate: | 200–800 cm/hr (0.66–2.62 mL/min)  | Sample:      | 1.5 mg/mL human polyclonal IgG in equilibration buffer |

#### Influence of pH

| pH                          | DBC (mg/mL-resin, 10% breakthrough) |        |
|-----------------------------|-------------------------------------|--------|
|                             | pH 5.3                              | pH 6.0 |
| BioPro IEX SmartSep S30     | 110                                 | 103    |
| Tosoh TSKgel SP-3PW (30 µm) | 61                                  | 64     |
| GE Source 30S (30 µm)       | 58                                  | 58     |

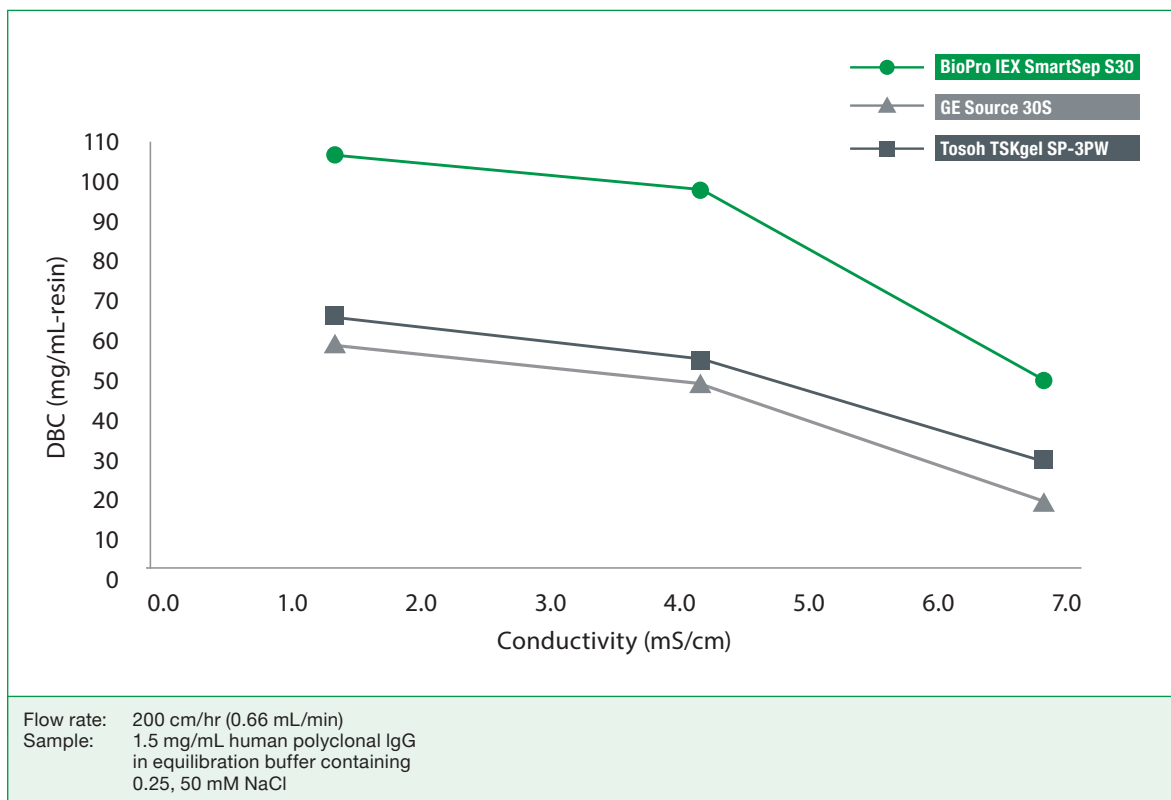


High binding capacities are achieved regardless of the pH of elution. Therefore, milder eluting conditions for IgG can be selected to protect the product purity.

## Purification of monoclonal antibodies

### Influence of salt concentration

|                             | DBC (mg/mL-resin, 10% breakthrough) |            |           |
|-----------------------------|-------------------------------------|------------|-----------|
| pH                          | 5.3                                 |            |           |
| NaCl concentration          | 0 mM                                | 25 mM      | 50 mM     |
| Conductivity                | 1.36 mS/cm                          | 4.14 mS/cm | 6.8 mS/cm |
| BioPro IEX SmartSep S30     | 107                                 | 97         | 50        |
| Tosoh TSKgel SP-3PW (30 µm) | 64                                  | 55         | 27        |
| GE Source 30S (30 µm)       | 58                                  | 49         | 19        |

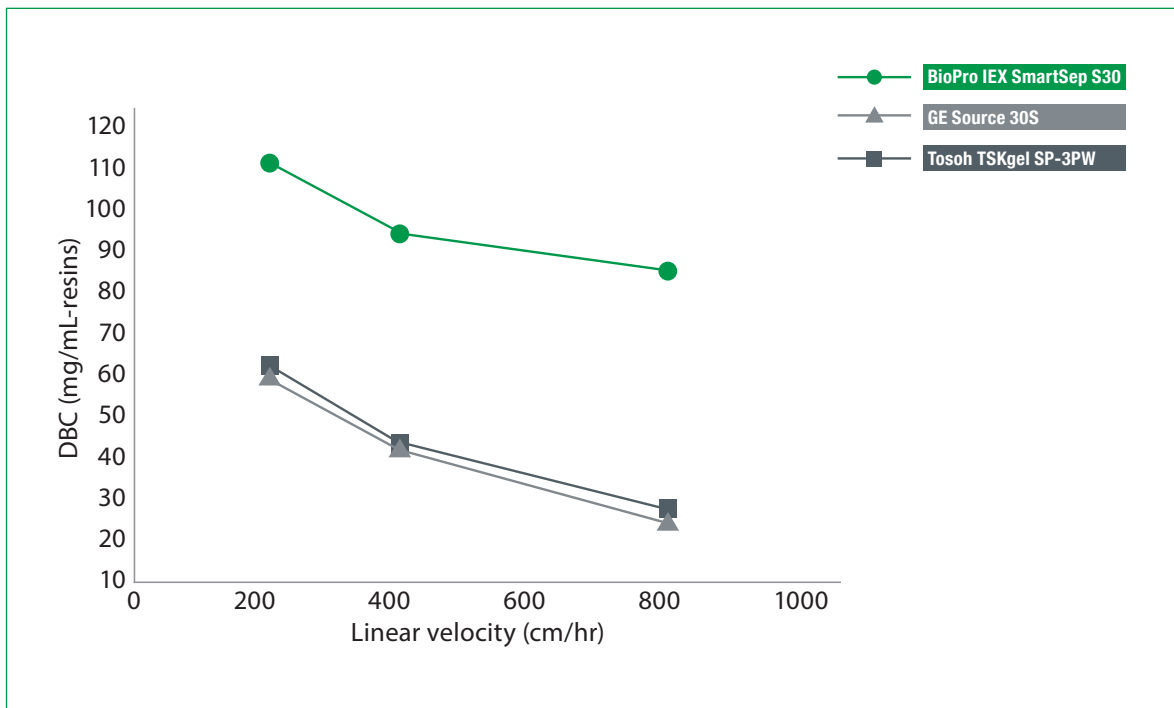


**BioPro IEX SmartSep S30 has a higher tolerance to salt concentration. This simplifies the desalting process after Protein A chromatography and will help to shorten the production process.**

## Purification of monoclonal antibodies

### Influence of linear velocity

| Linear velocity             | DBC (mg/mL-resin, 10% breakthrough) |           |           |
|-----------------------------|-------------------------------------|-----------|-----------|
|                             | 200 cm/hr                           | 400 cm/hr | 800 cm/hr |
| BioPro IEX SmartSep S30     | 110                                 | 93        | 84        |
| Tosoh TSKgel SP-3PW (30 µm) | 61                                  | 42        | 26        |
| GE Source 30S (30 µm)       | 58                                  | 41        | 23        |

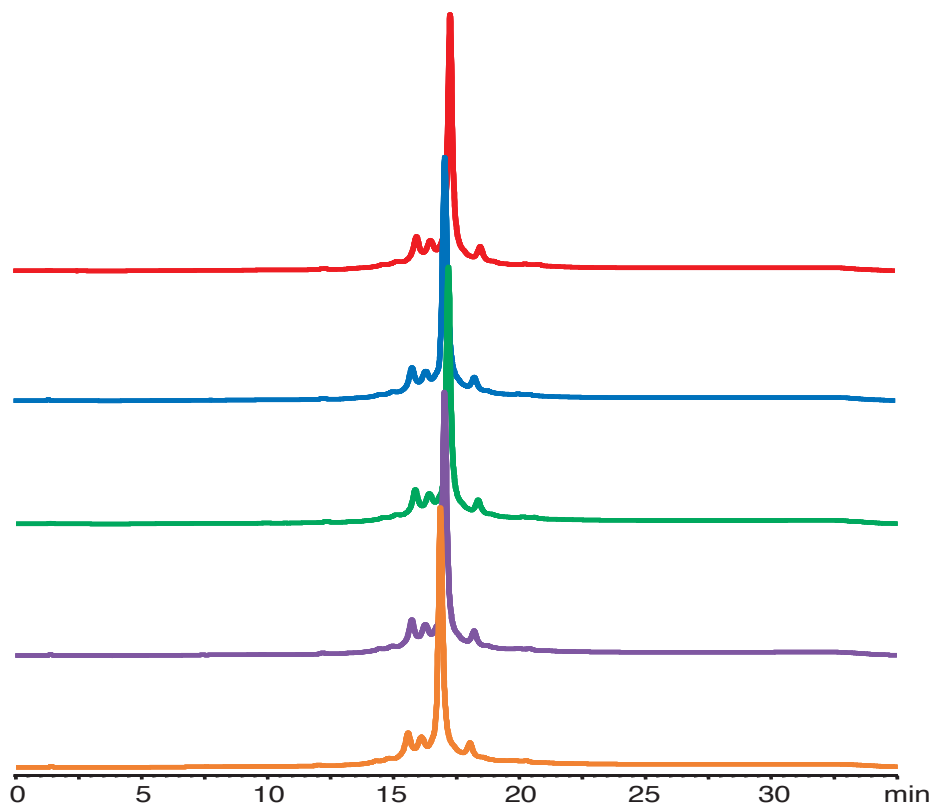


BioPro IEX SmartSep S30 maintains higher binding capacity values over a wider range of linear velocities. This will increase the product throughput for the purification process.

### Conclusions

BioPro IEX SmartSep resins meet the highest demands for the purification of monoclonal antibodies. High binding capacity is achieved regardless of elution of pH, linear velocity or salt concentration. This allows purification processes to be carried out more efficiently.

- Higher throughput with no loss of efficiency
- Simplification of desalting processes
- Reduced processing costs
- Short delivery time for industrial-scale quantities
- Full compliance with GMP regulations



Purified monoclonal antibody IgG1

# Purification of oligonucleotides



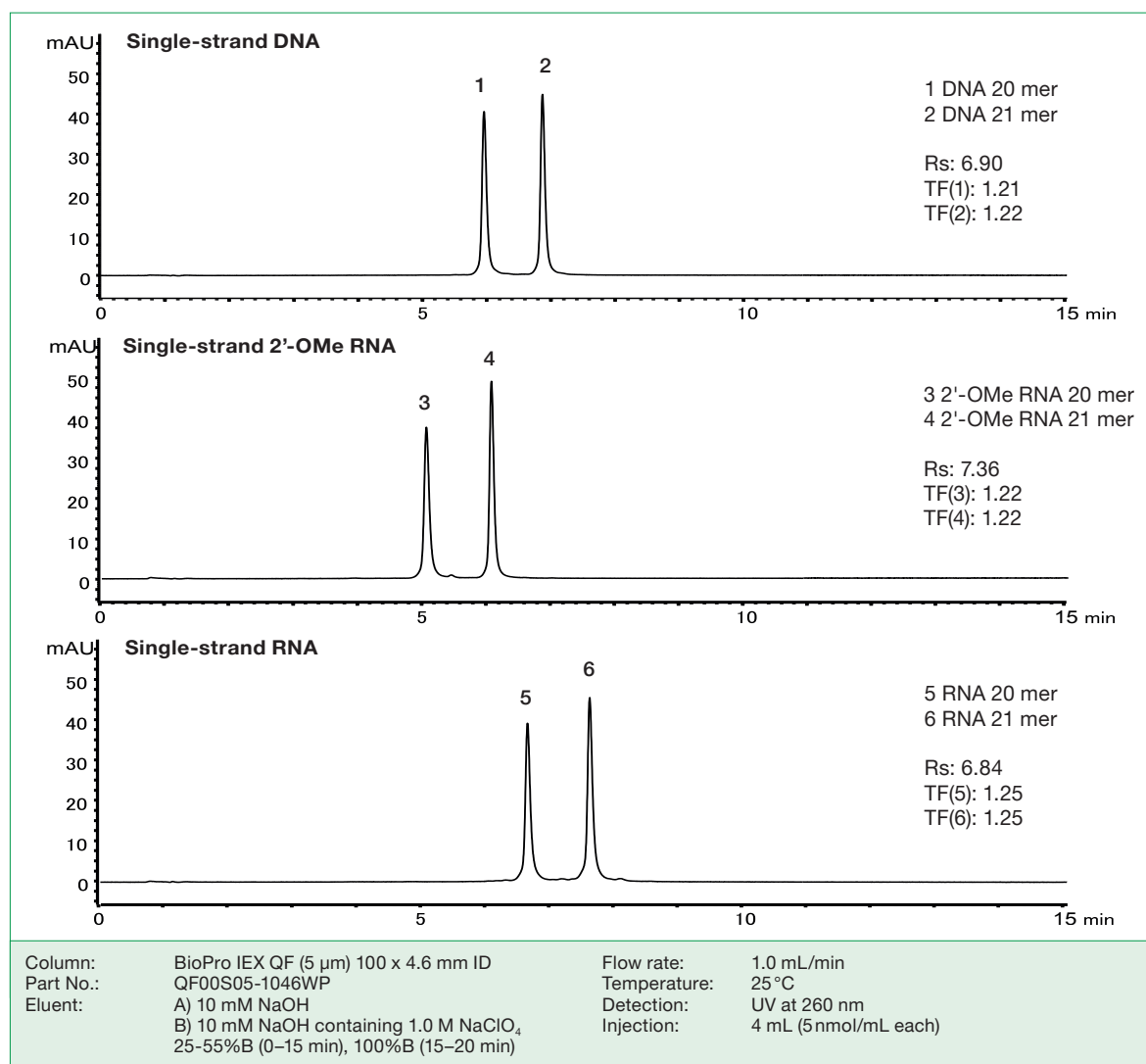
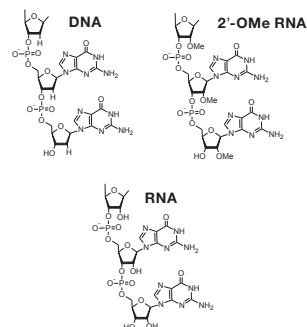
## Examples of analysis under the optimised conditions

Nucleic acids such as antisense RNA (asRNA), small interfering RNA (siRNA) and aptamers are expected to be the next generation of biopharmaceuticals. In order to provide these drugs, purification and analytical separations that can recognize slight structural differences after synthesis are important issues.

### Samples

|   |                   |  |
|---|-------------------|--|
| 1 | Single-strand DNA | 5'-TCATCACACTGAATACCAAT-3' (DNA 20 mer)  |
| 2 |                   | 5'-GTCATCACACTGAATACCAAT-3' (DNA 21 mer)   |
| 3 | Single-strand RNA | 5'-U(M)C(M)A(M)U(M)C(M)A(M)C(M)A(M)C(M)U(M)G(M)A(M)A(M)U(M)A(M)C(M)C(M)A(M)A(M)U(M)-3' (2'-OMe RNA 20 mer)     |
| 4 |                   | 5'-G(M)U(M)C(M)A(M)U(M)C(M)A(M)C(M)A(M)C(M)U(M)G(M)A(M)A(M)U(M)A(M)C(M)C(M)A(M)A(M)U(M)-3' (2'-OMe RNA 21 mer) |
| 5 |                   | s5'-UCAUCACACUGAAUACCAU-3' (RNA 20 mer)  |
| 6 |                   | 5'-GUCAUCACACUGAAUACCAU-3' (RNA 21 mer)  |

N(M)=2'-OMe RNA



Good separation without carry over or peak tailing of oligonucleotides was achieved by optimisation of the buffer/counter ion in the mobile phase and gradient profile, and by using the non porous anion exchange column BioPro IEX QF.

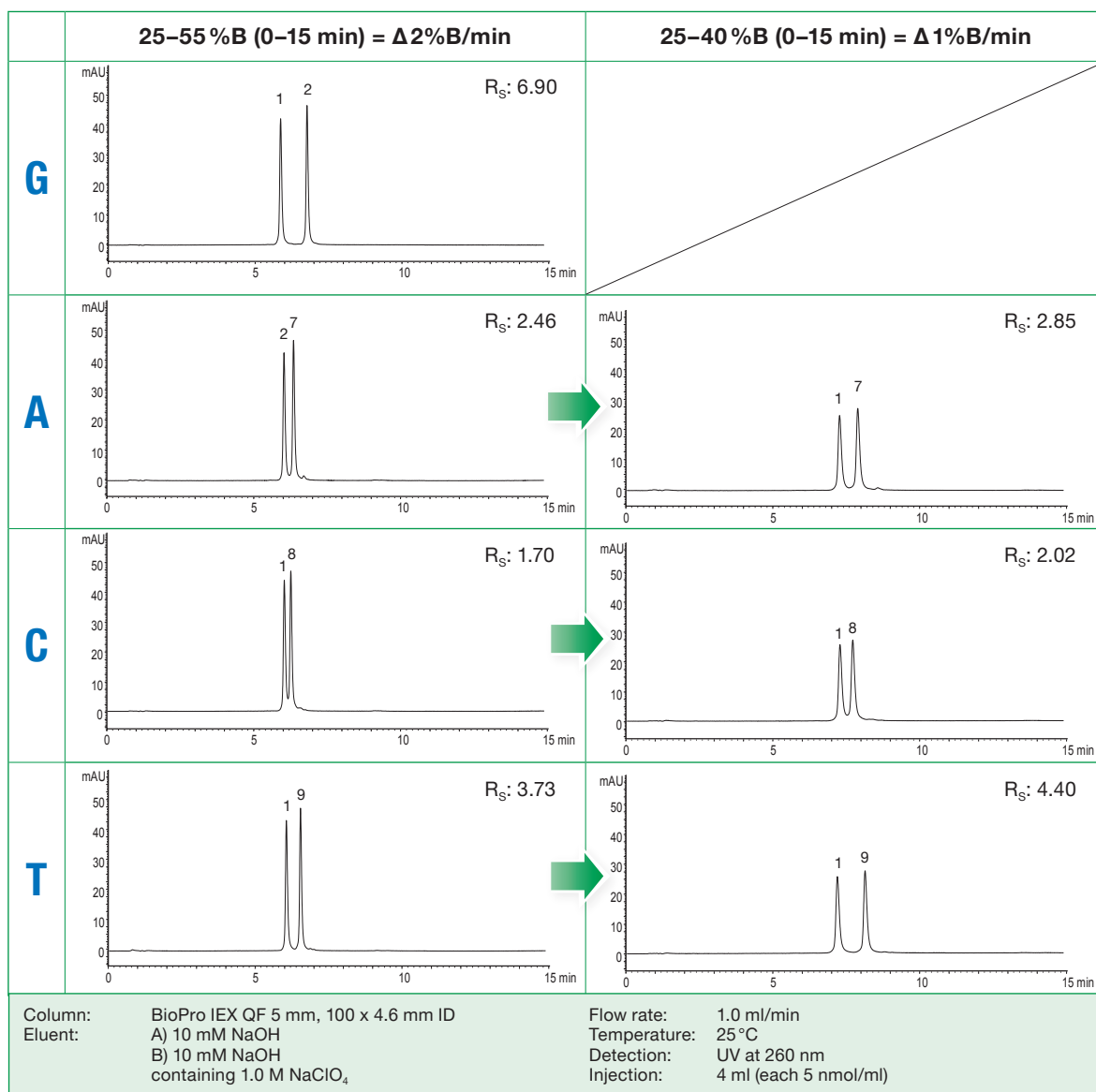
# Purification of oligonucleotides

## Separation of ssDNAs with single-base differences

### Samples

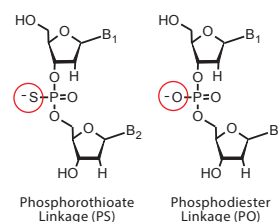
|   |                     |   |
|---|---------------------|---|
| 1 | Single-stranded DNA | 5'-TCATCACACTGAATACCAAT-3' (DNA 20 mer)           |
| 2 |                     | 5'- <b>G</b> TCATCACACTGAATACCAAT-3' (DNA 21 mer) |
| 7 |                     | 5'- <b>A</b> TCATCACACTGAATACCAAT-3' (DNA 21 mer) |
| 8 |                     | 5'- <b>C</b> TCATCACACTGAATACCAAT-3' (DNA 21 mer) |
| 9 |                     | 5'- <b>T</b> TCATCACACTGAATACCAAT-3' (DNA 21 mer) |

When ssDNAs (single-stranded DNAs) with single-base differences (differing in the type of base of 5' end of DNA 21mer) are analysed under the conditions described, all of the peak separations got worse. By using a shallower gradient, improved separations could be achieved.



### Samples

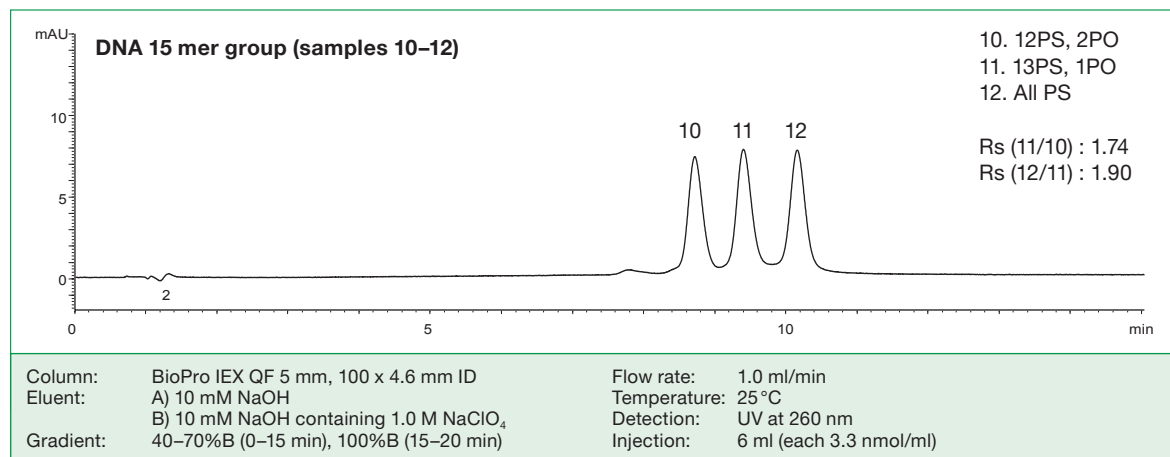
|    |                     |  |
|----|---------------------|--|
| 10 | Single-stranded DNA | 5'-TATATATATATATATATATATTT-3' (DNA 15 mer 12PS, 2P0)   |
| 11 |                     | 5'-TATATATATATATATATATATATT-3' (DNA 15 mer 13PS, 1P0)  |
| 12 |                     | 5'-TATATATATATATATATATATAT-3' (DNA 15 mer All PS)  |
| 13 | Single-stranded RNA | 5'-U <sup>^</sup> A <sup>^</sup> C <sup>^</sup> A <sup>^</sup> U <sup>^</sup> C <sup>^</sup> A <sup>^</sup> C <sup>^</sup> A <sup>^</sup> C <sup>^</sup> A <sup>^</sup> C <sup>^</sup> U <sup>^</sup> G <sup>^</sup> A <sup>^</sup> A <sup>^</sup> U <sup>^</sup> A <sup>^</sup> C <sup>^</sup> A <sup>^</sup> A <sup>^</sup> U <sup>^</sup> -3' (RNA 20 mer All PS) |
| 14 |                     | 5'-G <sup>^</sup> U <sup>^</sup> C <sup>^</sup> A <sup>^</sup> A <sup>^</sup> U <sup>^</sup> C <sup>^</sup> A <sup>^</sup> C <sup>^</sup> A <sup>^</sup> C <sup>^</sup> U <sup>^</sup> G <sup>^</sup> A <sup>^</sup> A <sup>^</sup> U <sup>^</sup> A <sup>^</sup> C <sup>^</sup> A <sup>^</sup> A <sup>^</sup> U <sup>^</sup> -3' (RNA 21 mer All PS)                |





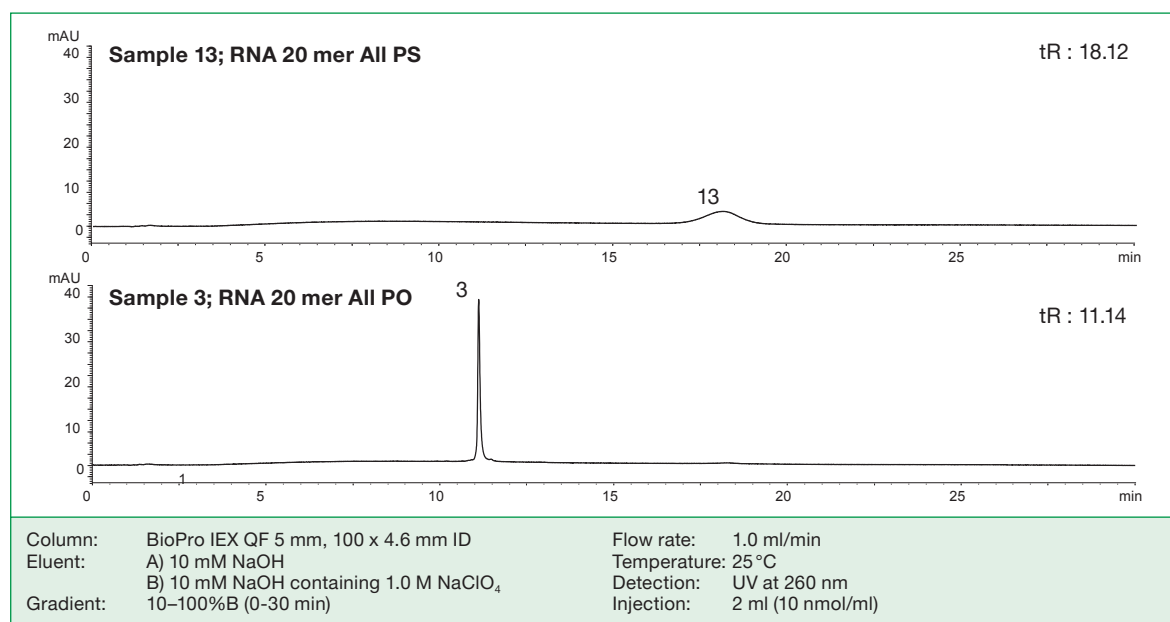
Using the optimised conditions described, [all PS], [13PS, 1PO] and [12PS, 2PO] of DNA 15mer (samples 10–12) were clearly separated by ion exchange chromatography.

### Resolution of phosphorothioate oligonucleotides with different degrees of thiolation



The separation of RNA 20mer all PS (sample 13) is compared with RNA 20mer all PO (sample 3) under the same conditions. Since acidity of all PS is much higher than that of all PO, a higher salt concentration is required for elution. The peak of all PS is much broader because it is thought that all PS contains as many as 219 (524, 288) stereoisomers.

### Difference in required salt concentrations for eluting modified RNA (All PS) and normal RNA (All PO)

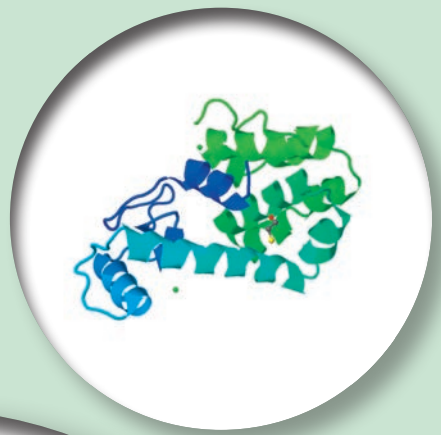
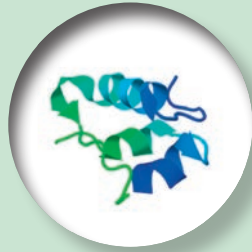


## Conclusions

### By using BioPro IEX :

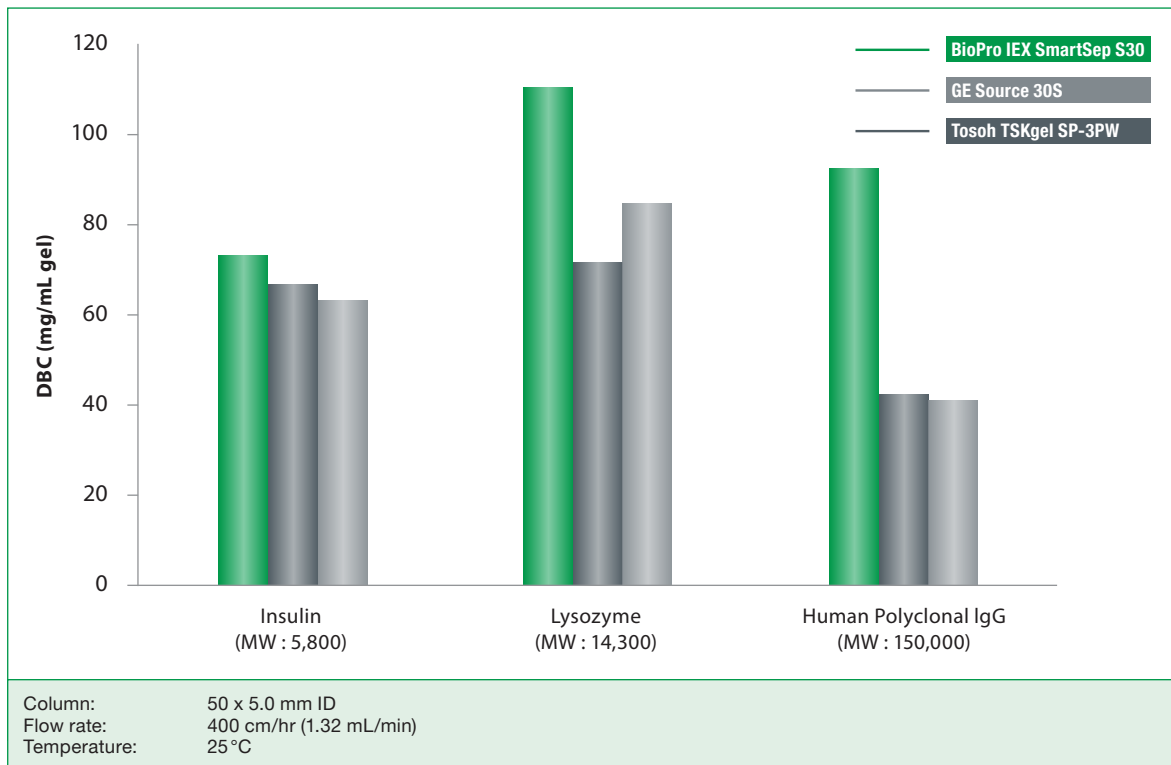
- Each ssDNA, ssRNA and 2'-OMe ssRNA with single-base differences in length can be successfully separated.
- [All PS], [13PS, 1PO] and [12PS, 2PO], which consist of 15-mer ssDNA, can also be separated under the optimised conditions.
- Higher salt concentration is required to elute All PS compared to eluting All PO.
- All PS with single-base differences in length can be separated to a limited extent and for further optimisation is required.

# Purification of proteins and peptides

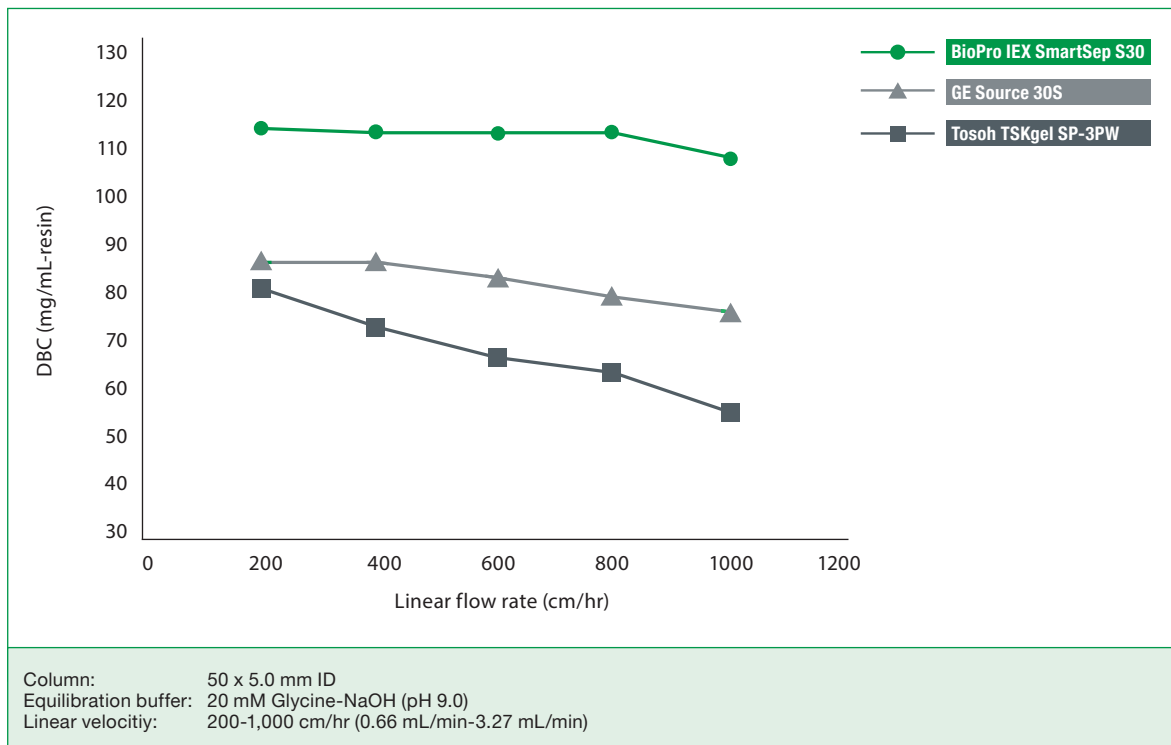


## Purification of proteins and peptides

### Comparison of the Performance of BioPro IEX SmartSep and Competitors' Products in the Purification of Lysozyme, Insulin and Polyclonal IgG



**BioPro IEX SmartSep shows higher dynamic binding capacity for both small peptides and large proteins.**

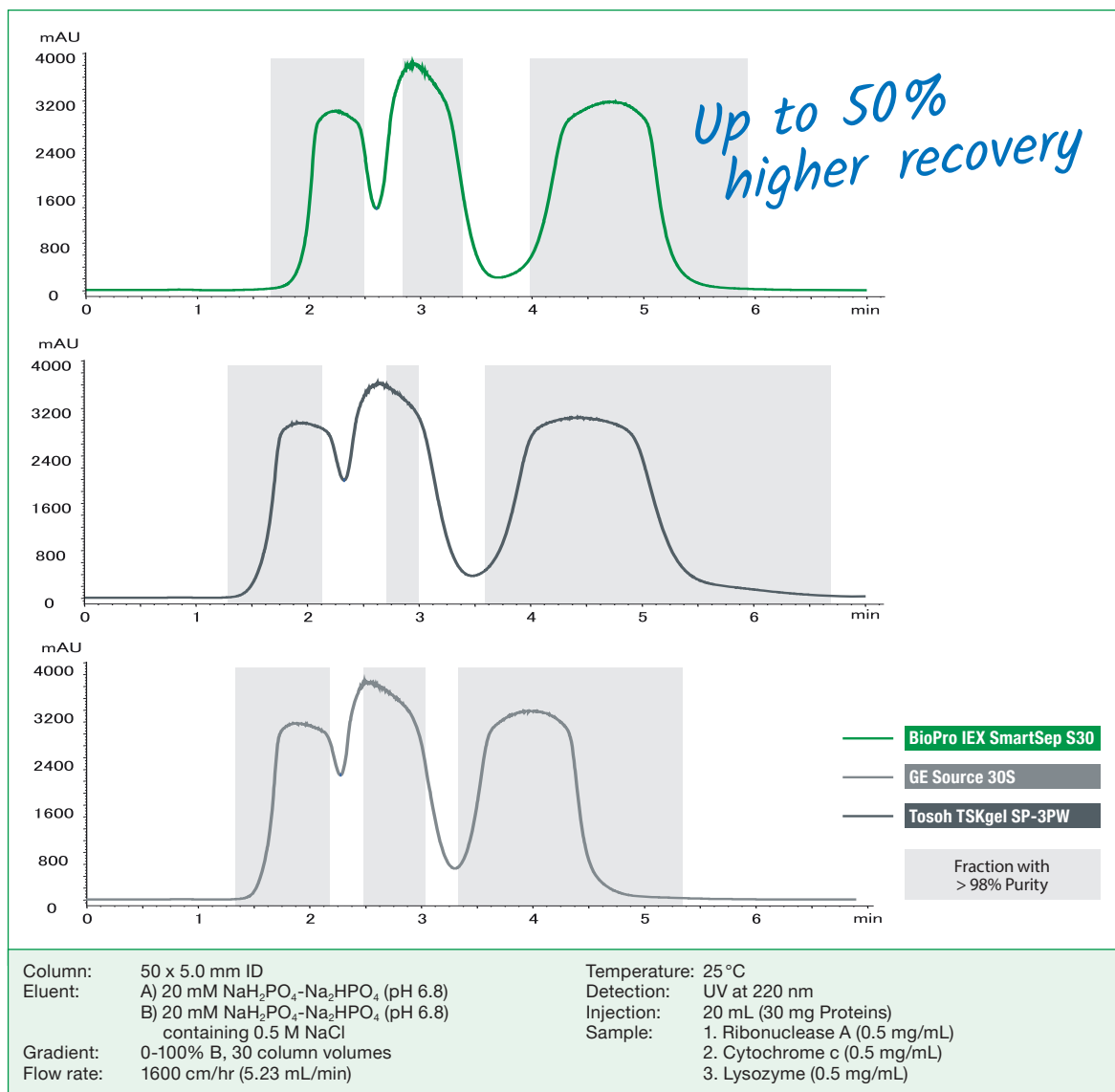


**YMC's BioPro IEX resins show higher dynamic binding capacities over the full range of applicable flow rates.**

## Purification of proteins and peptides

BioPro IEX SmartSep resins offer the perfect solution for challenging separations. With the high binding capacity and recovery, the resins allow high-throughput purifications and increased productivity. Easy elution of target compounds improves the whole process.

### Comparison of resolution with competitors' materials



|                         | Recovery (> 98% Purity) |              |          |        |
|-------------------------|-------------------------|--------------|----------|--------|
|                         | Ribonuclease A          | Cytochrome c | Lysozyme | Total  |
| BioPro IEX SmartSep S30 | 90.5 %                  | 81.5 %       | 99.3 %   | 90.7 % |
| TSKgel SP-3PW           | 74.2 %                  | 54.4 %       | 99.5 %   | 76.9 % |
| GE Source 30S           | 87.2 %                  | 76.0 %       | 99.5 %   | 87.8 % |

BioPro IEX SmartSep S30 maintains its high resolution and high sample loading ability even at 1600 cm/hr and under high loading condition (30 mg/mL). It allows up to 50% higher recovery for specific target compounds compared to the competitor's materials. These features of the BioPro IEX SmartSep material indicate the possibility of cost savings for your purification.

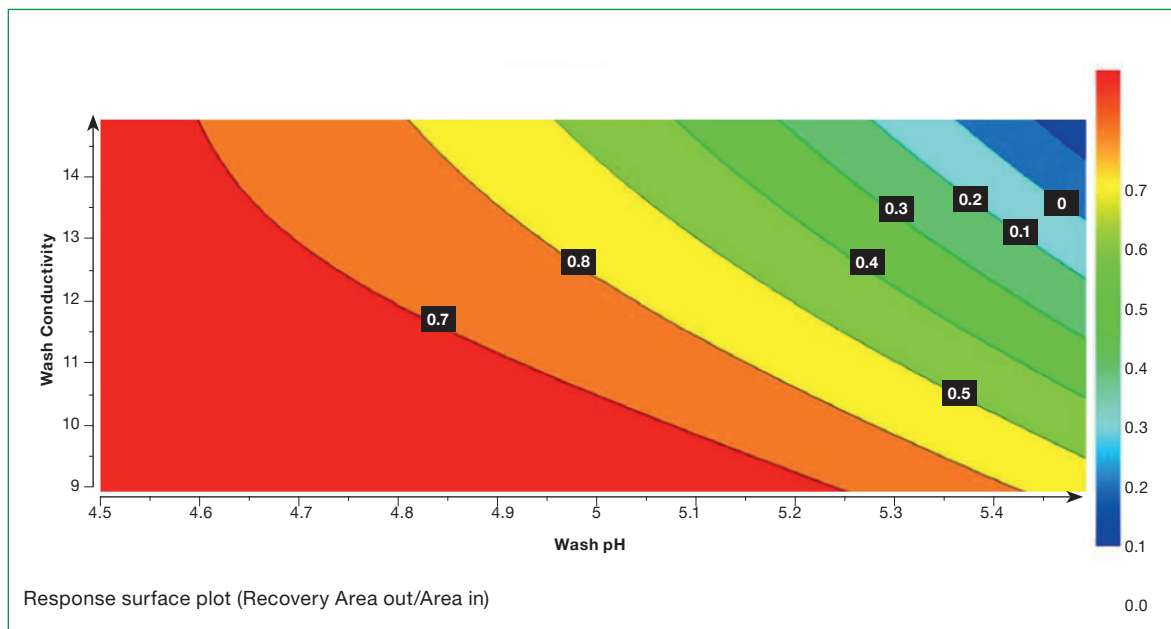
## Purification of proteins and peptides

The monoclonal antibody IgG (PI = 8.9) was purified in a two-step process out of cultured medium. The two combined separation modes are affinity and ion exchange chromatography. For the second step, the strong cation exchanger

BioPro S75 is used in bind-and-elute mode. In order to evaluate the optimum purification conditions, the influence of salt concentration and pH during the washing phase were analysed in a DoE (design of experiments) process.

### Recovery (%) at various salt concentrations and pH

| Conductivity \ pH | 4.5  | 5.0  | 5.5  |
|-------------------|------|------|------|
| 15 mS/cm          | 72.2 | 40.1 | 0.0  |
| 12 mS/cm          | 73.4 | 68.2 | 10.1 |
| 9 mS/cm           | 73.1 | 69.5 | 64.0 |



These results show that the recovery is higher if the washing step is performed under acidic conditions. As the target mAb should not be denatured, pH 5 was chosen for the purification. A conductivity of 10 mS/cm was selected for the washing step.



The background of the slide is a black field filled with numerous glowing circles of varying sizes and colors. The colors range from bright, vibrant green to a pale, almost white light green. The circles are scattered across the frame, creating a dense, abstract pattern that resembles a microscopic view of particles or a digital data visualization.

# Properties of BioPro IEX resins

### Scale up and availability of BioPro IEX

- Predictable scale-up process
- Preparative grade resins with particle sizes from 10 µm to 75 µm up to several thousand litres
- Full compliance with GMP requirements
- Short delivery for industrial-scale quantities
- High capacity with low operating pressures even at high flow rates
- Reduced processing costs
- Prepacked columns with 5 µm porous resins
- Non-porous resins for fast analysis



### Mission Statement

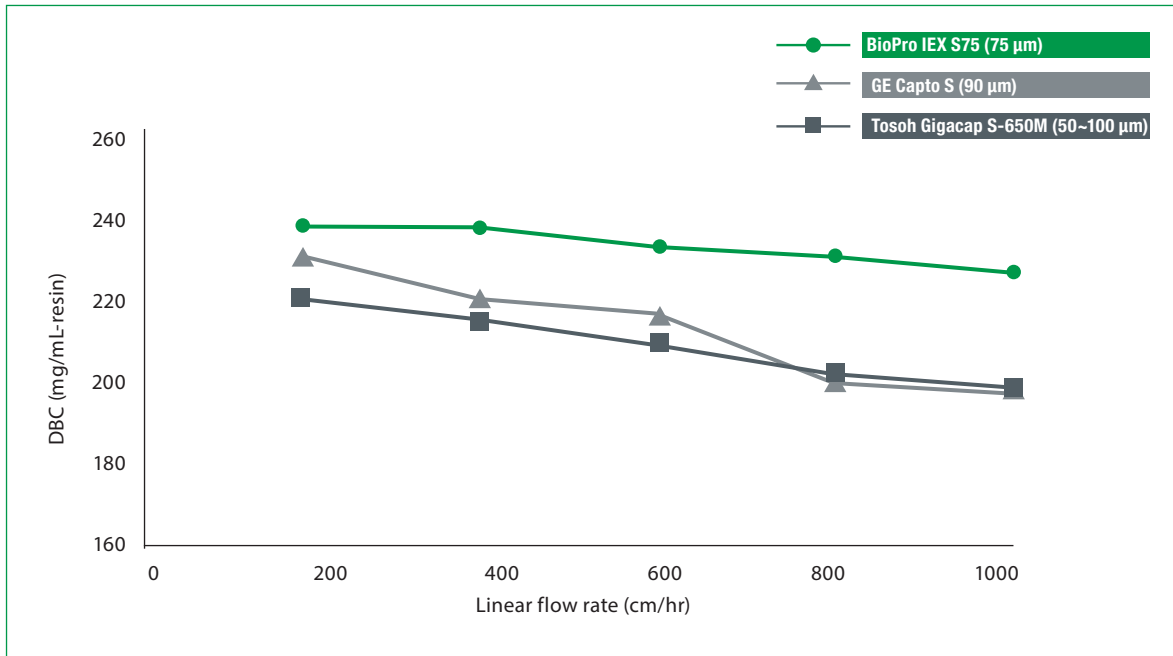
YMC will never knowingly change any product that is being used in a validated production process or validated analytical method.



## High dynamic binding capacity

### High binding capacity and high recovery

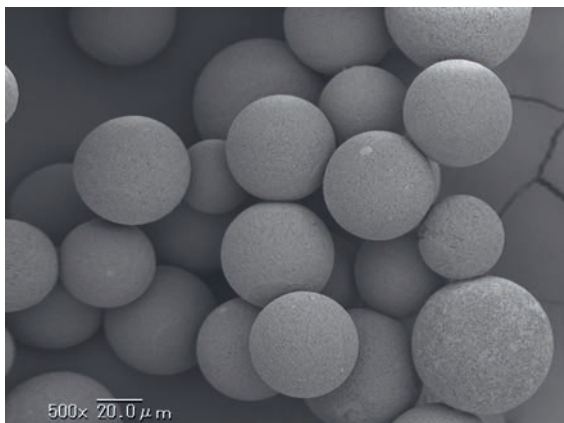
The porous versions of BioPro IEX show high dynamic binding capacity (DBC) and excellent recovery, making them useful for preparative separations of proteins and antibodies.



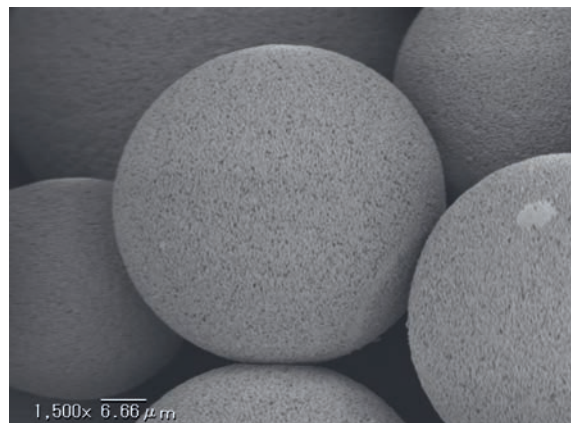
Column: BioPro IEX S75, 50 x 5.0 mm ID  
Sample: 1.0 mg/ml Lysozyme in equilibration buffer  
Eluent: A) 20 mM Glycine-NaOH (pH 9.0)  
B) 20 mM Glycine-NaOH (pH 9.0) containing 0.5 M NaCl  
Detection: UV at 300 nm

The sample loading at high flow rates is determined by the dynamic binding capacity of an ion exchange resin.

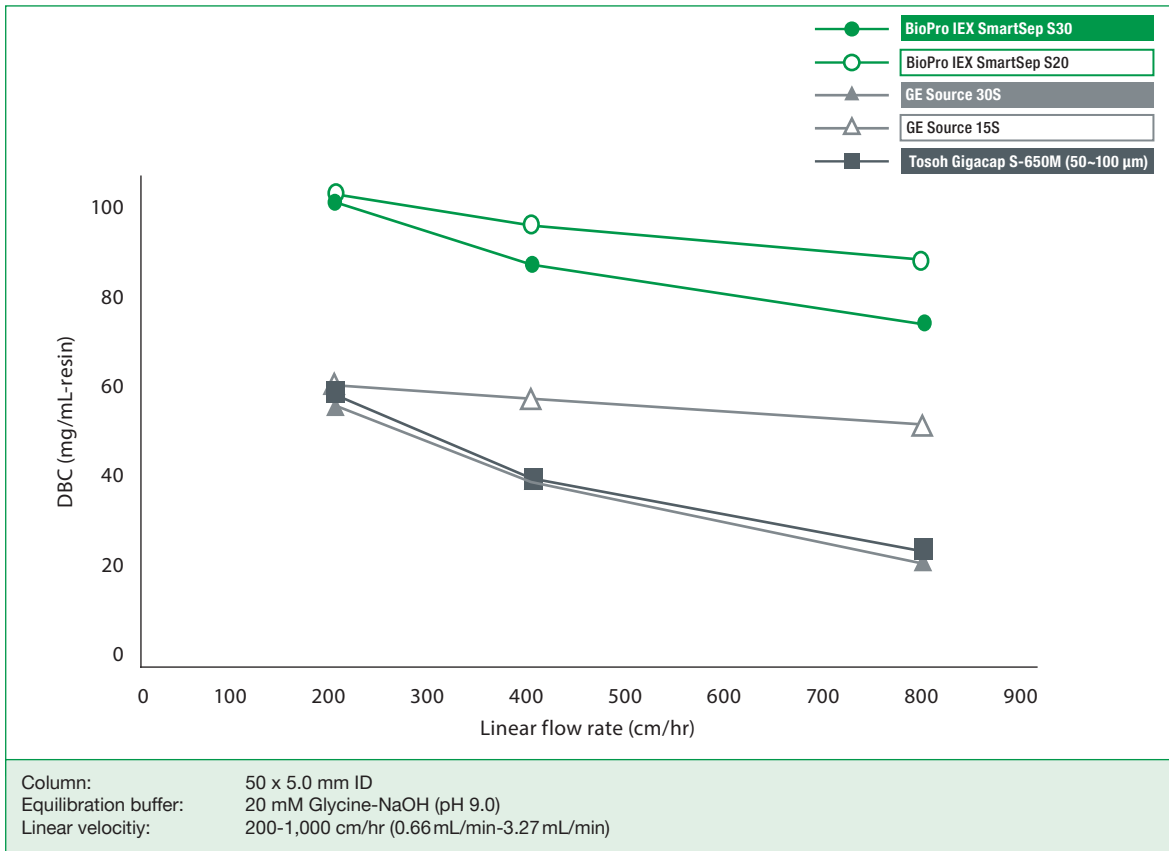
The dynamic binding capacity of BioPro IEX is excellent even at high flow rates. When compared to similar competitor products it consistently exhibits a higher dynamic binding capacity. This results in higher sample loading in a preparative processes.



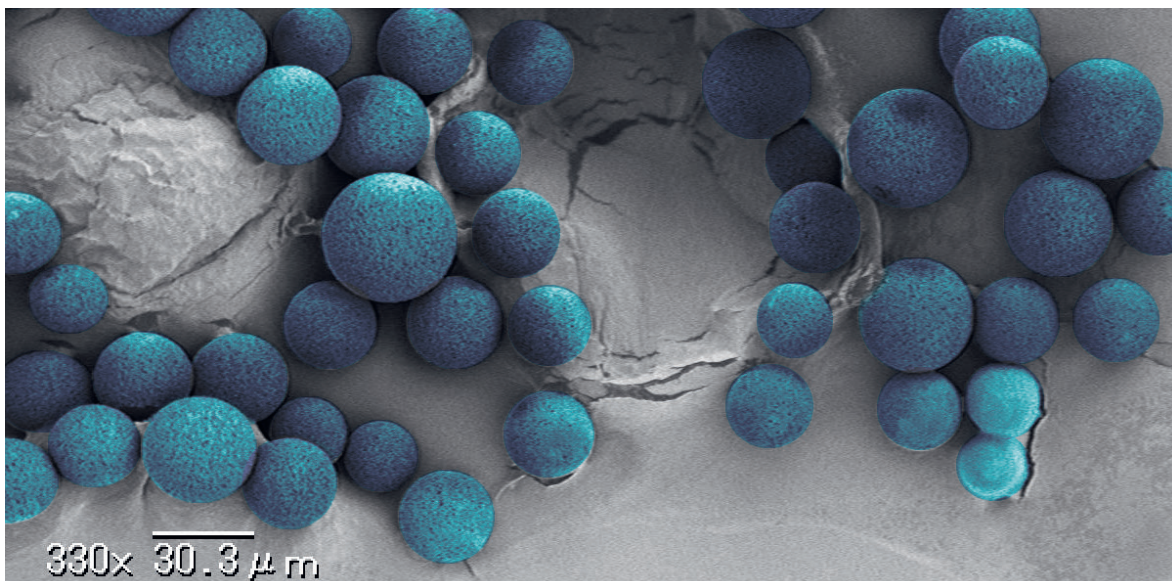
BioPro IEX S75 Particles



## Comparison of the DBC for human polyclonal IgG at different flow rates for BioPro IEX SmartSep S30 and competitors' products.



BioPro IEX SmartSep shows considerably higher DBC across a wide range of linear velocity. A high DBC at flow rates of up to 1,000 cm/hr can reduce process time and significantly increase productivity.



BioPro IEX S30 Particles

## Excellent alkaline CIP stability

Cleaning-in-place (CIP) is essential for the economic use of packed chromatography columns. Efficient cleaning procedures increase the lifetime of the separation process and thereby contribute to the overall cost effectiveness. In addition, powerful CIP procedures strongly increase the safety and productivity of every downstream process.

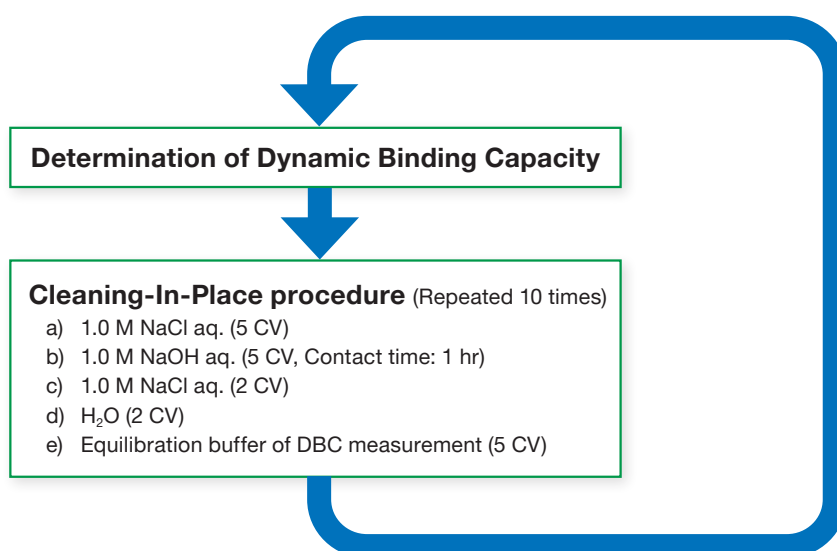
Sodium hydroxide (NaOH) solutions are well established for the removal of precipitated proteins, hydrophobic proteins, nucleic acids, endotoxins and viruses and have become the first choice for

cleaning and sanitising of chromatography resins. In order to optimise process development time and costs, there is an increasing demand for efficient cleaning procedures and compatible chromatography resins.

IEX resins from YMC are fully compatible with typical CIP procedures.

As an example, CIP studies have been performed using NaOH solutions with BioPro IEX S75/Q75 as well as with BioPro IEX SmartSep S30/Q30.

All YMC IEX resins maintain their performance values even after 100 CIP cycles.



### DBC (IgG) (BioPro IEX SmartSep S30, BioPro IEX S75)

|                       |  |              |  |
|-----------------------|--|--------------|--|
| Column:               | 50 × 5.0 mm ID                             | Temperature: | 25 °C  |
| Equilibration buffer: | 20 mM citric acid-NaOH (pH 5.3)            | Detection:   | UV at 280 nm   |
| Elution buffer:       | Equilibration buffer containing 0.5 M NaCl | Sample:      | 1.5 mg/mL human polyclonal IgG in equilibration buffer |
| Flow rate:            | 200 cm/hr (0.66 mL/min)                    |              |  |

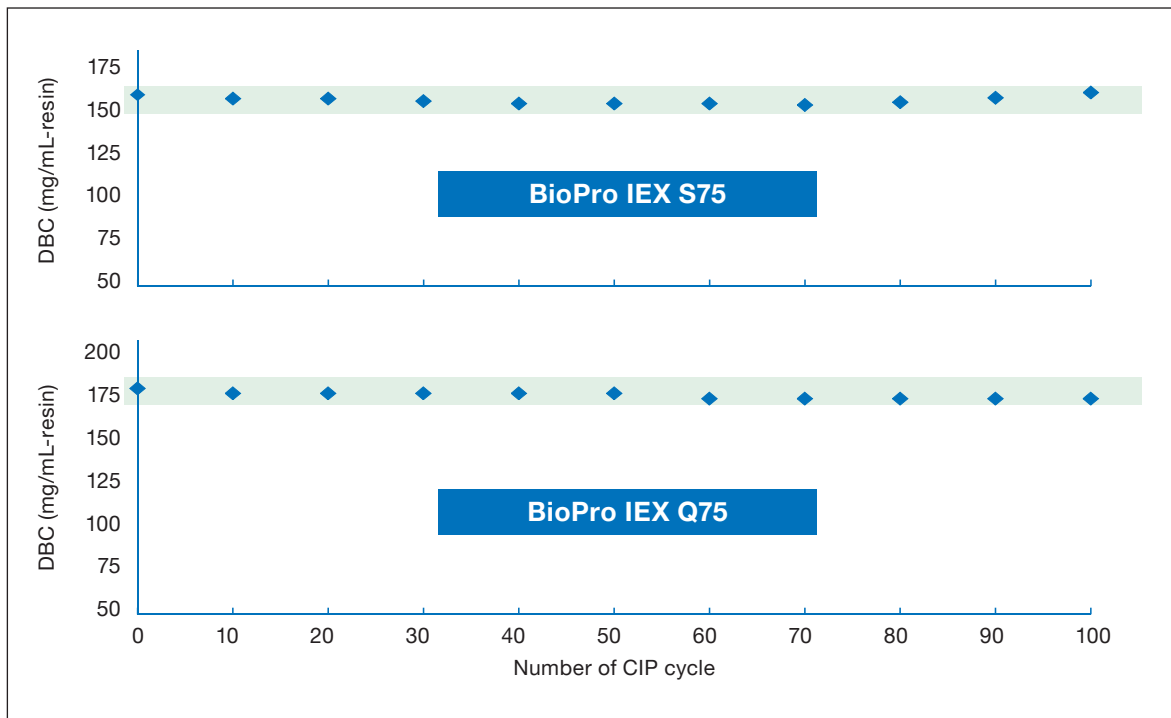
### DBC (BSA) (BioPro IEX SmartSep Q30, BioPro IEX Q75)

|                       |  |              |                                       |
|-----------------------|--|--------------|---------------------------------------|
| Column:               | 50 × 5.0 mm ID                             | Temperature: | 25 °C                                 |
| Equilibration buffer: | 20 mM Tris-HCl (pH 8.6)                    | Detection:   | UV at 280 nm                          |
| Elution buffer:       | Equilibration buffer containing 0.5 M NaCl | Sample:      | 1.5 mg/mL BSA in equilibration buffer |
| Flow rate:            | 200 cm/hr (0.66 mL/min)                    |              |                                       |

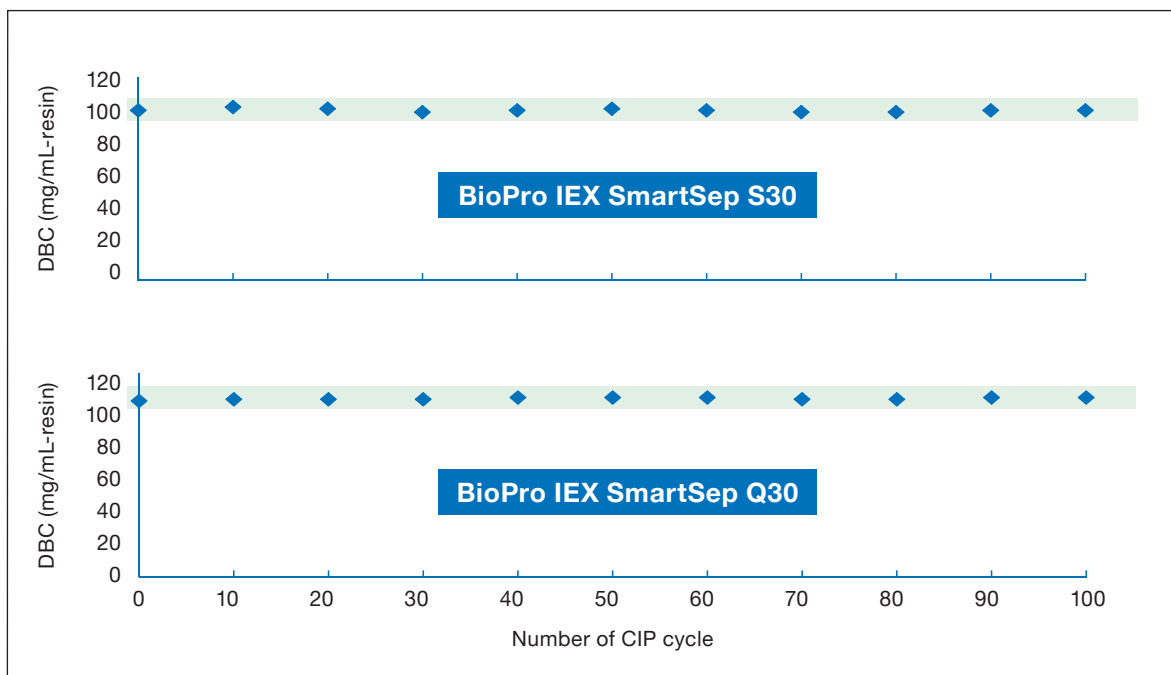
### CIP cycle

|              |   |
|--------------|---|
| Column:      | 50 × 5.0 mm ID  |
| Flow rates:  | 200 cm/hr (1.0 M NaCl, H <sub>2</sub> O, Buffer)<br>30 cm/hr (1.0 M NaOH) |
| Temperature: | 25 °C   |

## Excellent alkaline CIP stability

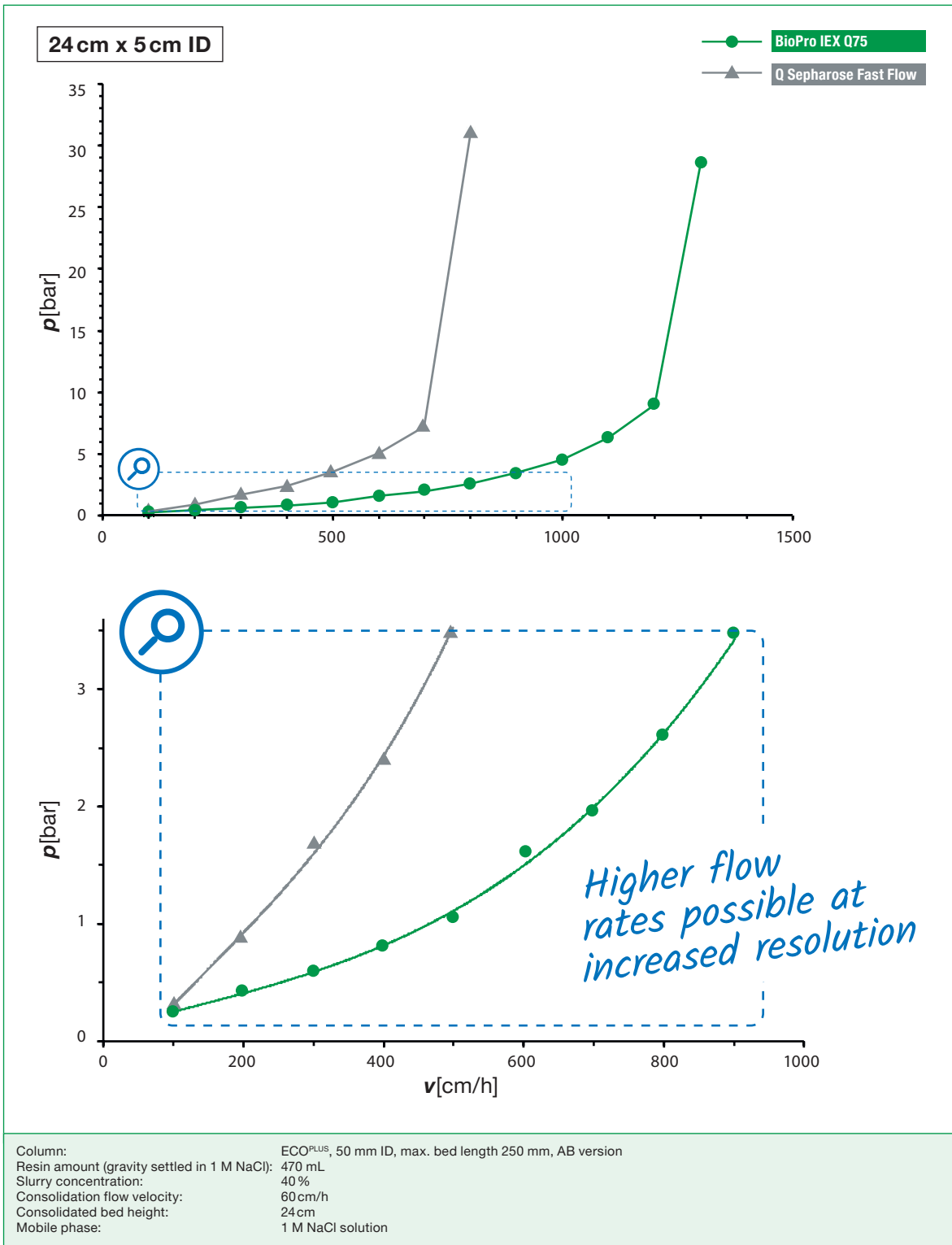


**BioPro IEX S75 and Q75 maintain their binding capacity even after 100 CIP cycles.  
BioPro IEX resins show excellent alkaline CIP stability.**



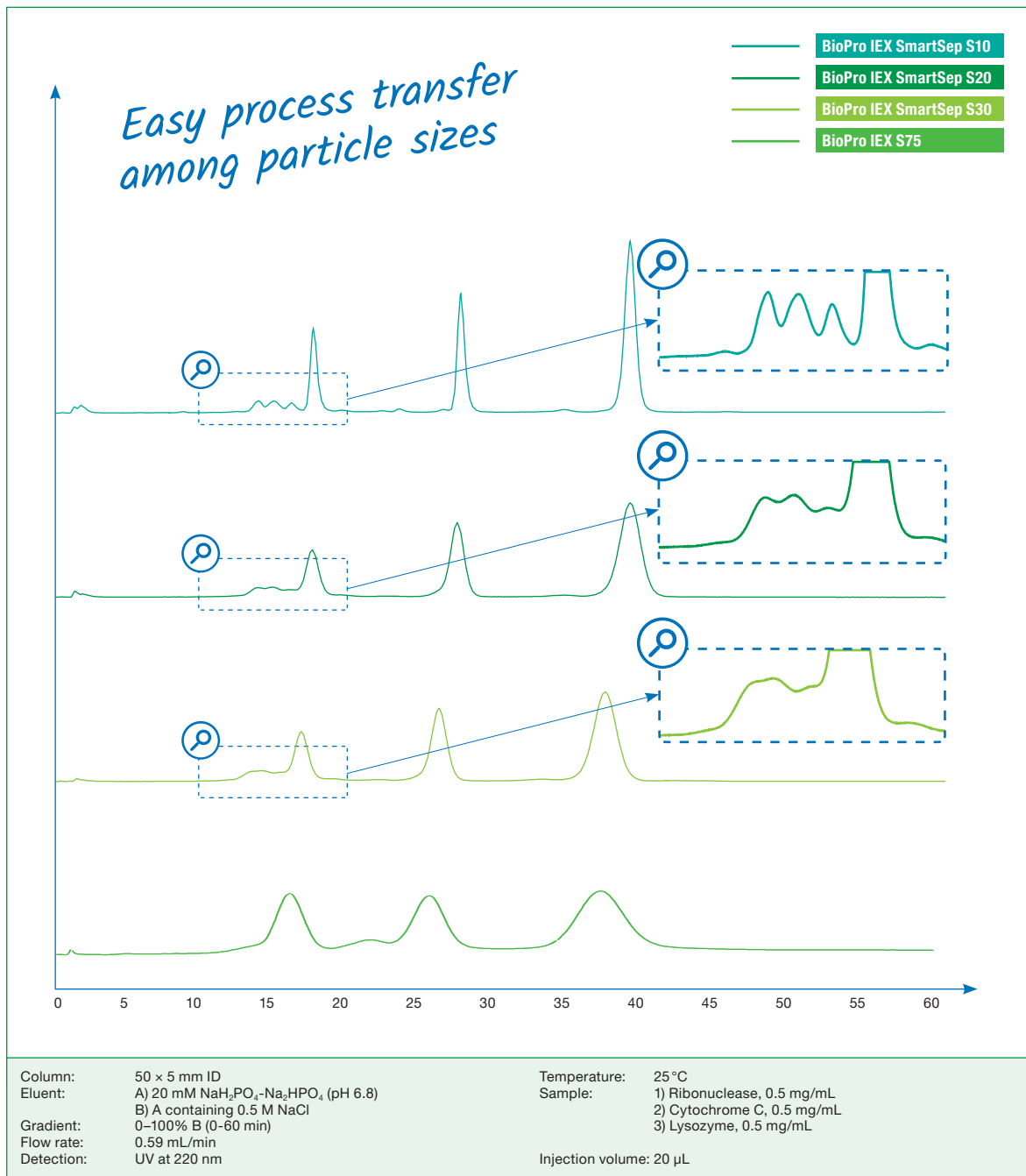
**BioPro IEX SmartSep S30 and Q30 maintain their binding capacity even after 100 CIP cycles.  
BioPro IEX SmartSep resins show excellent alkaline CIP stability.**

## Pressure-flow characteristics



The pressure-flow curve of BioPro IEX Q75 suggests reversible compression behaviour over a wide range of linear flow velocity. Despite using smaller particles (75  $\mu\text{m}$ ) compared to the 90  $\mu\text{m}$  particle size of the competitor's resin, BioPro IEX Q75 shows much better pressure flow characteristics. Higher flow rates can be applied to increase the throughput.

- Improved resolution
- Higher flow rates possible
- Increased productivity



One of the advantages of YMC's BioPro IEX resins is its full scalability. This property provides an identical chromatographic behaviour across all particle sizes. This is beneficial, as separation and fractionation can be optimised on the analytical scale. Depending on the required resolution the optimal bead size can be selected. Then, the process can be reliably transferred to the production scale. This enables highly flexible implementation of BioPro IEX resins, resulting in a perfectly tailored solution.

An illustrated example is depicted below for the three enzymes ribonuclease, cytochrome c and lysozyme. This shows that the separation of the main peaks remains stable across the four different particle sizes. If the highest resolution is required, 10 µm particles are the optimum choice. 10 µm particles allow the isolation of trace impurities.

During a capturing process the 75 µm material demonstrates adequate separation. The three main peaks are well separated.





# Specifications and Ordering information



## BioPro IEX for Capture

| BioPro IEX Series        | BioPro IEX Q75                                    | BioPro IEX S75                  |
|--------------------------|---|---------------------------------|
| Ion exchange type        | strong anion exchanger                            | strong cation exchanger         |
| Charged group            | -R-N <sup>+</sup> (CH <sub>3</sub> ) <sub>3</sub> | -R-SO <sub>3</sub> <sup>-</sup> |
| Matrix                   | Hydrophilic polymer beads                         |                                 |
| Pore size                | Porous  |                                 |
| pH Range                 | 2–12  |                                 |
| Compression factor       | 1.05–1.15   |                                 |
| Particle size            | 75 µm   |                                 |
| Pressure resistance      | 0.3MPa  |                                 |
| Typical flow rate        | 200–1000 cm/hr<br>Max. 2000 cm/hr                 |                                 |
| Ion-exchange capacity    | min. 0.10 meq/ml-resin                            |                                 |
| Dynamic binding capacity | min. 160 mg/ml-resin (BSA)                        | min. 160 mg/ml-resin (lysozyme) |

Regulatory support file available under non-disclosure agreement.  
Used in validated cGMP-manufacturing processes.

Customised material available on request.  
DMF registered with FDA.

## BioPro IEX SmartSep for intermediate purification and polishing

| BioPro IEX Series        | BioPro IEX SmartSep Q10                           | BioPro IEX SmartSep Q20              | BioPro IEX SmartSep Q30 | BioPro IEX SmartSep S10              | BioPro IEX SmartSep S20              | BioPro IEX SmartSep S30 |
|--------------------------|---|--------------------------------------|-------------------------|--------------------------------------|--------------------------------------|-------------------------|
| Ion exchange type        | strong anion exchanger                            |                                      |                         | strong cation exchanger              |                                      |                         |
| Charged group            | -R-N <sup>+</sup> (CH <sub>3</sub> ) <sub>3</sub> |                                      |                         | -R-SO <sub>3</sub> <sup>-</sup>      |                                      |                         |
| Matrix                   | Hydrophilic polymer beads                         |                                      |                         |                                      |                                      |                         |
| Pore size                | Porous  |                                      |                         |                                      |                                      |                         |
| pH Range                 | 2–12  |                                      |                         |                                      |                                      |                         |
| Compression factor       | 1.05–1.15   |                                      |                         |                                      |                                      |                         |
| Particle size            | 10 µm   | 20 µm                                | 30 µm                   | 10 µm                                | 20 µm                                | 30 µm                   |
| Pressure resistance      | Regular use:<br>3 MPa<br>Max.: 4 MPa              | Regular use:<br>2 MPa<br>Max.: 3 MPa |                         | Regular use:<br>3 MPa<br>Max.: 4 MPa | Regular use:<br>2 MPa<br>Max.: 3 MPa |                         |
| Typical flow rate        | 200–1000 cm/hr<br>Max. 2000 cm/hr                 |                                      |                         |                                      |                                      |                         |
| Ion-exchange capacity    | min. 0.08 meq/ml-resin                            |                                      |                         |                                      |                                      |                         |
| Dynamic binding capacity | min. 100 mg/ml-resin (BSA)                        |                                      |                         | min. 100 mg/ml-resin (lysozyme)      |                                      |                         |

## Screening kits and test samples

### Screening kits and bulk samples for media selection and method development

YMC offers a number of ion exchange screening kits based on 1 mL or 5 mL columns and also bulk resin samples for testing. This provides a significant advantage and efficiency in resin screening and purification method development.

#### 1 ml Type (26 x 7.0 mm ID)



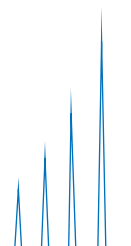
- Resin screening
- Purification method development

#### 5 ml Type (26 x 15.6 mm ID)



- Purification method development
- Loadability studies

*Please contact us to order your free bulk resin samples for testing.*



### Availability

- Large production capacity for YMC's IEX resins
- Lot sizes up to 400 L available
- Short delivery time even for large quantities
- Full compliance with GMP requirements

### Strong anion exchanger: BioPro IEX Q

| Product                 | Particle Size | Code    | Pack Sizes* |        |     |     |      |      |
|-------------------------|---------------|---------|-------------|--------|-----|-----|------|------|
|                         |               |         | 50 ml       | 250 ml | 1 L | 5 L | 10 L | 20 L |
| BioPro IEX SmartSep Q10 | 10 µm         | QSA0S10 | ✓           | ✓      | ✓   | ✓   | ✓    | ✓    |
| BioPro IEX SmartSep Q20 | 20 µm         | QSA0S20 | ✓           | ✓      | ✓   | ✓   | ✓    | ✓    |
| BioPro IEX SmartSep Q30 | 30 µm         | QSA0S30 | ✓           | ✓      | ✓   | ✓   | ✓    | ✓    |
| BioPro IEX Q75          | 75 µm         | QAA0S75 | ✓           | ✓      | ✓   | ✓   | ✓    | ✓    |

\* Larger or customised pack sizes are available on request.

### Strong cation exchanger: BioPro IEX S

| Product                 | Particle Size | Code    | Pack Sizes* |        |     |     |      |      |
|-------------------------|---------------|---------|-------------|--------|-----|-----|------|------|
|                         |               |         | 50 ml       | 250 ml | 1 L | 5 L | 10 L | 20 L |
| BioPro IEX SmartSep S10 | 10 µm         | SSA0S10 | ✓           | ✓      | ✓   | ✓   | ✓    | ✓    |
| BioPro IEX SmartSep S20 | 20 µm         | SSA0S20 | ✓           | ✓      | ✓   | ✓   | ✓    | ✓    |
| BioPro IEX SmartSep S30 | 30 µm         | SSA0S30 | ✓           | ✓      | ✓   | ✓   | ✓    | ✓    |
| BioPro IEX S75          | 75 µm         | SPA0S75 | ✓           | ✓      | ✓   | ✓   | ✓    | ✓    |

\* Larger or customised pack sizes are available on request.

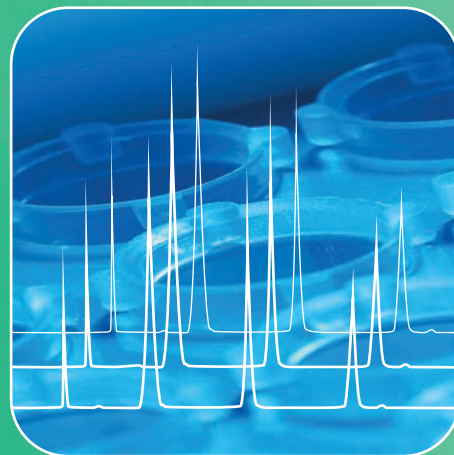
Regulatory support file available under non-disclosure agreement. Used in validated cGMP-manufacturing processes. Customised material available on request. DMF registered with FDA.

### Preparative screening kits

| Product name*                        | Particle Size | Pack size               | Column volume | Product code   |
|--------------------------------------|---------------|-------------------------|---------------|----------------|
| BioPro IEX Q75                       | 75 µm         | 5 / pack                | 1 mL          | BPQAA0S75-01PK |
|                                      |               |                         | 5 mL          | BPQAA0S75-05PK |
| BioPro IEX SmartSep Q30              | 30 µm         | 5 / pack                | 1 mL          | BPQSA0S30-01PK |
|                                      |               |                         | 5 mL          | BPQSA0S30-05PK |
| BioPro IEX SmartSep Q20              | 20 µm         | 5 / pack                | 1 mL          | BPQSA0S20-01PK |
|                                      |               |                         | 5 mL          | BPQSA0S20-05PK |
| BioPro IEX S75                       | 75 µm         | 5 / pack                | 1 mL          | BPSPA0S75-01PK |
|                                      |               |                         | 5 mL          | BPSPA0S75-05PK |
| BioPro IEX SmartSep S30              | 30 µm         | 5 / pack                | 1 mL          | BPSSA0S30-01PK |
|                                      |               |                         | 5 mL          | BPSSA0S30-05PK |
| BioPro IEX SmartSep S20              | 20 µm         | 5 / pack                | 1 mL          | BPSSA0S20-01PK |
|                                      |               |                         | 5 mL          | BPSSA0S20-05PK |
| IEX Selection Kit<br>Q75/S75/Q30/S30 | 30 µm, 75 µm  | 4 / pack<br>1 per resin | 1 mL          | BPSIA0S99-01PK |
|                                      |               |                         | 5 mL          | BPSIA0S99-05PK |

\* Other screening kits are available on request

# More about YMC

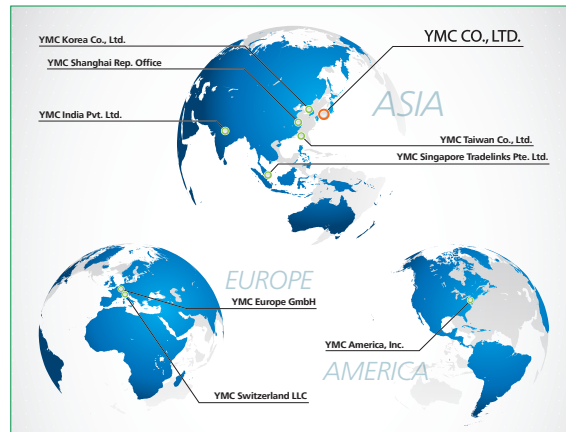




### Fully Integrated Manufacturing

YMC operates a fully integrated manufacturing process for the BioPro IEX resins. This process includes the manufacture of the base beads and the modification for the IEX functionality.

This gives YMC complete traceability and control over the entire manufacturing process. YMC can guarantee reliable product supplies for today and in the future.



### Global Supplies

BioPro IEX resins are available worldwide through a dedicated support network headed by YMC operations in Japan, the US and in Europe to ensure easy, reliable method transfer between research and production sites across the world. Batch sizes up to 400 L are available, in many different packaging formats. Individual supply agreements are common for validated processes.



### Quality Control

The rigorous quality control procedures set by YMC start with the manufacturing of the base material. Every batch is evaluated for compliant reproducibility to ensure consistent performance. The YMC facilities are certified according to ISO 9001. Quality agreements are common for validated processes. The manufacturing site is regularly audited successfully by numerous pharmaceutical companies all around the globe.



### Regulatory Support

Since all YMC processes and working procedures are thoroughly monitored and documented, YMC always has been in perfect condition to prove full compliance with the requirements. The BioPro IEX resins are supplied with the full technical documentation to show compliance with all applicable regulations. The resins are registered for Drug Master Files and are in use for GMP production of biotherapeutics.



## More about YMC – YMC glass columns

Ideally suited for use with BioPro IEX stationary phases:  
Glass columns made by YMC for biochromatography



### ECO columns

Glass columns for low and medium pressure applications

Inner diameter: 10–80 mm  
Column volumes: 0–5 L

- Easy piston adjustment
- Heating/cooling jacket for temperature sensitive applications
- 1 m long glass bodies for SEC applications



### ECO<sup>PLUS</sup> columns

Glass columns for medium and high pressure applications

Inner diameter: 5–50 mm  
Column volumes: 0–1 L

- Easy assembly with Quick-Lock system
- Faster runs due to increased pressure limits
- Improved reproducibility due to calibrated glass body



### YMC Pilot<sup>PLUS</sup>

Glass columns for pilot scale BioLC applications

Inner diameter: 0–200 mm  
Column volumes: 0–25 L

- Bubble-free column packing due to unique drain function
- Easy unpacking with removable column body
- 100% biocompatibility

### Prepacked Glass Columns

Save time and purchase a prepacked glass column

You may choose from services which include packing of

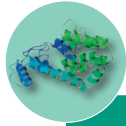
- New ECO and ECO<sup>PLUS</sup> columns in standard and custom dimensions
- Your used ECO or ECO<sup>PLUS</sup> columns
- BioPro IEX resins and other stationary phases



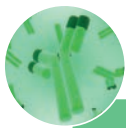
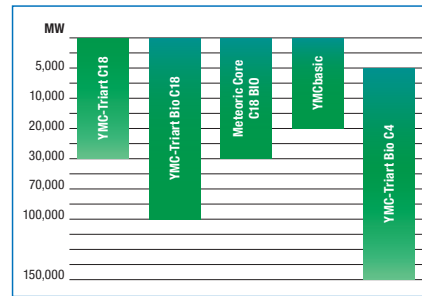
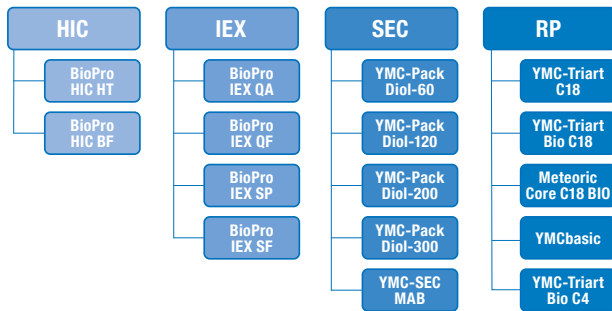
Did you know that you can also...  
... contact us for on-site packing support?  
... learn how to pack a column for yourselves in a YMC seminar?

For further information please contact YMC:  
Phone: +49 (0)2064 427-0  
Email: [info@ymc.eu](mailto:info@ymc.eu)

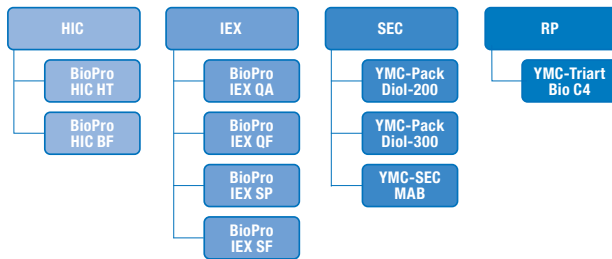
# More about YMC – YMC columns for biomolecules



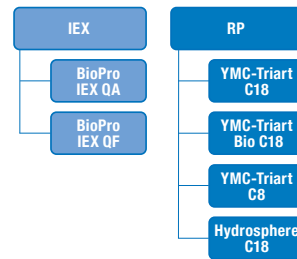
## Proteins / Peptides



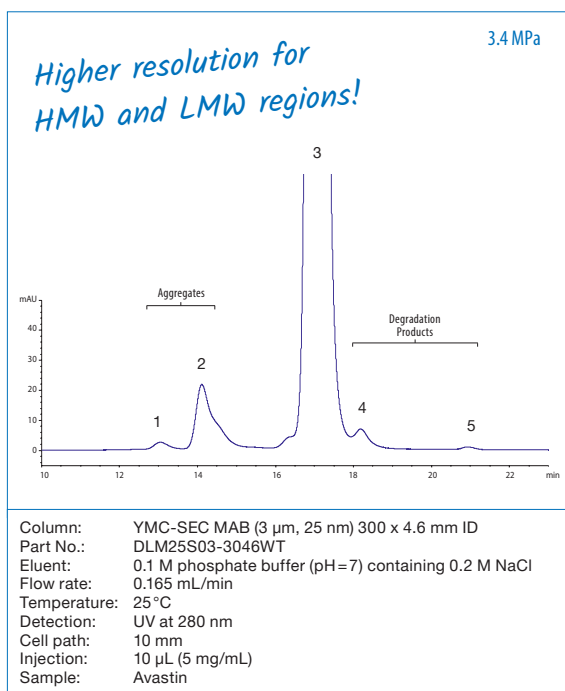
## (Monoclonal) Antibodies



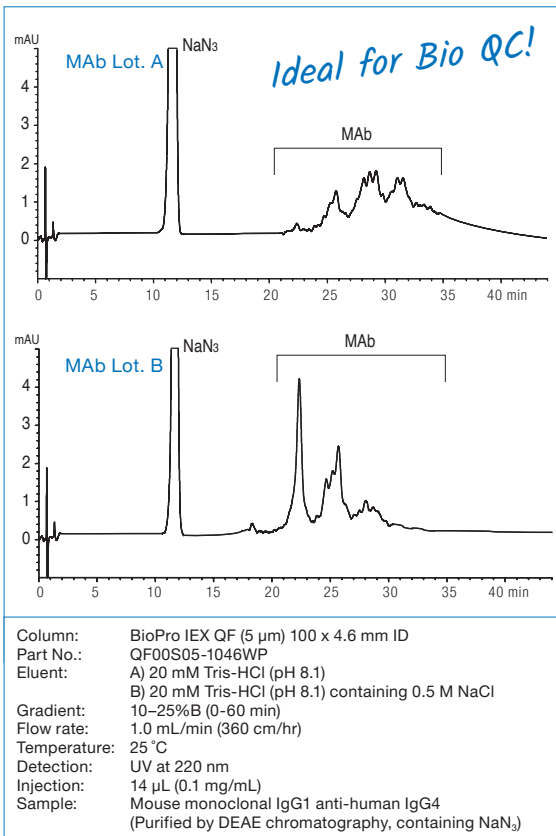
## Oligonucleotides / Nucleic Acids



### YMC-SEC MAB – Simultaneous analysis of antibodies, fragments and aggregates

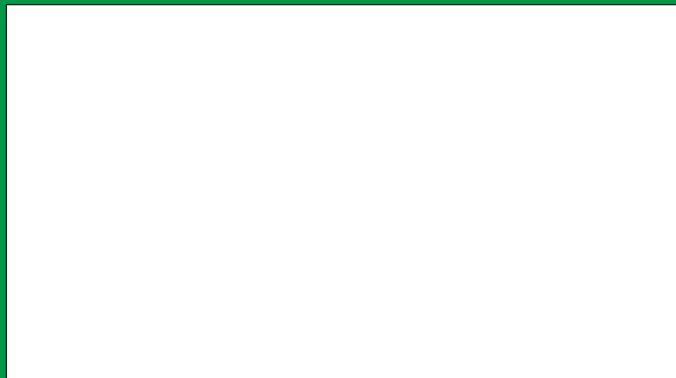


### BioPro IEX Columns - Outstanding resolution and excellent reproducibility





Your local distributor:



**YMC Europe GmbH**

Schöttmannshof 19  
D-46539 Dinslaken  
Germany  
Phone +49(0)2064 427-0, Fax +49(0)2064 427-222  
[www.ymc.eu](http://www.ymc.eu)

**YMC Schweiz GmbH**

Im Wasenboden 8  
4056 Basel  
Switzerland  
Phone +41(0)61 561 8050, Fax +41(0)61 561 8059  
[www.ymc-schweiz.ch](http://www.ymc-schweiz.ch)

**YMC CO., LTD.**

YMC Karasuma-Gojo Bld. 284 Daigo-cho,  
Karasuma Nishiiru Gojo-dori Shimogyo-ku,  
Kyoto 600-8106 Japan  
Phone +81(0)75 342 4515, Fax +81(0)75 342 4550  
[www.ymc.co.jp](http://www.ymc.co.jp)